МИНИСТЕРСТВО ОБРАЗОВАНИЯ И НАУКИ РОССИЙСКОЙ ФЕДЕРАЦИИ

Государственное образовательное учреждение высшего профессионального образования

УЛЬЯНОВСКИЙ ГОСУДАРСТВЕННЫЙ ТЕХНИЧЕСКИЙ УНИВЕРСИТЕТ

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Профессиональное развитие будущих инженеров-строителей средствами иностранного языка

Лексический практикум по английскому языку для студентов, обучающихся по специальности 270109.65 «Теплогазоснабжение и вентиляция»

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Пособие структурно состоит из основных тематических циклов строительной направленности и предназначено для обучения английскому языку студентов специальности 270109.65 «Теплогазоснабжение и вентиляция».

Содержание каждого цикла разработано в соответствии с программой курса иностранного языка для технических вузов ГОС ВПО и методически обосновывается. Скрупулезно подобраны тексты по основным разделам строительного производства, что соответственно определяет лексическое наполнение учебного пособия. Словарь определяется содержанием ситуаций профессионального общения и удачно зафиксирован в заданиях. Разрешение проблем презентации, активизации и закрепления языкового материала обеспечивает достаточный уровень языковой компетенции студентов.

Теоретическая часть пособия представляет собой обзор новейших разработок ведущих российских педагогов, а также является практической рекомендацией для повышения качества обучения и организации учебного процесса.

Цель пособия – развитие навыков коммуникации и технического перевода в условиях будущей профессиональной деятельности.

Пособие может представлять интерес для специалистов в области педагогики и методики преподавания, а также для преподавателей английского языка вузов и ссузов и использоваться аспирантами в качестве подготовки для сдачи кандидатского минимума по английскому языку.

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Оглавление

Введение

Глобальные изменения в информационной, профессиональной, коммуникативной и других сферах современного общества требуют корректировки содержательных, методических и технологических аспектов образования, а также пересмотра прежних ценностных приоритетов, целевых установок и педагогических средств. Главной целью образовательного процесса является всестороннее развитие личности, способной адаптироваться к условиям быстроменяющегося мира, проявляя при этом свою автономность и креативность.

В условиях реформации российской системы образования необходимо искать новые методические решения проблем современного обучения. Несмотря на обилие образовательных программ и технологий вопросы повышения качества обучения стоят чрезвычайно остро.

В процессе современной глобализации и интеграции, предусматривающей межнациональное общение, знание иностранных языков просто необходимо. Состояние высшей школы, развитие международных отношений, направленность на гуманизацию образования требуют сегодня пересмотра ценностного отношения к изучению иностранного языка в техническом вузе. Становится актуальным создание условий для формирования образовательной среды, в которой каждый интеллигентный человек, специалист мог бы овладеть иностранным языком.

При обучении иностранным языкам особое значение приобретают принципы профессиональной направленности и активности, что свидетельствует о совершенствовании умений студентами владеть своими эмоциями в процессе общения, устанавливать контакт с аудиторией, адекватно реагировать на изменяющуюся обстановку, повышать самоорганизацию в процессе работы, отрабатывать приемы самоконтроля и самокоррекции и развивать свой творческий потенциал.

Данное исследование представляет собой попытку рассмотреть профессиональное развитие личности, а также процесс совершенствования профессионально важных качеств будущего специалиста – инженера-строителя в аспекте изучения иностранного языка в неязыковом вузе.

Модульно-блочная модель, представленная в пособии, основана на базе широко распространенного в последнее время знаково-контекстного

обучения, основанного А. А.Вербицким: **блок «А»** понимается нами как **информационный**, содержащий формы учебной деятельности академического типа**, блок «В» (рефлексивный)** отвечает содержанию квазипрофессиональной деятельности, **блок «С» (исследовательский)** направлен на развитие учебно-профессиональной деятельности с элементами эксперимента. И наконец, **блок «D» (креативный)** – с заданиями повышенной сложности, предназначен для совершенствования творческих способностей обучаемых. Таким образом, обучение осуществляется как на репродуктивном, так и на продуктивном уровнях.

В пособии также предложены тексты для дополнительного чтения, позволяющие расширить познавательный кругозор в пределах изучаемого направления.

Словарь символов и специальный терминологический русско-английский словарь в приложении представляют собой вспомогательные элементы совершенствования иноязычной коммуникативной деятельности.

Часть I.

Теоретическое обоснование профессионального развития будущих инженеров-строителей на базе общенаучных дисциплин

Сложившиеся социальные отношения, состояние науки и техники и уровень научного мышления оказывают влияние на моральные принципы и требования, предъявляемые обществом к личности. Оказывая воздействие на развитие человека, процесс воспитания и образования формирует научный, технический, нравственный и культурный потенциал общества. На современном этапе задачей высшего профессионального образования становится подготовка специалиста, готового к успешной мотивированной профессиональной деятельности, которая бы удовлетворяла его материальные запросы, способствовала реализации его творческих проявлений и соответствовала социально-экономическим интересам общества.

Выпускник технического вуза должен быть подготовлен к экономически целесообразной деятельности в условиях современного производства, будучи при этом зрелой, нравственно сформированной личностью с развитым интеллектом, со сложившимся научным мировоззрением и мышлением.

Учитывая заинтересованность государства в быстрой отдаче и максимальном получении прибыли от вложений в образовательную сферу, следует признать экономически обоснованной установку наших вузов на узконаправленную подготовку специалистов, способных к продуктивной деятельности с минимальным периодом адаптации к условиям конкретного производства. Но общество, заинтересованное в повышении интеллектуального и культурного уровня граждан, не должно стремиться к упрощению содержательной стороны образования. Изучение гуманитарных и общенаучных дисциплин, научно-теоретическая деятельность расширяют эрудицию, формируют социальную позицию и развивают логическое и научное мышление. Поэтому говоря о качестве подготовки современного инженера, следует создать оптимальную систему высшего профессионального образования за счет реорганизации содержательных основ с точки зрения перераспределения учебной нагрузки с акцентом на увеличение объема самостоятельной внеаудиторной работы студентов с разработкой

методических приемов и форм ее проведения. Помимо развития интеллекта и логического мышления, студентов следует обучить навыкам самостоятельной работы по расширению, углублению и совершенствованию своих научных знаний для дальнейшего повышения профессиональной эрудиции и квалификации в условиях быстрого обновления технологий.

Сочетание гуманитарных и технических дисциплин позволит ознакомить студентов с современными теоретическими изысканиями и методами научного анализа, с новейшими производственными технологиями, что сформирует у них четкое представление о состоянии и перспективах развития науки и техники в сфере их будущей специальности. Использование приемов индивидуализации в обучении поможет избежать разноуровневой подготовки, а обеспечение условий для развития технического творчества и научно - исследовательской деятельности в вузе повлечет за собой осуществление инновационной деятельности в будущей специализации.

Глава 1. Социально-педагогические основания профессионального развития личности

Профессионализм включает в себя целый комплекс уровней его организации (биологический, психический, социальный, духовный), что дает нам право рассматривать профессиональную деятельность в пространстве общей культуры. Взаимозависимость профессиональных достижений и разностороннего интеллектуального развития очевидна и объясняется единством личности – органической взаимосвязью ее физических, психических, духовных систем и взаимодействием общих и специальных навыков и умений. Согласно концепции профессионального развития личности, разработанной Е.И.Роговым, «под **профессионализмом** следует понимать совокупность изменений, происходящих в человеке в процессе овладения и длительного выполнения деятельности, обеспечивающих качественно новый более эффективный уровень решения сложных профессиональных задач в особых условиях» [5, с. 64]. Мы же больше склоняемся к трактовке понятия **профессионализма** Н. В.Кошелевой «как гарантированного успешного выполнения деятельности как в стандартных, так и в изменяющихся условиях» [7, с. 9], взяв за основу трактовку И. А. Зайце-

вой **профессиональной компетентности** как «системы специальных знаний, умений и навыков, опыта выполнения профессиональных действий, а также совокупности личных, качеств, определяющих способы выполнения профессиональных функций» [4, с. 89].

Исследование профессионального развития личности как комплекса уровней ее организации доказало необходимость ее расценивания в качестве междисциплинарного знания. В педагогике мы рассматриваем процессы обучения и воспитания человека на разных возрастных этапах. Психология делает упор на внутренние ресурсы личности. Социология дает нам возможность рассмотреть некоторые социальные особенности человеческого существования: этапы, закономерности, участников процесса социализации. Философия способствует развитию мышления. Культурология играет важную эстетическую роль в процессе формирования идеала профессиональной деятельности. Наконец, иностранный язык развивает коммуникативную функцию, а также страноведческий кругозор для дальнейшего развития производственных отношений на мировом уровне.

Дифференцированный подход заставляет учитывать внутренние ресурсы для решения проблем учебно-воспитательного процесса. Принцип гуманизации диктует построение и реализацию процесса профессионализации личности, учитывая ее возрастные особенности, ценностные ориентации и уровень подготовленности к трудовой деятельности. Принцип последовательного моделирования целостного содержания профессиональной деятельности в процессе обучения в техническом вузе осуществляется путем постепенного насыщения учебного процесса элементами профессиональной деятельности через преподавание как специальных, так и общеобразовательных дисциплин.

Итак, профессиональная подготовка в вузе, являясь глубоко специализированным процессом, должна всесторонне развивать личность, естественно не без учета ее индивидуальных способностей и возможностей.

Единство общеобразовательного и специального компонентов профессионального развития заключается во взаимной зависимости их содержания, а степень их соотношения закономерно изменяется на различных стадиях профессионального совершенствования.

Говоря о стадиях **профессионального роста**, мы избираем модель Супера. Он разделил профессиональный путь человека на 5 характерных

этапов, во время которых личность находится в непрерывном поиске и развивает свою профессиональную Я-концепцию. Подробно рассмотрим их:

1. Этап роста (от рождения до 14 лет). В процессе развития Я-концепции ребенок проигрывает различные роли, проявление интереса к которым может повлиять на выбор будущей профессии.

2. Этап исследования (от 15 до 24 лет). Происходит самоанализ собственных возможностей, интересов, потребностей и способностей, по результатам которого молодые люди подходят к выбору профессии.

3. Этап упрочения карьеры (от 25 до 44 лет). Наблюдается тенденция к сохранению выбранного рода занятий. Работники стараются занять прочное положение в выбранной ими сфере деятельности, совершенствуют свое профессиональное мастерство.

4. Этап сохранения достигнутого (от 45 до 64 лет). На пике своей профессиональной карьеры, работники стараются сохранить достигнутое положение на службе.

5. Этап спада (после 65лет). Отмечается процесс размышления о продуктивном периоде профессиональной деятельности. Характер работы меняется в связи со снижением физических и умственных возможностей человека. Трудовая деятельность прекращается.

Конечно, характерные черты вышеуказанных этапов не могут соответствовать трудовой биографии абсолютно всего рабочего населения страны. Современная социально-экономическая реальность существенно сместила акценты, ориентируя личность на самореализацию в профессиональной сфере ради достижения собственного материального благосостояния и развития общества. В этой связи **профориентация** в аспекте междисциплинарных знаний становится системой взаимодействия личности и государства.

Глава 2. Знаково-контекстное обучение в аспекте совершенствования языковых и профессиональных компетенций будущего специалиста

Под **знаково-контекстным обучением** мы понимаем форму активного обучения, ориентированную на профессиональную подготовку учащихся высшей школы и реализуемую посредством системного использо-

вания профессионального контекста. Данная концепция была разработана А.А.Вербицким в 1991году. Согласно особенностям этой методики контекстное обучение опирается на теорию деятельности, в соответствии с которой усвоение социального опыта осуществляется в результате активной деятельности субъекта. «Основной единицей работы преподавателя и студентов становится здесь не порция информации, а ситуация в ее предметной и социальной определенности; деятельность обучающихся приобретает черты, в которых проявляются особенности учебной и будущей профессиональной деятельности» [2, с. 2].

«Основные **принципы контекстного обучения** по Вербицкому:

- педагогическое обеспечение личностного включения студента в учебную деятельность;

- последовательное моделирование в учебной деятельности студентов целостного содержания, форм и условий профессиональной деятельности специалистов;

- проблемность содержания обучения и процесса его развертывания;

- адекватность форм организации учебной деятельности студентов целям и содержанию образования;

- ведущая роль совместной деятельности, межличностного взаимодействия и диалогического общения субъектов образовательного процесса (преподавателя и студентов между собой);

- педагогически обоснованное сочетание новых и традиционных педагогических технологий;

- единство обучения и воспитания личности профессионала» [11, с. 57].

В знаково-контекстном обучении воплощаются принципы активности личности, что непосредственным образом, оказывает влияние на моделирование форм и условий профессиональной деятельности специалистов. Особое внимание здесь следует обратить на реализацию поэтапного перехода студентов к базовым формам деятельности более высокого ранга: от учебной деятельности к квазипрофессиональной, и далее к учебно-профессиональной и наконец, к профессиональной. Преподавание общенаучных дисциплин предлагается трактовать в контексте профессиональной деятельности, избрав сочетание разнообразных форм, методов и средств традиционного и активного обучения.

Рассмотрим знаково-контекстный подход на примере обучения иностранному языку в техническом вузе.

Информация в ходе обучения подается через «знаки» - то есть посредством *информативной составляющей:*

1) через объяснения преподавателем грамматического, страноведческого, общенаучного, или содержащего профессиональную специфику материала;

2) через индивидуальную или коллективную работу с учебными пособиями;

3) через работу на компьютере (в компьютерном классе);

и посредством *фонетической составляющей*:

1) через саму речь преподавателя, то есть путем непосредственного произнесения терминов и структур на иностранном языке;

2) через работу с аудио/видео материалами (в лингафонном и лингвистическом кабинетах).

Далее приведем алгоритм действий:

1. Введение и закрепление специальных терминов профессиональной направленности (согласно теме урока) на иностранном языке с переводом их на русский язык и с последующим объяснением их значения, используя наглядные средства. Это можно обозначить как «знак-значение-образ».
2. Усвоение специальных терминов на иностранном и русском языках с последующим разъяснением их профессионального назначения сначала на русском, а затем и на иностранном языках. Обозначим этап как «термин – знание – понятие».
3. Освоение профессиональных терминов на иностранном и русском языках в процессе выполнения лексических упражнений и специальных заданий различных типов согласно структуре: «термин – умение – смысл».
4. Присвоение профессиональных терминов на иностранном и русском языках в процессе их практического применения в различных видах деятельности по принципу «термин – навык – опыт».

Для ясности следует уточнить, что мы понимаем под **«усвоением»** – постижение сути, под **«освоением»** – выработку умений, навыков как

форм реализации знаний, и наконец, под **«присвоением»** – не только знания и умения, но и их применение в повседневной практике.

В процессе реализации вариативных форм и методов обучения, способствующих профессиональному развитию студентов средствами преподавания иностранного языка, мы развиваем *коллективную, креативную, рефлексивную и проектную виды деятельности*. Эти же виды деятельности развиваются и в ходе изучения технических дисциплин. Таким образом, целесообразно говорить о взаимовлиянии учебных дисциплин общенаучного и технического профиля.

Инженерную деятельность можно представить как единство трех типов деятельности: естественнонаучной (направленной на познание природы), технической (обеспечивающей создание технических объектов и систем) и социальной (ориентированной на познание закономерностей и запросов общества). Исходя из этого, общеевропейские стандарты, предусмотренные для аккредитации образовательных программ профессиональной подготовки к инженерной деятельности, описывают требования, предъявляемые к профессиональным и личностным компетенциям выпускников технических вузов по 6 разделам:

1) Знания (естественнонаучные и математические о новейших достижениях в определенной области техники и технологий, а также междисциплинарные знания в широком контексте инженерной деятельности).

2) Инженерный анализ (постановка и решение инженерных задач в новых возникающих сферах специализации, решение ранее неизвестных задач в условиях неопределенности и конкуренции).

3) Инженерное проектирование (способность применять инженерные знания для разработки и реализации проектов, удовлетворяющих заданным требованиям, в том числе в смежных областях, применяя творческий подход к разработке новых идеи и оригинальных методов).

4) Исследования (способность осуществлять поиск литературы и использовать базы данных и другие источники информации, планировать и проводить эксперименты, проводить аналитические исследования, критически оценивать их результаты).

5) Инженерная практика (способность осуществлять подбор и использование необходимого оборудования, инструментов и методов, соединять теорию и практику для решения инженерных задач, способность интегрировать знания из различных сфер деятельности для решения сложных практических задач).

6) Личностные компетенции, которые, по сути, являются профессионально важными качествами (понимание сущности профессии инженера и обязанности служить обществу, способность эффективно работать индивидуально и как член команды, владение иностранными языками, достаточное для общения при работе в международных командах, умение использовать различные методы эффективной коммуникации в профессиональной среде и в социуме, осведомленность в вопросах проектной деятельности, творческий поиск в рамках профессии, осознание необходимости и способности самосовершенствования).

Согласно вышеописанным стандартам, в процессе изучения дисциплин общенаучного плана (в частности, в процессе изучения иностранного языка) в неязыковом вузе развитие языковых компетенций происходит в аспекте развития профессиональных компетенций посредством постепенного поэтапного совершенствования информативного, творческого, проектного, аналитического, исследовательского и организационного компонентов. Разъясним, что под **«языковой компетенцией»** мы понимаем «реальность самого языка, представляющего собой многоуровневую систему, в которой выделяются в качестве основных уровней: фонемный, морфемный, лексический, синтаксический и текстовой. Каждый из них составляет особую подсистему языка, которая характеризуется составом однородных единиц (фонем, морфем, слов, предложений, текстом) и правилами, нормами их использования. Поскольку язык в целом представляет собой единство, то в реальной речи людей все эти подсистемы представлены во взаимосвязи. То есть, слово воспринимается в составе высказывания, звуки речи и морфемы усваиваются в составе слова, которое позже может участвовать в определенном высказывании, а высказывание понимается в контексте речи или в некой ситуации общения» [1, с. 65].

Поэтапно рассмотрим механизм продвижения от учебной деятельности к профессиональной:

На I этапе обучения иностранному языку студентов технических осуществляем учебную деятельность академического типа, сочетая семинарские (практические) занятия с элементами лекции.

На II этапе переходим к квазипрофессиональной деятельности, используя в обучении такие игровые формы, как диалог-ситуацию, интервью, конференцию-дискуссию по заданной проблеме, сценки как имитацию деловой игры и др.

На III этапе используем учебно-профессиональное направление, которое выражается в написании тематических рефератов, в выступлении с докладом по заданной проблематике на иностранном языке, в участии на студенческих внутривузовских, межвузовских и международных научных конференциях с последующей публикацией статей в сборниках по итогам конференций, участии в олимпиадах и конкурсах местного и регионального значения.

И наконец, на завершающем IV этапе совершенствуем профессиональную деятельность на практике, например, предприняв поездку на производственную практику в страну изучаемого языка в рамках образовательного проекта международного студенческого обмена с последующим написанием и защитой отчета, курсовой работы и сдачей проекта.

Глава 3. Применение модульных технологий для осуществления приемов дифференциации и индивидуализации в обучении иностранному языку

Необходимость применения **междисциплинарного подхода** объясняется усилением тенденции интеграции научных знаний, повышением требований к будущим специалистам, компетентным во всех смежных со специальностью областях. Таким образом, происходит уплотнение информационного поля, которое требует новых технологий систематизации знаний.

Современное образование отводит недостаточное количество аудиторных часов на изучение общенаучных дисциплин. В результате преподаватель стремится дать как можно больше материала, требуемого образовательными стандартами, закрепление которого вынуждено проходить во внеурочное время. Следовательно, своевременная целенаправленная

организация самостоятельной работы студентов для получения знаний даже по родственным дисциплинам должна способствовать их должному применению на практике в качестве научно-практических ориентиров для выполнения качественной познавательной и профессиональной деятельности. В данных условиях междисциплинарный подход, выражающий необходимость обобщенного учебного познания и целостности учебного процесса, основанный на идее междисциплинарных связей, приобретает особую актуальность. В образовательном процессе это представляется согласованием учебных дисциплин по родственным предметам с точки зрения общности трактовки изучаемых понятий, явлений, процессов и времени их изучения, которое способствует приобретению целостных интегративных знаний, обобщенных приемов учебной деятельности, в результате чего происходит ускорение темпа переработки и усвоения научной информации, устраняется дублирование. Таким образом, как пишет Прохорова О.Л., «**междисциплинарность** – есть тщательно разработанная взаимосвязь учебных предметов на основе их согласования и объединения по родственным основаниям, результатом которой является целостное интегративное знание, определяемое как знание, сформированное на основе взаимосвязи, взаимодействия, унификации элементов знаний различных предметных областей, ориентированных на профессиональную деятельность обучаемого» [9, с. 46].

В процессе изучения иностранного языка возможна трансформация знаний, умений и навыков из специальных дисциплин в гуманитарные, и наоборот, так как источником междисциплинарной информации в процессе педагогического управления самостоятельной работой являются несколько учебных дисциплин.

Таким образом, **междисциплинарная связь** нами рассматривается как «полифункциональный компонент, выполняющий образовательную, развивающую и конструктивную функции (А. В. Усова, Е. Ю. Никитина)» – утверждает О. Л. Прохорова [9, с. 48]. Недостаточная реализация междисциплинарного подхода в обучении приводит к разрыву между теоретическими знаниями обучаемых и их практическим применением, что, несомненно, снижает качество профессиональной подготовки и заметно продлевает период профессиональной адаптации в будущем.

Выбор **модульного подхода** объясняется тенденцией увеличения объема учебного материала, передаваемого на самостоятельное изучение, что требует обеспечения гибкости содержания обучения, приспособления к индивидуальным потребностям личности и уровню ее базовой подготовки. Проблема большого удельного веса самостоятельной работы обучаемых и недостатка делового общения в процессе изучения ими иностранного языка требует поиска таких форм и методов обучения, которые позволяют активизировать познавательную деятельность обучаемых**.**

«**Модульное обучение** предполагает высокую технологичность, четкую структуризацию содержания обучения, последовательное изложение теоретического материала с предъявлением всех элементов дидактической системы (целей, содержания, способов управления учебным процессом) в форме модульной программы, обеспечение учебного процесса методическим материалом и системой оценки и контроля усвоения знаний, позволяющей корректировать процесс обучения. Модульное обучение также предусматривает вариативность обучения, адаптацию учебного процесса к индивидуальным возможностям и запросам обучаемых» [9, с. 50].

Учебный модуль мы определяем, согласно трактовке О. Л. Прохоровой, как «автономную организационно-методическую структуру учебной дисциплины, которая включает в себя дидактические цели, специально отобранный комплекс учебных элементов (логически завершенных единиц учебного материала, составленных с учетом междисциплинарных связей), методическое руководство (включая дидактические материалы) и систему контроля, изучение которых обеспечивает формирование у обучаемых устойчивых знаний, развитие на их основе навыков и умений решения профессионально значимых задач, овладение эффективными способами и приемами осуществления учебно-познавательной деятельности в процессе педагогического управления самостоятельной работой обучаемых в течение полного обучающего цикла (от знакомства с целями обучения до контроля по модулю)» [9, с. 54.].

Рассмотрим основные характеристики модуля (по О. Л. Прохоровой):

1) «междисциплинарность (содержания модуля основывается на понимании того факта, что профессиональная деятельность носит целостный характер). Заданный характер модуля достигается за счет включения в содержание модуля комплекса иноязычных профессионально ориентиро-

ванных заданий (учебных коммуникативных ситуаций), максимально приближенных к естественной (аутентичной) среде, что, в свою очередь, способствует приобретению иноязычных знаний и опыта в условиях, моделирующих реальные ситуации социального взаимодействия и усвоения социально-культурных ценностей;

2) самостоятельность и целостность учебного модуля как организационно-методической структуры выражается в замкнутом цикле: каждый модуль имеет собственные цели обучения, специально отобранное содержание, соответствующие формы и методы обучения, систему текущего и итогового контроля; структурная целостность модуля представлена системой взаимосвязанных учебных элементов – введение в модуль, базовые модули, специализированные модули; контроль по модулю;

3) гибкость модуля является стержневой характеристикой модульной технологии и проявляется в ступенчатости модульной программы, возможности варьировать сложность, объем материала, последовательность его изучения в: зависимости от различных условий образовательного процесса;

4) профессионально-прикладная направленность модуля выражается в направленности деятельности обучаемого в процессе изучения иностранного языка на приобретение личностно значимого опыта, на создание личностного образовательного продукта, действенность и оперативность которого достигается за счет решения иноязычных профессионально ориентированных заданий, организации многократного повторения способов решения той или иной проблемной коммуникативной задачи в многочисленных вариантах предметно-коммуникативных ситуаций» [9, с. 53-54].

Таким образом, избрав **междисциплинарно-модульный подход**, «выступающий в качестве принципа работы с содержанием образования в целом, конкретной учебной информацией и учебной деятельностью, и предоставляющий свободное творческое пространство для выработки и реализации оптимального управленческого решения, а также рассматривающий обучаемого как субъект поэтапного процесса изучения учебных элементов конкретного модуля на основе междисциплинарной, задачной и профессионально-прикладной его характеристик» [9, с. 60], мы вносим в учебный процесс системообразующее начало и обеспечиваем его целост-

ность «за счет приобщения будущих специалистов к системному методу мышления, расширения области познания на основе выделения связей между элементами знаний из разных учебных дисциплин в качестве специальных объектов усвоения», а также оптимизируем учебный процесс (путем достижения целей обучения при наименьших затратах силы, времени, средств и путем обеспечения целостности, гибкости и высокой технологичности процесса обучения) с учетом индивидуальных потребностей личности и уровня базовой подготовки.

Учет индивидуальных потребностей личности в высшей школе требует осуществления **дифференциации** в формах работы со студентами. Одним из распространенных ее способов является руководство учебной деятельностью различных подгрупп студентов. Ю. К. Бабанский считает, что основным принципом дифференциации должна быть дифференциация помощи обучающимся со стороны преподавателя без существенного снижения сложности содержания. Если дифференцируется не только и не столько объем и сложность учебного материала, сколько помощь обучаемому, то такой подход позволяет любому обучающемуся достичь максимума возможностей в данный момент, что и соответствует критериям оптимизации его обучения.

Дифференциация по сложности заданий позволяет организовать учебно-познавательную деятельность студентов на иностранном языке с опорой на их реальные возможности, что создает благоприятные условия для развития в обучении. Только умелое сочетание коллективной, самостоятельной и индивидуальной работы с обучающимися на практических занятиях по иностранному языку обеспечивает надлежащую педагогическую действенность учебно-воспитательного процесса. Ориентация на развитие познавательных интересов личности требует, чтобы дифференциация обучения учитывала потребности каждого студента. Обучаясь в одной группе по единой программе, студенты могут усваивать иноязычный материал в различном объеме. Базовым критерием при этом является уровень обязательной подготовки по иностранному языку. На его основе формируются более высокие уровни овладения материалом. Такой вид дифференциации в последнее время получил название «уровневая».

В нашем понимании **уровневая дифференциация** – это такая организация учебного процесса, при которой каждый обучающийся имеет

право и возможность овладевать учебным материалом по программе на разном уровне (А – низком, В – среднем, С – не ниже базового). Уровень овладения находится в зависимости от его способностей и индивидуальных особенностей личности, при котором за критерий оценки деятельности обучающегося принимаются его усилия по овладению этим материалом, творческому его применению. Требования программы должны усложняться за счет углубления, расширения знаний, предусмотренных Государственным стандартом в расчете на способности студентов, а также на современные педагогические технологии. Эффективность уровневой дифференциации предполагает выполнение ряда условий:

- «четкое выделение уровней усвоения материала и разъяснение принципов данной системы обучающимся;

- соответствием между уровнями обученности и характером предъявляемых требований;

- последовательность в усвоении обучающимися учебного материала в переходе от одного уровня к другому;

- объективность в оценке выполнения студентами задач каждого уровня, а также открытость этой информации для всех членов студенческой группы;

- соблюдение принципа добросовестности при выборе уровня усвоения и формы отчетности» [4, с. 55-56].

В любой образовательной системе в той или иной степени осуществляется **дифференцированный подход**. **Технология уровневой дифференциации** представляет собой совокупность организационных решений, средств и методов дифференцированного обучения иностранному языку, охватывающих определенную часть учебного процесса. Особенностями данной технологии являются: блочная подача материала, работа с малыми группами на нескольких уровнях усвоения, создание учебно-методического комплекса.

Технология уровневой дифференциации обучения иностранному языку студентов технического вуза имеет несомненные преимущества, поскольку в данном случае исключается «уравниловка» и усреднение обучаемых. Взяв за основу базовый уровень иноязычной обученности, преподаватель разрабатывает ряд дополнений к программе этого уровня, увеличивая объем содержания для разноуровневых подгрупп (микро-

групп) и требования ко всем видам речевой деятельности, владению грамматическими и лексическими навыками. При этом углубление за счет способностей студентов, овладевающих соответствующими лексическими, грамматическими и речевыми навыками должно проходить за одинаковое количество часов. Студент начального уровня иноязычной обученности может получить дополнительные консультации по пройденному материалу, а студенту продвинутого уровня обученности стоит усложнить задачу с целью активизации приобретенных умений и навыков. Поскольку в группе уже нет традиционно слабых студентов, то преподавателю нет необходимости искусственно занижать общий уровень преподавания. Одновременно появляется возможность эффективно работать с обучающимися, плохо адаптирующимися к общественным нормам, а у «хорошо успевающих» студентов усиливается мотивация к приобретению более глубоких знаний. Таким образом, очевидны положительные качества: помочь слабому студенту обрести уверенность в своих силах и вдохновить его на выполнение поставленной задачи, а с другой стороны – активизировать творческий потенциал «сильного студента» и поддерживать в нем потребность самообразования. Так, мы предлагаем усвоение учебного материала по блокам «A», «B», «C» как приобретение необходимого уровня знаний и навыков, обязательного для прохождения зачета и сдачи экзамена с оценкой «удовлетворительно» или «хорошо». Усвоение материала по блоку «D» относится к дополнительному уровню приобретения знаний (уровню повышенной сложности), что дает возможность обучаемому получить на экзамене оценку «отлично».

Реализация любой педагогической технологии является процессом динамичным, поэтому преподаватель должен иметь возможность улучшать и изменять ее по мере необходимости.

Обозначив формирование **профессиональной иноязычной коммуникативной компетентности** основной целью профессиональной иноязычной подготовки будущего специалиста, мы подразумеваем его способность и готовность решать коммуникативные задачи в сфере профессиональной деятельности, выполнять поиск и анализ информации, необходимый для изучения зарубежного опыта, а также для работы с технической литературой и документацией в области выбранной специализации. Все это предполагает владение знаниями, практическими умениями и на-

выками, которые позволят будущему специалисту использовать иностранный язык как средство информационной деятельности, систематического пополнения своих профессиональных знаний, профессионального общения и профессиональной культуры в целом. Поскольку коммуникативная деятельность тесно связана с формированием профессионально-познавательных потребностей студентов, то при преподавании иностранного языка в техническом вузе таковыми выступают потребности в профессиональных технических знаниях и особенностей профессионального технического общения через овладение иностранным языком.

Рассмотрим профессиональную иноязычную компетентность как совокупность трех основных компонентов: «мотивационно-ценностного», «когнитивно-деятельностного» и «эмоционально-волевого» [8, с. 95-97]. Мотивационно-ценностный компонент рассматривает желание повысить свой языковой уровень для эффективного функционирования в различных ситуациях профессионального общения. Когнитивно-деятельностный компонент предполагает объединение иноязычных коммуникативных компетенций в сфере профессионально ориентированной деятельности и общие компетенции (лингвистические, социолингвистические, прагматические и др.) представляющие профессионально важные качества, способности и умения современного квалифицированного инженера. Эмоционально-волевой компонент связан с адекватной оценкой своих способностей и выработкой чувства собственной ответственности за успехи в учебной и будущей профессиональной деятельности.

Н. В. Патяева предлагает рассмотреть вышеуказанные компоненты согласно уровням сформированности профессионально-иноязычной компетентности:

на элементарном уровне:

мотивационно-ценностный компонент выражен:

слабой мотивацией и интересом к профессионально-иноязычной подготовке;

недостаточным осознанием значимости профессионально-иноязычной подготовки для будущей карьеры;

отсутствием навыков творческой деятельности на занятиях по профессиональной иноязычной подготовке.

Когнитивно-деятельностный компонент выражен:
умением пользоваться справочной литературой;
умением строить простые высказывания на темы, связанные с будущей профессиональной деятельностью;
умением заполнять анкеты, формуляры;
общей оценкой профессионально-речевых умений «удовлетворительно».
Эмоционально-волевой компонент выражен:
умением работать с научной литературой, обобщать факты, оценивать важность информации, прогнозировать развитие тенденций;
умением вести беседу на профессиональные темы с соблюдением речевых норм, принятых в стране изучаемого языка; высказывать свою точку зрения, используя аргументацию и эмоционально-оценочные средства;
умением четко и логично выражать свои мысли при написании делового письма или отчета;
общей оценкой профессионально-речевых умений «отлично».

на функциональном уровне:

мотивационно-ценностный компонент выражен:
устойчивой мотивацией и высоким уровнем интереса к профессионально-иноязычной подготовке;
осознанием значимости профессиональной иноязычной подготовки для будущей карьеры;
интересом к творческим видам деятельности на занятиях;
желанием работать с иноязычными Интернет-ресурсами.
Когнитивно-деятельностный компонент выражен:
умением пользоваться нормативно-технической документацией;
умением принять участие в беседе в ситуации профессионального общения, выразить свое мнение;
умением писать несложные письма делового характера;
общей оценкой профессионально-речевых умений «хорошо».
Эмоционально-волевой компонент выражен:
довольно высокой самооценкой студентами подготовленности к профессионально-иноязычной коммуникации;
значительной степенью уверенности при участии в профессионально важных видах речевой деятельности на иностранном языке;

желанием управлять своим собственным процессом обучения и использовать дополнительные ресурсы в профессиональной иноязычной подготовке.

на продвинутом уровне:

мотивационно-ценностный компонент выражен:

сильной мотивацией к профессиональной иноязычной подготовке и высокой степенью осознания ее значимости для эффективного функционирования в будущей профессиональной деятельности;

уверенностью в необходимости свободного владения иностранным языком для будущей карьеры;

особым интересом к творческим видам деятельности.

Когнитивно-деятельностный компонент выражен:

умением работать с научной литературой, обобщать факты, оценивать важность информации, прогнозировать развитие тенденций;

умением вести беседу на профессиональные темы с соблюдением речевых норм, принятых в стране изучаемого языка;

умением высказывать свою точку зрения, используя аргументацию и эмоционально-оценочные средства;

умением четко и логично выражать свои мысли при написании делового письма или отчета;

общей оценкой профессионально-речевых умений «отлично».

Эмоционально-волевой компонент выражен:

высокой самооценкой умений применять языковые знания в различных видах деятельности, связанных с будущей профессией;

уверенностью в большинстве ситуаций будущей профессиональной деятельности, требующих применения иностранного языка;

высокой степенью осознания своих текущих и будущих потребностей в образовании и желанием и умением управлять своим процессом обучения;

умением эффективно использовать дополнительные ресурсы при профессионально-иноязычной подготовке.

Формирование профессиональной иноязычной коммуникативной компетентности студентов технического вуза есть процесс образования и развития личности будущего специалиста. В техническом вузе, где студенты приобретают знания, умения и навыки своей будущей профессиональной деятельности, формирование профессиональной иноязычной

коммуникативной компетентности является специфическим по своему содержанию. Оно будет реализовываться в профессиональных видах деятельности, предполагая использование форм и методов обучения, адекватных этому виду деятельности и задачам формирования профессиональной иноязычной коммуникативной компетентности студента. В данном случае было бы необходимым рекомендовать использование популярных активных педагогических технологий, основанных на принципах ненавязчивого, ситуативно-игрового обучения (интерактивные методы обучения: «мозговой штурм», «аквариум», «круглый стол», «интервью», деловые игры, дискуссии, «обучение в сотрудничестве», метод проектов: игровое моделирование, микросценарии, метод интеграции новых информационных технологий: учебные аудио / видео конференции, деятельностная методика с обилием речевой практики, CASE-технологии и др.).

Реализация технологии уровневой дифференциации как средства формирования профессиональной иноязычной коммуникативной компетентности студентов технического вуза предполагает не только дифференциацию задач, но и дифференциацию условий выполнения этих задач, включая различную степень помощи со стороны преподавателя, вариативность возможности опоры на учебный материал, а также различные формы контроля за их выполнением. При организации дифференцированной работы в учебных группах по иностранному языку учет вариативных форм контроля преподавателем за речевой деятельностью и самоконтроля студентов служит критерием деления групп на подгруппы с целью планирования преподавателем дальнейшей учебной стратегии обучения.

Таблица 1

Критерии оценивания уровней развития коммуникативной компетентности Зайцевой И. А.

Уровни	Характеристика уровня
Низкий	- неумение выразить свое отношение к ситуации общения; - отсутствие средств выразительности речи; - неумение логично и последовательно строить свое высказывание; - авторитарная направленность поведения в обществе.
Средний	- низкий уровень информированности в области межличностного общения, но способность определить уровень информированности, симпатии и антипатии собеседника; - отсутствие вербальных средств общения или невыразительное их использование; - неуверенность в жестах, позе, мимике; неумение владеть голосом; неспособность управлять своим эмоциональным состоянием перед большой аудиторией и в ситуации конфликта; - стремление к установлению отношений сотрудничества с другими; - владение нормами литературного языка и следование им в поведении.
Высокий	- высокая степень информированности в области общения; - умение устанавливать контакт с группой и строить отношения взаимопонимания с каждым членом группы; - владение речевыми и невербальными средствами общения, с помощью которых обучающийся легко транслирует собственное расположение к собеседнику; - инициативная и непринужденная форма общения.

Глава 4. Ориентирующие основы содержания процесса обучения иностранному языку в техническом вузе

В условиях оптимизации обучения вопрос о содержании учебной программы стоит весьма остро, но определенно предпочтение отдается в пользу единства обучения и воспитания, а также повышению сознательности и самостоятельности студентов.

Содержание образовательного процесса представляет собой «специально отобранную и признанную обществом (государством) систему элементов объективизированного опыта, предлагаемую студенту вуза для усвоения» [11, с. 28]. Это также можно рассматривать как совокупность действий, выполняемых субъектом преподавания (преподавателем) и субъектами учения (учебной группой) для решения выбранных дидактических задач. Простейшими результатами обучения являются **знания (**«усвоенные или познанные индивидом, вербальные, образные, символические или операционные (манипулятивные) сведения, произвольно воспроизводимые или используемые индивидом в своей речи или действиях») [12, с. 103]**, умения** («уровни усвоения составного действия или деятельности, позволяющие индивиду осуществлять их осознанно и с необходимым уровнем качества» [12, с. 103], **навыки** («автоматизированное выполнение операций, не требующее постоянного контроля сознания» – [12, с. 102], и **убеждения** («знания или способы действия, осознанно выбранные субъектом в качестве эталонов для принятия решений или оценивания») – [12, с. 103].

Но в рамках государственных стандартов третьего поколения, обусловленных всеобщей европеизацией российского образования и переходом к компетентностной системе оценивания результатов обучения, требуется более строгое и четкое определение **уровней усвоения учебного материала** по каждой дисциплине. В связи с этим, рекомендуется использовать технологический подход, разработанный профессором Ю. Г. Фокиным, который под **уровнем усвоения** понимает «указание требований к усвоению любого элемента усвоения», обозначив следующие «уровни:

О – знать на уровне **ориентирования;**

Р – знать на **репродуктивном** уровне;

А – знать на **аналитическом** уровне;

С – знать на **системном** уровне;

Н – иметь **навыки** выполнения специфических операций;

М – уметь использовать инструкции, **методики;**

В – уметь **варьировать** изученное применение**;**

П – уметь осуществлять **поиск** средств для разрешения сформулированной проблемы (задачи);

Ф – уметь выявлять и **формулировать** проблему (главную задачу), подлежащую решению для выхода объекта из неблагоприятной ситуации» [12, с. 105].

Такой технологический подход универсален возможностью использовать любые **виды обучения** и любые **дидактические приемы** (как индивидуально, так и в их совокупности), например:

Информационно-вербальное – информация излагается только в словесной форме;

Информационно-логическое – изложение информации с ее пояснением и выделением логических связей;

Дискуссионное – усвоение информации в процессе ее обсуждения на дискуссиях и семинарах;

Информационно – опорное – сочетание изложения с построением опорного конспекта и многократным повторением изложенного;

Программированное – дозированная подача материала с учетом перехода на следующий уровень только после прохождения контроля предыдущего уровня;

Проблемное – рассмотрение проблемных ситуаций учения;

Проектное – стимулирование проектной деятельности в специально организованном проектном задании;

Ситуационное – создание ситуаций профессионального общения, требующих реализации междисциплинарного подхода;

Зрелищное – включение в обучение различных наглядных средств;

Тренирующее – многократное выполнение операций с целью выработки автоматического навыка их выполнения;

Погружающее – погружение субъекта учения в специально сформированную среду для формирования определенных навыков и качеств личности;

Экспертное – представление учебной информации в виде объекта для анализа, редактирования и экспертного оценивания.

Среди **форм обучения** наиболее эффективной назовем основную, **традиционную очную** как единственную форму непосредственного общения преподавателя и субъектов учения, поскольку освоение иностранного языка предполагает постоянную коммуникацию, особенно на начальном и среднем уровнях, а **дистанционное компьютеризированное обучение** с реализацией эпистолярно-электронного общения следует применять дополнительно.

«Структура управляемого усвоения материала не является произвольной» (как при работе в классе, так и при самостоятельной работе), а «определяется формой задания, которое формулирует преподаватель, участвующий в обучении» посредством своих действий, – как пишет Ю. Г. Фокин. Сосредотачивая внимание на деятельностно-ориентированных методах обучения, он представляет свою классификацию следующим образом:

1. Рассматривает «**восприятие информации**: **Образной, Знаковой, Формализованной, Текстовой и Контекстной».**
2. К типам **«использования информации»** относит: «**Наблюдение, Созерцание, Ориентирование, Запоминание, Анализ, Варьирование, Поиск** средств решения сформулированной проблемы и **Выявление** и формулирование проблемы для решения».
3. **«Реализацию результатов»** видит в: **«Переживаниях, Эрудиции, Целевом накоплении информации, Документировании, Управлении, Воспроизведении и Исполнении»** [12, с.162].

На основе этого профессор Ю. Г. Фокин считает необходимым выделить специфику заданий, «способствующих возникновению у субъекта учения результатов, связанных с освоением того или иного элемента деятельности» [12, с. 166]:

«Задания операционного типа» ориентируют студента именно на правильности исполнения операции и формирование знаний и навыков, возникающих при этом, нежели на результат.

«Задания избирающего типа» ориентируют студента на исполнение действий, осваиваемых в будущей профессиональной деятельности; они наиболее полезны для формирования ситуационных навыков.

«Задания реализующего типа» состоят в реализации студентом заданного плана», оценивание которого будет учитывать согласованность запланированных студентом операций.

«Задания планирующего типа» требуют от студента реализации заданного способа» и обоснованности составленного плана действий с оцениванием его качества.

«Задания стимулирующего типа» связаны с внешним направлением активности субъекта учения на определенный объект, который впоследствии может стать мотивом соответствующей деятельности».

«Задания мотивирующего уровня» обеспечивают осознание студентом соответствующей профессиональной потребности», выражающиеся в самооценке студентом результатов своей деятельности с учетом рецензионной характеристики преподавателя [12, с. 167-169].

Итак, согласно Закону РФ «Об образовании», статье 14 «Общие требования к содержанию образования», основными требованиями к содержанию образовательного процесс является его соответствие «поставленным целям, его необходимость и достаточность по полноте и уровню отраженного в нем объективизированного опыта для достижения целей», а также его соответствие психолого-педагогическим, общедидактическим требованиям, обеспечивающее его технологичность (реализуемость). Речь идет о том, чтобы отобранный материал был выстроен последовательно в соответствии с логикой обучения и развития, учитывал посильность его освоения студентом на заданном уровне при наличии имеющихся ограничений во времени обучения, условиям реализации образовательного процесса и т.д.» [11, с. 30-31]. Таким образом, неминуемо встает вопрос об элементах содержания образования и объеме учебного материала для усвоения на каждом конкретном занятии.

Учитывая классификационную ориентированность структуры образовательного процесса, под **единицей содержания образовательного процесса по специальности** понимаем **образовательный модуль**, а под **единицей содержания образовательного процесса по дисциплине** понимаем **учебный элемент.** То есть, единица содержания представляет собой некий фрагмент, который необходим для обеспечения изучения последующего материала. Таким образом, одним из учебных модулей при рассмотрении всего содержания образовательной программы подготовки

специалиста в области строительства может выступить иностранный язык, как учебная дисциплина, создающая своего рода фундамент для изучения специальных дисциплин. И здесь уже крайне важным аспектом, влияющим на результативные показатели качества обучения, будет наполнение данного учебного модуля и объем учебного материала. Эти вопросы всегда возникают перед преподавателем, и неоднозначно рассматриваются методистами. Мы не будем давать четких рекомендаций, поскольку понимаем различие уровней языкового познания обучаемых и уровней сложности изучаемого материала, но предложим вашему вниманию одну весьма интересную **гипотезу ограниченности объема усвоения** профессора Ю.Г. Фокина, который утверждает, что «для обеспечения усвоения учебного материала на уровне осознания логических связей и значимости отдельных положений на одно двухчасовое занятие можно выносить не более 20 единиц усвоения, а для обеспечения запоминания не более 5 единиц усвоения», понимая под единицей усвоения «любое логически завершенное определение, утверждение или описание, содержащее около 20 слов» [12, с. 148].

Глава 5. Развитие профессионально важных качеств будущего специалиста в процессе овладения английским языком

В программе дисциплины «иностранный язык» в вузах неязыковых специальностей Министерства Образования Российской Федерации и Государственном образовательном стандарте высшего профессионального образования по направлению «Строительство» курс иностранного языка носит коммуникативно-ориентированный и профессионально направленный характер и включает в себя следующие требования к минимуму содержания образовательной программы:

1) языковой материал:

фонетический (специфика артикуляции звуков, интонации, акцентации и ритма нейтральной речи в изучаемом языке; основные особенности полного стиля произношения, характерные для сферы профессиональной коммуникации; чтение транскрипции);

лексический (лексический минимум в объеме 4000 учебных лексических единиц общего и терминологического характера; понятие диффе-

ренциации лексики по сферам применения; понятия о свободных и устойчивых словосочетаниях, фразеологических единицах; понятие об основных способах словообразования);

грамматический (грамматические навыки, обеспечивающие коммуникацию общего характера без искажения смысла при письменном и устном общении; основные грамматические явления, характерные для профессиональной речи; понятия о стилях; основные особенности научного и технического стилей);

2) речевой материал:

говорение (диалогическая и монологическая речь с использованием наиболее употребительных грамматических средств в основных коммуникативных ситуациях неофициального и делового общения; основы публичной речи (устное сообщение, доклад);

аудирование (понимание диалогической и монологической речи в сфере бытовой и профессиональной коммуникации);

чтение (виды текстов по широкому и узкому профилю специальности);

письмо (виды речевых произведений: аннотация, реферат, деловое письмо, тезисы, частное письмо, биография и др.);

3) страноведческий материал (культура и традиции стран изучаемого языка, правила речевого этикета).

Вышеуказанные аспекты содержания обучения «соответствуют компонентам иноязычной коммуникативной компетенции (лингвистическому, прагматическому и социолингвистическому)», как утверждает Н. В Патяева [8, с. 106]. Руководствуясь новым социальным заказом, нашедшим свое отражение в компетентностной модели специалиста, мы также видим необходимость включения в содержание профессионально-иноязычной подготовки материала, способствующего формированию ключевых компетенций, которыми должен обладать современный специалист в области техники и технологии. Формирование и развитие в процессе обучения иностранному языку таких профессионально-важных для квалифицированного инженера-строителя качеств, способностей и умений, как «творческий подход к решению инженерных проблем, умение работать в команде, опыт проектной работы, умение пользоваться иноязычными Интернет-ресурсами в профессиональной области, овладение основными стратегиями обучения, необходимыми для продолжения обучения», опыт

аналитико-исследовательской деятельности с целью самокоррекции и совершенствования, должно быть заложено в содержательную основу образовательного процесса по дисциплине и повсеместно реализовываться (используя разнообразные средства и методы обучения и контроля). В таком случае, иностранный язык будет рассматриваться не как учебный предмет дополнительного общеразвивающего плана, а как вспомогательная профессиональная дисциплина, позволяющая будущему специалисту конкурировать на международном уровне.

Постановка и достижение описанных целей в курсе обучения иностранному (английскому) языку как универсальному языку международного общения повлечет за собой не только повышение мотивации к его изучению, а следовательно, и повышение качества иноязычной подготовки обучаемых, но и будет способствовать повышению общего уровня профильной подготовки будущего специалиста.

Заключение

Фундаментализация содержания образования достигается расширением и углублением междисциплинарных знаний специалиста, ориентированных на решение проблемных ситуаций в научной, проектировочной и предпринимательской деятельности; повышением уровня сформированности методов познавательной, профессиональной, коммуникативной и аксиологической деятельности; обеспечением синтеза естественнонаучного и гуманитарного знания. При этом многими учеными подчеркивается возрастание роли гуманитарной составляющей в подготовке инженеров нового типа. Это объясняется тем, что для современного общества, имеющего эволюционную модель развития, свойственным является преобладание информационно-интеллектуального ресурса над материально-вещественным. Именно информация, коммуникативная составляющая, новая интеллектуальная технология, мотивация к самообразованию становятся на данный момент основным ресурсом развития эволюционирующей модели общества. В данном контексте возрастает и роль профессионально-иноязычной подготовки инженеров. Так, при разработке национальной доктрины инженерного образования предлагается уделить особое внимание совершенствованию иноязычной подготовки инженеров. Ста-

вится задача пересмотреть цели, содержание и технологию обучения иностранным языкам в системе инженерного образования, обеспечить решение вопросов повышения мотивации к профессионально-иноязычной подготовке, разработки многоуровневой личностно-ориентированной системы иноязычной подготовки студентов, формирования в вузе активной информационно-обучающей языковой среды.

В данной работе была основательно рассмотрена возможность совмещения учебных программ гуманитарных (на примере дисциплины «английский язык») и технических дисциплин в единый дидактический комплекс. Обозначена определяющая роль преподавателя в успешности формирования профессиональной компетенции специалиста в аспекте интегративно-контекстного обучения иностранному языку строительной специальности. Таким образом, имеется полное основание для постановки вопроса о введении в учебную программу технического вуза новой социально-профессиональной учебной дисциплины «иностранный язык специальный».

Методические рекомендации студентам

Основной целью курса «Иностранный язык» в неязыковом вузе является обучение практическому владению разговорно-бытовой речью и языком специальности для активного применения иностранного языка как в повседневном, так и в профессиональном общении. Критерием практического владения иностранным языком является умение достаточно уверенно пользоваться наиболее употребительными и относительно простыми языковыми средствами в основных видах речевой деятельности: говорении, аудировании, чтении и письме.

Требования, предъявляемые к студентам по окончании курса, следующие:

- владеть навыками разговорно-бытовой речи;

- понимать устную (монологическую и диалогическую) речь на бытовые и специальные темы;

- активно владеть наиболее употребительной грамматикой;

- знать базовую лексику общего языка, а также литературу, представляющую нейтральный научный стиль, и терминологию своей специальности;

- читать и понимать со словарем специальную литературу по широкому и узкому профилю специальности;

- владеть основами публичной речи, т.е. делать сообщения, доклады;

- задавать вопросы и отвечать на вопросы по специальности;

- владеть основными навыками письма;

- иметь представление об основных приемах аннотирования, реферирования и перевода литературы по специальности;

Выше обозначенные требования соответствуют ГОС ВПО (ГСЭ. Ф.01) и представляют собой серьезные задачи, но в целом они формируют языковую компетенцию. Студентам следует понимать, что такая языковая компетенция не строится одномоментно. Это длительный и трудоемкий процесс; в неязыковом вузе он занимает два года. В течение этого времени студенты обязаны регулярно посещать практические занятия, активно работать, как аудиторно, так и внеаудиторно, регулярно подвергаясь контролю со стороны преподавателя в форме тестирования и в виде зачетов в конце семестров и экзамена в конце курса обучения.

Значительная роль в программе отводится самостоятельной работе студентов, таким образом, практическое владение языком предполагает и умение самостоятельно работать со специальной литературой на иностранном языке с целью получения профессиональной информации. За два года обучения студенты должны приобрести навыки самостоятельной работы. В первую очередь их ориентирует на это внеаудиторное дополнительное чтение, по которому студенты обязаны регулярно отчитываться в соответствии с предъявляемыми требованиями, а также подготовка и защита рефератов на иностранном языке, что требует от студентов сформированных навыков говорения на иностранном языке и умения выступать публично.

Самостоятельная работа с использованием компьютеров создает оптимальные условия для эффективного усвоения учебного материала и является залогом успешного обучения иностранным языкам. В возрастаю-

щем потоке информации, особенно в связи с распространением глобальной компьютерной сети «Интернет», большое значение приобретает умение самостоятельно извлекать информацию из иноязычного текста и следить за всеми новшествами в области науки и техники, происходящими в мире.

Чтобы эти задачи были решены успешно, преподаватели ориентируют студентов на самостоятельную работу с самого начала курса обучения. Все рекомендации преподавателя относительно учебной литературы, дополнительной литературы, ведения словарей и пр. должны быть приняты студентами к сведению и выполняться с точностью и аккуратно. Студентам следует также поработать над организацией своего учебного процесса и рациональным использованием времени. Чем быстрее и лучше студенты справятся с этой задачей, тем легче будет процесс овладения иностранным языком.

Часть II.
Практический лексический курс английского языка для строительных целей

Chapter 1

The built environment

Block A

Key terms and concepts:

air velocity

allowed exposure time

atmospheric pollutants

clo value

comfort equation

conduction

convection

radiation

evaporation

data logger

decipol

dry-bulb air temperature

dry resultant temperature

environmental temperature

equivalent wind chill temperature

globe temperature

heat stress index

humidity

infrared scanner

Kata thermometer

mean radiant temperature

metabolic rate

odorants

olf

olfactory

percentage of people dissatisfied

pitot-static tube

predicted mean vote

sling psychrometer

thermistor anemometer

thermocouple

thermohygrograph

trend

vane anemometer

vapour pressure

wet-bulb temperature

wind chill index

The building as an environmental filter

One of people's basic needs is to maintain a constant body temperature, and the metabolism regulates heat flows from the body to compensate for changes in the environment. We have become expert in fine-tuning the environmental conditions produced by the climate in relation to the properties of the building envelope to avoid discomfort. A simple tent or cave may be sufficient to filter out the worst of adverse weather conditions, but the ability of this type of shelter to respond to favourable heat gains or cooling breezes may be too fast or too slow to maintain comfort.

Outside the tropics, houses may be advantageously oriented towards the sun to take advantage of solar heat gains, which will be stored in the dense parts of the structure and later released into the rooms to help offset heat losses to the cool external air during winter. Buildings within the tropical zone require large overhanging roofs and shutters over the windows to exclude as much solar radiation as possible and to shade the rooms. Thus the building envelope acts to moderate extremes of climate, and by suitable design of illumination and ventilation openings, together with heating, cooling and humidity controls, a stable internal environment can be matched to the use of the building.

Basic needs for human comfort

The building services engineer is involved with every part of the interface between the building and its occupant. Visually, colours rendered by natural and artificial illumination are produced by combinations of decor and windows. The acoustic environment is largely attributed to the success achieved in producing the required temperatures with quiet services equipment, all of which is part of the thermal control and transportation arrangements. Energy consumption for thermally based systems is the main concern, and close coordination between client, architect and engineer is vitally important.

Heat transfer between the human body and its surroundings can be summarized as follows:

Conduction

Points of contact with the structure are made with furniture. Clothing normally having substantial thermal insulation value and discomfort should be avoided.

Convection

Heat removed from the body by natural convection currents in the room air, or fast-moving airstreams produced by ventilation fans or external wind pressure, is a major source of cooling. The body's response to a cool air environment is to restrict blood circulation to the skin to conserve deep tissue temperature, involuntary reflex action (shivering) if necessary and in extreme cases

inevitable lowering of body temperature. This last state of hypothermia can lead to loss of life and is a particular concern in relation to elderly people.

Radiation

Radiation heat transfer takes place between the body and its surroundings. The direction of heat transfer may be either way, but normally a minor part of the total body heat loss takes place by this method. Radiation between skin and clothing surfaces and the room depends on the fourth power of the absolute surface temperature, the emissivity, the surface area and the geometric configuration of the emitting and receiving areas. Thus a moving person will experience changes in comfort level depending on the location of the hot and cold surfaces in the room, even though air temperature and speed may be constant.

Some source of radiant heat is essential for comfort, particularly for sedentary occupations, and hot-water central heating radiators, direct fuel-fired appliances and most electrical heaters provide this. The elderly find it particularly difficult in keeping warm when they are relatively immobile, and convective heating alone is unlikely to be satisfactory. A source of radiant heat provides rapid heat transfer and a focal point, easy manual control and quick heat-up periods. Severe cases of underheating can be counteracted by placing aluminium foil screens in positions where they can reflect radiation onto the rear of the chair.

Overheating from sunshine can also cause discomfort and glare, and tolerance levels for radiant heating systems have been established.

Evaporation

Humid air is exhaled, and further transfer of moisture from the body takes place by evaporation from the skin and through clothing. Maintenance of a steady rate of moisture removal from the body is essential, and this is a mass transfer process depending on air humidity, temperature and speed as well as variables such as clothing and activity.

Ventilation

The quality of the air in a building depends upon the quantity, type and dispersal of atmospheric pollutants. Some of these, odorants, can be detected by the olfactory receptors in the nose. These are the odours, vapours and gases that ingress from the outdoor environment and are released from humans, animals, flora, furnishings and the structural components of the building. Solid particles

of dust, pollen and other contaminants often have little or no smell. These might be seen in occasional shafts of sunlight, and become visible when they have settled. Cleaning fluids such as ammonia, cigarette smoke, hair spray, deodorants and perfumes can be most noticeable. The inflow of diesel exhaust fumes, road tar, paint vapours and creosote creates unpleasantly noticeable pollution, even when of short duration. The presence of harmful pollutants such as carbon monoxide and radon gases is not detectable by the occupant.

Professor Ole Fanger has introduced units of subjective assessment for odorants only. **The olf** quantifies the concentration of odorous pollutants. **The decipol** is the evaluation of the pollutant as determined by the recipient through the olfactory sensations from the nose. **One olf** is the emission rate of biological effluents from one standard person, or the equivalent from other sources. One decipol is the pollution caused by one standard person when ventilated with **101/s** of unpolluted air.

Office accommodation normally has one person for each **10 m^2** of floor area, so the biological effluent pollution load produced by normal occupancy is **0.1 olf/m^2.** Smokers, building and furnishing materials and ventilation systems add to the pollution load. The average pollution in an existing building that has 40% of the occupants as smokers produces **a load G of 0.7 olf/m^2**. A low-pollution building with an absence of smoking has **a load G of 0.2 olf/m^2**. When there is complete mixing of the ventilation air with the air in the room, the rate of supply of outdoor air that is necessary to maintain the required standard of air.

Comfort criteria

The main comfort criteria for sedentary occupants in buildings in climates similar to that of the British Isles are as follows:

1). The dry resultant temperature should be in the range **19-23 ° C** depending on room use.

2). A feeling of freshness is produced when the mean radiant temperature is slightly above air temperature. A significant amount of radiant heating is needed in order to achieve this.

3). The air temperature and the mean radiant temperature should be approximately the same. Large differences cause either radiant overheating or ex-

cessive heat loss from the body to the environment, as would be experienced during occupation of a glasshouse through seasonal variations.

4). Percentage saturation should be in the range **40-70%.**

5). Maximum air velocity at the neck should be **0.1 m/s** for a moving-air temperature of **20 °C d.b**. Both hot and cold draughts are to be avoided. Data are available for other temperature and velocity combinations.

6).Variable air velocity and direction are preferable to unchanging values of these variables. This is achieved by changes in natural ventilation from prevailing wind, movement of people around the building, on-off or high-low thermostatic operation of fan-assisted heaters or variable-volume air-conditioning systems.

7). The minimum quantity of fresh air for room use that will remove probable contamination from smoking, for example, is **10.41/s per person**.

8). Mechanical ventilation systems should provide at least four air changes per hour to avoid stagnant pockets and ensure good circulation.

9). Incoming fresh air can be filtered to maintain a clean dust-free internal environment.

10). The difference between room air temperatures at head and foot levels should be **no more than 1 °C**.

11). Ventilation air quantity can be determined by some other controlling parameter: removal of smoke, fumes or dust, solar or other heat gains and dilution of noxious fumes.

Block B

Lexical exercises

I. Answer the questions:

1. Where are thermocouples used? What are their advantages?
2. How can heat leakages due to inadequate thermal insulation and damaged pipes or cables be detected?
3. What is the function of environmental temperature?
4. Explain the meaning of the terms «olf» and «decipol». How are olf and decipol used in the design of ventilation systems?

5. How could we measure an investigation into the thermal comfort provided in a building? Which instruments would be used?
6. How do extremes of heat and cold affect the workers on a site? What environmental measurements and corrective actions can be taken to ensure safe and healthy working conditions?
7. How do heating, cooling and humidity control systems interact with the building to provide a comfortable environment?

II. Make up the dialogues:

Topics: 1). The problems of modern services engineers.

2). Monitoring of heating, cooling and humidity control systems.

Block C

Experimental work

1. Effects of room air temperature gradients on comfort: measure floor-to-ceiling air temperature gradients with a multichannel thermocouple probe and discuss their effects on the comfort conditions encountered.
2. Room air velocity distribution: produce velocity contours for different parts of the room and compare with observed comfort conditions.
3. Measure the Kata cooling power and air velocity, the globe temperature and the dry-bulb air temperature.
4. Compute the other temperature scales and compare with subjective assessments of the conditions.
5. Make and test a thermocouple temperature-measuring circuit with copper-constantan wire and an accurate potentiometer. Build junctions into walls and building structures, plot their temperature profiles and calculate their thermal transmittances.
6. Compare the WCI and the EWCT on two sites operated by workers wearing similar clothes.

Site A: air velocity, 5m/s; air temperature, 2.0 °C d.b.

Site B: air velocity, 0.6 m/s; air temperature, —10 °C d.b.

Block D

Creative work

Write a technical report on the aspects of the provision of outdoor air for the ventilation of the following:

1) a commercial building that has offices, retail shops and a pedestrian atrium;

2) an underground high – security manufacturing and storage facility for nuclear materials;

3) a large open – plan metal – fabrication factory;

4) a university;

5) an hotel;

6) a sport centre that has swimming, weight training, aerobics, racquet courts and restaurant facilities.

Chapter 2

Heating

Block A

Key terms and concepts:

absorption heat pumps

building energy management system (BEMS)

ceiling heating

chemistry of combustion

chimney

class of oil

combined heat and power (CHP)

combustion air

computer-based control

dedicated
digital signal
district heating
duct
efflux velocity
electrical power generation
embedded pipe system
equivalent length
evacuated tube radiant system
expansion vessel
fan convector
flue gas constituents
free-standing flue
geothermal heating system
grille
groundwater
heat exchanger
heating system performance testing low,- medium and high-pressure hot water
microbore
neutral point
oil storage and handling
pipe heating systems
outstation
plant management system
plant status
pressure drop rate
programmable logic controller
pump head
pump performance curve
radiant panel
radiator temperature correction factor

Redwood oil viscosity
sealed system
skirting heater
storage heater
supervisor
thermal storage
turbulence
underfloor heating
wall-flame, vaporizing and pressure jet burners
warm-air system
water flow rate
water velocity

Heating equipment

A wide variety of heating equipment is available that can heat the occupied space either directly by combustion of a fuel or indirectly by utilizing air, water or steam as a heat transfer fluid. The cost of electricity reflects the complexity of its production and distribution, but from the user's point of view it is a refined source of energy, which can be converted with 100% efficiency. Electrical energy purchased at night can be used to heat water, concrete or cast iron in insulated containers. This stored heat is released when needed.

An economic balance is sought between capital and running costs for each application, bearing in mind the building's use. Automatic controls can monitor water and air temperatures, operational times and weather conditions to minimize fuel and electricity consumption. In order to take maximum advantage of a building's thermal storage capacity, optimum-start controllers are used to vary start and stop times for systems that are used intermittently. Computer control is employed in large buildings, where the capital cost can be offset by reduced energy consumption and personnel savings.

Radiators

Heat emitters providing radiation come into this group. A steel single-panel radiator emits about 15% of its total heat output by radiation and the remainder by convection. Radiant output from multiple panel and column types

may be a lower percentage of the total. Electric, gas and coal appliances produce large amounts of convection and are partly convectors. Types of radiator are as follows:

Hot water: single, double or triple panel, column, skirting heaters, recessed panels, banks of pipes.

Electricity: off-peak storage heaters, radiant appliances convectors radiant ceiling systems.

Gas, coal and oil: radiant appliances.

The main characteristics of these appliances are as follows:

Steel single panels: neat appearance, high heat output per square metre of surface area, easy to clean, narrow.

Steel double panels: greater heat output per square metre of wall area used, difficult to clean, protrude into the room, more costly.

Cast iron panels: heavy and more obtrusive, low heat output, very long service period.

Steel and cast iron columns: high heat output per square metre of wall area used, bulky, heavy, often mounted on feet, difficult to clean except the hospital pattern which are smooth finished.

Radiant panels: flat cast iron or steel plates with water pipes bonded to their back. They are often mounted at high level in industrial workshops and require a large surface area.

Banks of pipes: bare steel or copper pipes fitted at skirting level in rooms or storage areas to provide an inexpensive heating surface.

Off-peak storage: thermal storage heaters taking electricity at night during less expensive charging periods. The heat is stored at high temperature in cast iron or refractory bricks in an insulated casing. Heat is released continuously into the building unless the heater is fitted with a thermostatically controlled fan and a time switch that determines its operating period. The only other control is over the length of the charge period; this requires estimating the following day's weather pattern. Heaters are bulky and their weight requires attention to the floor structure to ensure sufficient strength.

Convectors

There are two types of convector: natural and fan.

Natural convectors rely on gravity convection currents produced by the heater. Skirting heaters have a finned pipe inside a sheet metal casing. Their heat emission is about **480 W per metre run**, they are light and easily handled and they are less obtrusive than taller equipment. They are always fitted onto two-pipe systems and the return pipe can be fitted inside the casing. Valves and air vents are enclosed in accessible boxes at the ends of continuous lengths. Natural convectors produce a uniformly rising current of warm air around the perimeter of the room and this is effective in producing a comfortable environment. There is negligible radiant heating. Other natural convectors are either **1 m high** or extend up to room height. They create strong convection currents with little radiation and are particularly suitable for locations where elderly, very young or disabled people are being cared for as there are no hot surfaces that may cause skin burns or start fires. Natural convectors have high heat outputs and can be built into walls, cupboards or adjacent rooms to improve their appearance. Electricity or low- or medium-temperature hot water can be used as the heating medium. The heating elements need periodic cleaning. Such heaters are used in locations where quiet operation and the lack of draughts or intense radiation are important design considerations, such as libraries, art galleries and antique furniture stores.

Fan convectors have a construction similar to natural convectors with the addition of one or more centrifugal fans and an air filter. Heat output can be very high and fans may be operated at various fixed speeds or from variable-speed motors. Fan operation is controlled from built-in thermostats or remote temperature sensors.

Installation can be at low or high level and the heated air stream is directed away from sedentary occupants. Fan convectors can be usefully sited at doorways to oppose incoming cold air and rapidly reheat entrance areas.

A two-pipe circuit must be used, and fan convectors are installed on separate circuits from hot-water radiators as their control characteristics are different.

Constant-temperature hot-water is supplied to them, whereas radiators may have variable water temperatures to reduce heat output in mild weather.

Embedded pipes and cables

Low-temperature hot-water heating pipes or electric heating cables are buried in concrete walls, floors or ceilings to provide a large low-temperature surface that is maintained at a few degrees above room air temperature. Floor-to-ceiling air temperature gradients tend to be less than those obtained with more concentrated forms of heat emission and a uniform distribution of comfort is produced.

Soft copper pipes are laid in position on the concrete floor slab and held by clips, and the ends are connected to header pipes in service ducts. Joints are avoided for the underfloor sections. Steel or plastic pipes may be used in some situations. Thermal expansion and contraction of the pipework must be accommodated and the floor surface temperature is limited to avoid damage to the structure, surface finishes or occupants. This is done by enclosing the pipe in a hard asbestos sleeve on water pipes operating at **85 °C** or by controlling water temperature to **45 °C** with a mixing valve system. Pipes are buried in the floor screed. Heating elements are evenly distributed to provide uniform radiation and convection to the occupants.

Warm air

Recirculated room air is heated either directly or indirectly by the energy source. Direct firing of combustion gases into the air is permissible only in large well-ventilated factory premises. All other applications require a fuel-to-air heat exchanger where the combustion products are enclosed in a sheet metal passageway. Room air is passed over the outside of this heating surface.

Heated air is passed through ducts to the occupied space. It is diffused into the room through a grille, which mixes it with room air convection currents and avoids draughts. Each grille has a damper to regulate the air flow. Extract grilles and ductwork return the air to the heater. Care is needed not to extract air directly from kitchens and bathrooms, as this would lead to odours and condensation in living areas.

The main advantage of warm-air systems is quick heating up and response to thermostatic control. A source of radiant heat is needed in the sitting room to complement the otherwise purely convective heating. Stub ducts are used to connect the heater to the supply and recirculation grilles.

Oil-firing equipment

Fuel oil is graded in the Redwood no. 1 viscosity test according to its time of flow through a calibrated orifice at **38 °C**. Vaporizing and wall-flame burners in boilers of up to **35 kW** heat output use **28 s** oil, pressure jet burners use **gas oil class D (34 s),** and industrial boiler plant uses **grade E (250 s)**, **grade F (1000 s)** and **grade G (3500 s)**. Power stations may use **6000 s** residual oil, heated to make it flow. This is the tar residue from crude oil distillation and can only be burnt economically on such a large scale.

In the United Kingdom domestic oils can be stored in outdoor tanks**. Grades E, F** and **G** require immersion heaters in the tank and pipeline heating to ensure flow.

Wall-flame burners have a rotating nozzle which sprays oil onto peripheral plates around the inside of a water-cooled vertical cylindrical combustion chamber. An electric spark ignites the oil impinging on the plates, establishing a ring of flame around the walls of the boiler. Correct oil flow rate from the reservoir is controlled by a ball valve. Oil is pumped at high pressure through a fine nozzle, forming a conical spray in the furnace. Combustion air is blown into this oil mist from a centrifugal fan. The turbulent interaction of oil and air causes further atomization of the oil droplets, and the mixture is ignited by an electric spark.

Combustion

Combustion is an exothermic chemical reaction that liberates heat. Fuel must be intimately mixed with sufficient oxygen and raised to a temperature high enough for combustion to be maintained. All the carbon and hydrogen in the fuel are burnt into gaseous products that can be safely vented into the atmosphere. Hydrocarbon fuels are highly energy-intensive. They require little storage volume and their combustion is controllable.

The constituents of dry air are **21% oxygen**, **79% nitrogen** and less than **1% other chemicals** such as carbon dioxide, carbon monoxide, nitrous oxides and rare gases, measured by volume. Nitrogen is inert and takes no part in the chemistry of combustion, but it is heated in its passage through the furnace. The quantity of air required for complete combustion and the composition of the

products can be evaluated from the fuel chemistry. For **methane (CH4)** the complete volumetric analysis would be

methane + air —>carbon dioxide + water vapour + nitrogen

The chemical symbols for these are as follows: **oxygen**, **O2; nitrogen**, **N2; carbon dioxide**, **CO2; water vapour**, **H2O.** Therefore (after complete combustion) we have

$$CH_4 + 20_2 + N_2 \text{ --> } C0_2 + 2H_20 + N_2$$

All measurements are at the same temperature and pressure. It is assumed that the water vapour is not condensed.

Some condensation is inevitable, however, and when **sulphur (S)** is present in the fuel, it combines with some of the **O2** to form **sulphur dioxide (SO2)**. If the gaseous **SO2** comes into contact with condensing water vapour and further **O2**, weak **sulphuric acid (H2SO4)** may be formed in the flue. Coagulation of liquid **H2SO4** and carbon particles from chimney surfaces leads to the discharge of acid smuts into the atmosphere, causing local damage to washing, cars and stonework. Acidic corrosion of the boiler and chimney greatly reduce their service period. The flue gas temperature is kept above the acid dewpoint of about **50 °C** to avoid such problems.

It can be seen from the methane combustion equation that **2 m^3** of **O2** are required to burn **1 m^3** of **CH_4** completely. This **O2** is contained in **2/0.21 = 9.52 m^3** of air, and this air contains **9.52 — 2 = 7.52 m^3 N2**.

In order to ensure complete combustion under all operating conditions and to allow for deterioration of boiler efficiency between servicing, excess air is admitted. This ranges from **30%** for a domestic pressure jet oil burner down to a few per cent in power station boilers where continuous monitoring and close control are essential. Excess **O2** from the excess air appears in the flue gas analyses. Measurement of **O2** and **CO2** levels reveals the quantity of excess air.

The presence of **carbon monoxide (CO)** in the flue gas indicates that some of the carbon in the fuel has not been completely burnt into **CO2** and that more combustion air is needed. The theoretically correct air-to-fuel ratio is the stoichiometric ratio.

The **CO2** content of oil-fired boiler plant flues will be about **12% at 30% excess air**, the combustion air volume required per kilogram of fuel burnt will

be about **14.6 m^3** and the flue gas temperature leaving the boiler will be about **200 °C**. For domestic natural draught gas-fired boilers, excess air may be **60%,** the flue gas temperature will be **165 °C** and the **CO2** content will be around **7.5%.**

Thus the measured temperature on the test day is sufficiently close to the theoretically expected figure to say that the heating system meets its design specification.

Electrical power generation

Electricity is generated by alternators driven by steam turbines in power stations. The largest alternators produce **500 MW** of electrical power at **33 kV.** The steam is produced in a boiler heated by the combustion of coal or residual fuel oil, which could otherwise only be used for making tar. The oil is heated to make it flow through distribution pipework.

Nuclear power stations produce heat by a fission reaction and the active core is cooled by pressurized water **(pressurized water reactor (PWR)),** carbon dioxide gas **(high temperature gas-cooled reactor (HTGR))**, liquid sodium (fast breeder reactor) or heavy water **(Canadian deuterium (CANDU)** system). This fluid then transfers its heat to water, boiling it into steam to drive conventional turbines.

Smaller alternators are driven by methane combustion in gas turbine engines or by diesel engines. A large modern power station has four separate boiler-turbine-alternator sets, producing a total of **2000 MW** at a maximum of **38 % overall efficiency.**

Approximately half the input fuel's energy is dissipated in natural-draught cooling towers or sea water, depending on the plant location. Steam leaves the turbine at the lowest attainable subatmospheric pressure so that as much power as possible is extracted from it as it passes through the turbines. The temperature of the cooling water may be as low as **35 °C**, which is of little practical use unless a mechanical heat pump is employed to generate a fluid at **60-90 °C**. The heat could then be pumped to dwellings. Power stations are normally sited away from centres of population and heat transport costs are high.

During the next 25-100 years, the United Kingdom is going to have to make more efficient use of its indigenous hydrocarbon reserves, extend nuclear power generation capacity and develop alternative production methods such as tidal, wave, solar, wind, geothermal and hydroelectric plants.

District heating

District medium- or high-pressure hot-water heating, employing two-, three- or four-pipe underground distribution systems, will provide heat primarily to the largest and most consistent users, such as hospitals, factory estates and city centres. Further custom will be won from existing buildings by straight price competition. Flow and return pipes will be well insulated and may be installed inside one large-diameter pipe which will form the structural duct and moisture barrier.

The CHP plant generates electricity for the locality and is connected into the national grid. It should also incinerate local refuse, utilize the heat produced, and recycle materials such as metals and glass. It will provide hot water for sanitary appliances and air conditioning and, as these will be summer as well as winter heat loads, a method of separating them from the heating system will be used. The supply of heat to each dwelling will be controlled by an electric motorized valve, actuated by a temperature sensor in the heat exchanger, which will enable existing low-pressure hot-water systems to be connected. A heat meter, consisting of a water flow meter and flow and return temperature recorders, will continuously integrate the energy used, and quarterly bills could be issued through a directly linked computer.

Medium- and high-temperature hot-water heating systems are sealed from the atmosphere. Pressurization methods involve restraining thermal expansion, charging with air or nitrogen, or making use of the static head of tall buildings. As the boiling point of water increases with increasing pressure, high flow temperatures can be used. This permits a large drop in temperature from flow to return (**5 °C** or more), and water flow rates can be reduced compared with low-pressure hot-water open systems. Pipe sizes are smaller and the system is more economical to install when used on a large scale.

District cooling from a central refrigeration plant serving air-conditioning units in commercial buildings can be developed alongside a CHP scheme. Underground chilled water pipework will be separate from the heat network, and space, cost and acoustic advantages could be gained in comparison with individual systems. A higher standard of service should be available from centralized services, with fewer breakdowns and closer control of pollution.

Thermal resistance of materials

The thermal resistance of a slab of homogeneous material is calculated by dividing its thickness by its thermal conductivity:

$$R = l/X$$

where ***R*** is the thermal resistance **(m^2 K/W)**, / is the thickness of the slab **(m)** and A is the thermal conductivity **(W/mK)**. Resistance to heat flow by a material depends on its thickness, density, water content and temperature. The latter two parameters result from the material's location within the structure. Insulating materials are usually protected from moisture and the possibility of physical damage as they are of low density and strength. The thermal conductivity of masonry can be found from the bulk dry density and the moisture content, which depends on whether it is exposed to the climate or is in a protected position.

Block B

Lexical exercises

I. Answer the questions:

1. What factors are included in the decision on the siting of a heat emitter?
2. Why may the water in large heating systems be pressurized?
3. How do heating systems alter the mean radiant temperature of a room?
4. What safety precautions are taken in buildings occupied by very young, elderly, infirm or disabled people?
5. How can radiant heating minimize fuel costs while providing comfortable conditions?

II. Communication activities:

1. Describe two different types of heating system for each of the following applications: house, office, commercial garage, shop, warehouse and heavy engineering factory.

2. Sketch the installation of a ducted warm-air heating system in a house and describe its operation.

3. Explain how pressurization systems work.

4. List and discuss the merits of the methods used to generate electrical power.

5. Discuss the application of CHP systems in relation to density of heat usage, local and national government policy, possible plant sites, complexity of existing underground services, ground conditions, costs of competing fuels, type and age of buildings, traffic disruption during installation and better control of pollution. (The term "density of heat usage" refers to the actual use of heat in megajoules per unit ground plan area, including all floors of buildings and appropriate industrial processes requiring the sort of heat to be sold.)

Block C

Experimental work

1. A medium-pressure hot-water heating system is designed to provide a heat output of 100 kW with flow and return temperatures of 110 °C and 85 °C respectively. Calculate the pump water flow rate required in litres per second.

2. Find the dimensions of a double-panel steel radiator suitable for a room having an air temperature of 15 °C when the water flow and return temperatures are 86 °C and 72 °C respectively and the room heat loss is 4.25 kW.

3. List the characteristics of electrical heating systems and compare them with other fuel-based systems.

4. Outline the parameters considered when deciding whether to use a one- or two-pipe distribution arrangement for a radiator and convector-low pressure hot-water heating system.

Block D

Creative work

Draw the scheme of the general arrangement of the geothermal heating system.

Chapter 3

Ventilation and air conditioning

Block A

Key terms and concepts:

air-conditioning system
air flow rate
air temperature variation
air velocity
anemometer
biocide treatment
centrifugal compressor
chloro-fluorocarbon (CFC)
Coanda effect
coefficient of performance
criteria for air movement around people
dew-point temperature
divergence
dual duct
duct size
ductwork materials
dynamic thermal analysis
energy recovery
energy-saving systems
evaporative cooling
fan coil
fresh air required per person
humidity control

hydrogen fluorine alkaline
induction
latent heat gains
low-cost cooling
lubrication
maintenance
ozone depletion potential (ODP)
packaged units
pollutants
pressure-enthalpy diagram
primary energy
psychrometric chart and cycles
recirculated air
refrigeration
screw compressor
sensible heat gains
set point
shading
shutters
sick building syndrome (SBS)
single duct
stack effect
supply air moisture content
supply air temperature
total environmental loading
tracer gas
vapour compression
ventilation rate measurement

Natural and mechanical systems

Natural ventilation - applicable when the external climate, the use and design of the building permit it. Mild climate localities usually close to the coast where the sea is warm; internal air conditions are allowed to vary widely and are directly related to the external weather conditions; central heating system;

cooling may be provided from packaged direct expansion refrigeration units within each zone; manually operated internal or external shading blinds; passive solar architecture that may include thermal storage walls; chilled-water beams or flat panels may be installed at high level within offices to provide limited cooling (the chilled water in the beams and panels is maintained at a temperature that is above the room air dew-point so that there is no condensation on the exposed surfaces or within the ceilings, avoiding dehumidification and control of the zone relative humidity); chilled beams and panels provide no ventilation air.

Assisted natural ventilation - a development of natural ventilation, as above, where applicable. Mechanically operated ventilation louvres and exhaust air fans improve the control of air flow through the occupied spaces; the incoming outside air may be cooled with a water spray evaporative cooler in hot, dry climates; evaporative cooling is a low-cost means of cooling the incoming outside air, which is exhausted by either natural openings of doors and windows, or by exhaust air fans in confined zones; the incoming outdoor air may be cooled through a specific temperature range, say **10 K**, to provide limited cooling by means of direct expansion or chilled water refrigeration plant.

Mechanical ventilation which only passes outside air through the zone. This usually applies to moderate climates such as the United Kingdom where minimal cooling is required; in climates where the outside air temperature exceeds **30 °C d.b**. the flow rate of outside air is likely to be insufficient to provide enough cooling for zone temperature control in an air-conditioning system; where it is possible to locate the exhaust air duct alongside the incoming outside air duct, within the ceiling space or a plant room, an air-to-air fiat-plate heat exchanger is used to transfer heat between the incoming and outgoing air streams; the outgoing exhaust air is already at the correct zone temperature, of around **22 °C d.b**. (it cannot be recycled as it is vitiated with carbon dioxide, odours and atmospheric pollutants); heat transfer works throughout the year (in winter, the incoming outdoor air is preheated by up to **10 K** from the outgoing exhaust air; in summer, the incoming outdoor air is precooled by up to **10 K** from the outgoing exhaust air); heat transfer efficiency is around **55%**; a similar heat transfer can be obtained from a recuperative heat wheel that transfers heat from the outgoing exhaust air to the incoming outside air, generating up to a **10 K** temperature change in the outside air stream; the heat transfer medium of the wheel may be strips of mylar film.

Mechanical ventilation with recirculated room air. The maximum quantity of conditioned room air is recirculated to save energy use at the heating and refrigeration plant; the outside air motorized dampers are modulated from closed to fully open to control the zone air temperature without the use of the mechanical refrigeration plant for as long a time as possible (this provides low cost cooling to the building); when the refrigeration plant has to be used, the outside and exhaust air motorized dampers are moved to their minimum outside air positions, often around **10%** open, allowing the maximum use of recirculated room air; a range of ducted air-conditioning systems are in use, including single duct, dual duct, induction units, fan coil units and variable air volume systems.

The single-duct system works in the following way. Some of the air extracted from the room is exhausted to the atmosphere and as much as possible is recirculated to reduce running costs of heating and cooling plants. Incoming fresh air is filtered and mixed with that recirculated; it is then heated by a low-, medium- or high-pressure hot-water or steam finned pipe heat exchanger or an electric resistance element. The heated air is supplied through ducts to the room. The hot-water flow rate is controlled by a duct-mounted temperature detector in the extract air, which samples room conditions. The electrical signal from the temperature detector is received by the automatic control box and corrective action is taken to increase or reduce water flow rate at the electrically driven motorized valve at the heater battery.

During summer operation, chilled-water from the refrigeration plant is circulated through the cooling coil and room temperature is controlled similarly.

A temperature detector in the fresh air duct will vary the set value of the extract duct air temperature - higher in summer, lower in winter - to minimize energy costs. A low-limit temperature detector will override the other controls, if necessary, to avoid injection of cold air to the room.

The building is slightly pressurized by extracting only about **95%** of the supply air volume, allowing some conditioned air to leak outwards or exfiltrate.

Energy savings are maximized by recirculating as much of the conditioned room air as possible. Room air recirculation with economy-cycle motorized dampers can, sometimes, be retrofitted to existing systems as an energy conservation measure. In mild climates, such as in the United Kingdom full outside air systems are also used. These have no recirculation air ducts; either a fiat-plate heat exchanger or run-around pipe coils can be installed to preheat

and precool the incoming outside air to save energy. Such heat exchangers are around **55%** efficient, which is not as good as recirculation.

Humidification

In winter, incoming fresh air with a low moisture content can be humidified by steam injection, banks of water sprays, evaporation from a heated water tank, a spinning disc atomizer or a soaked porous plastic sponge. A preheater low-pressure hot-water coil usually precedes the humidifier to increase the water-holding capacity of the air. This also offsets the reduction in temperature of the air owing to transference of some of its sensible heat into latent energy, which is needed for the evaporation process.

A temperature sensor in the humidified air is used as a dew-point control by modulating the preheater power to produce air at a consistent moisture content throughout the winter. For comfort air conditioning, the room percentage saturation will be **50% ± 10%.** This permits a wide range of humidifier performance characteristics.

The humidification process often follows a line of constant wet-bulb temperature. The water spray temperature is varied to alter the slope of the line on the psychrometric chart. The preheating and humidification stages have been omitted, as close humidity control is deemed not to be needed in this case.

Some reheating of the cooled and dehumidified air will be necessary because of practical limitations of cooling coil design. Part of the boiler plant remains operational during the summer. Reheating can be avoided by using a cooling coil bypass which mixes air and air to produce the correct supply condition.

Air temperature profile

The recommended upper limit for the room environmental temperature for normally occupied buildings is **27°C (CIBSE, 1986, Section A8)**. The external design air temperature for comfort in offices in London **(CIBSE, 1986, table A2.22)** may be chosen as **29 °C d.b., 20 °C w.b**. Higher outdoor air temperatures occur. The indoor limit of **27 °C** will be exceeded in naturally ventilated buildings in the United Kingdom and in warmer locations **(Chadderton, 1997a, chapter 3)**. The elevation of indoor temperature above that of the outdoor air is caused by a combination of the infiltration of external air, solar ra-

diation and indoor heat gains. In parts of the world where high solar radiation intensity and continuously higher external temperatures are common, for example Sydney with **35 °C d.b**. and **24 °C w.b.**, the necessity for controlled air circulation and refrigeration can be recognized.

Environmental temperature is a combination of mean radiant and air temperatures. Intense solar radiation through glazing during the summer can lead to the mean radiant temperature being higher than the air temperature. The temperature of the air in an office, factory or residence may need to be kept to an upper limit of, say, **26 °C d.b**. in order to limit the environmental temperature to **27 °C**. Such conditions are tolerable, but not comfortable, for sedentary work. Considerable discomfort is experienced when strenuous physical activity is conducted.

The indoor air temperature fluctuates through each 24 h period owing to the position of the sun relative to the building. South-facing rooms that have a large area of glazing are likely to be exposed to the greatest indoor air temperatures. The windows and doors remained closed throughout the weekend. The office had only natural ventilation, no mechanical cooling, open light grey slatted Venetian blinds, and had been used normally for the preceding week. The exterior wall had a **70%** glazed area.

The 24-hour clock time is 9 hours: that is, a time between 0 and 24 h. The predicted outdoor air temperature curve has been calculated for maximum and minimum values, of **28 °C d.b.** and **13 °C d.b**. on an hourly basis for 24 h. This corresponds to the conditions after a week of warm sunny weather in June 1993 in Southampton.

This has been a common occurrence since 1990. A thermocouple temperature logger, measured the outdoor air, indoor air and the internal surface temperature of the outer pane of the double-glazed window, hourly. The thermocouple that was adhering to the glass showed a combination of two factors: first, that the air temperature in the cavity between the panes of double glazing rose to **35 °C;** second, that the glass absorbed some of the incident solar radiation and was raised in temperature. The internal room air temperature was measured in a shaded location at just above desk height. The room air temperature remained between **25 °C d.b**. and **31 °C d.b**. During normal use, the same office produced an internal air temperature of **25 °C d.b.** when the outdoor air temperature peaked at **27°Cd.b.**

While such an example does not prove conclusively that all south-facing rooms in the United Kingdom need to be air conditioned for human thermal comfort, it does give some evidence to strengthen the argument in favour of mechanical cooling. Working in air temperatures that move above **24 °C d.b**. in naturally ventilated spaces that have significant solar radiation can be noticeably uncomfortable. Whether the performance of human productivity or effectiveness becomes impaired is arguable. Low-cost cooling systems can be designed that make use of cool parts of a building to lower the temperature of the areas that are exposed to solar radiation. Heat pump systems, mechanical ventilation and evaporative water-cooling towers can be used to limit room air temperatures, without the need to involve high-cost refrigeration equipment.

Block B

Lexical exercises

I. Answer the questions:

1. How does the external wind environment affect the internal thermal environment of a building?
2. What does the «environmental temperature mean»?
3. What limit is recommended for the room environmental temperature for normally occupied buildings?
4. Which factors cause the elevation of indoor temperature?
5. How does the single-duct system work?
6. What's the difference between natural and mechanical systems of ventilation?
7. How can you explain **10 K**?

II. Communication activities:

1. Sketch and describe the arrangements for natural and mechanical ventilation of buildings. State two applications for each system.

2. Describe the operating principles of four different systems of air conditioning. State a suitable application for each.

3. State, with reasons, the appropriate combinations of natural and mechanical ventilation for the following: residence; city office block; basement boiler room; industrial kitchen; internal toilet accommodation; hospital operating theatre; entertainment theatre.

4. Explain, with the aid of sketches, how the external wind environment affects the internal thermal environment of a building.

Block C

Experimental work

1. A room has a sensible heat gain of 10 kW and a supply air temperature of 10 °C d.b. Find the supply air rate required to keep the room air down to 20 °C d.b.

2. Ten people occupy an office and each produces 50 W of latent heat. The supply air flow rate is 0.5m^3/s and its temperature is 12 °C d.b. If the room is to be maintained at 21 °C d.b. and 50% saturation, calculate the supply air moisture content.

A department store has 340 people in an area of 35 m x 25 m that is 4 m high. Smoking is permitted.

(a) Calculate the fresh air quantity required to provide 12.51/s per person.

If the air change rate is not to be less than 5 changes per hour, find the following:

(b) supply air quantity;

(c) percentage fresh air in the supply duct;

(d) extract air quantity if 85% of the supply air is to be mechanically withdrawn;

(e) recirculated air quantity;

(f) ducted exhaust air quantity.

3. List the procedure for the design of an air-conditioning system for an office block.

Block D

Creative work

Organize the scientific conference to discuss the following problems:

1. Access, spatial, visual, aural and thermal comfort needs of the occupants.
2. The size and the design of modern ventilation systems.
3. Air ventilation quality requirements.
4. Control of air moisture content and fresh – air recirculation in buildings.
5. Contemporary inventions in the sphere of air conditioning systems.

Chapter 4

Hot- and cold-water supplies

Block A

Key terms and concepts:

acidic and alkaline water

base exchange

concentrating solar collector

corrosion

decentralized hot-water system

delayed-action ball valve

demand units

dezincification

direct mains water

electrolytic action

equivalent length

flat-plate solar collector system

hard water

indirect hot water system

instantaneous hot-water

mineral salts

permanent hardness

pH value

pipe materials and jointing

pipe sizing

plumbo-solvent

pressure boosting

pressure drop

rainfall

reverse osmosis

sand filtration

sanitary appliance allocation

simultaneous demand

soft water

solar distillation

steam boilers

tank supplies

temporary hardness

urinal flush control

water flow

water main pipe sizing

zeolite

Water treatment

About 10% of the rainfall in the United Kingdom is used in piped services. Storage in reservoirs allows sedimentation of particulate matter, and then the water is filtered through sand and injected with chlorine for sterilization. A slow sand filter consists of a large horizontal bed of sand or a sand and granulated activated carbon sandwich (Thames Water). The carbon comes from

coal and acts as a very efficient filter that traps microscopic traces of pesticides and herbicides. Water percolates down through the bed by gravity. Rapid sand filters have the raw water pumped through a pressurized cylinder that contains the filter medium. This filter material is either crushed silica, quartz or anthracite coal. Filtering removes metallic salts, bacteria and turbidity (mud-diness). It also removes colouring effects, odours and particles, which affect the taste of the water. The naturally occurring pH value and the total dissolved salt concentration are virtually unaltered by the water supply authority.

Water quality varies with the local geology and can be classified as hard, soft, acidic or alkaline. Mineral salts of calcium and magnesium have soap-destroying properties and are considered in the evaluation of water hardness.

Temporary hardness is due to the presence of calcium carbonate, calcium bicarbonate and magnesium bicarbonate, which dissolve in water as it passes through chalky soil. These salts are deposited as scale on heat transfer surfaces during boiling, causing serious reduction in plant efficiency. They are known as carbonate hardness.

Permanent hardness is due to the presence of the non-carbonate salts calcium sulphate, calcium chloride, magnesium chloride and other sulphates and chlorides. Neutralization of these is achieved by means of chemical reactions.

Soft water contains up to **100 mg/1** of hardness salts, as in Cornwall, and hard water contains as much as **600 mg/1**, as in parts of Leicestershire. Acidic water is produced by contact with decomposing organic matter in peaty localities and normally occurs in soft-water regions. This water is very corrosive to steel, is plumbo-solvent and can cause dezincification of gunmetal pipe fittings.

The pH value denotes acidity or alkalinity due to the presence of free hydrogen ions in the water: **acidic water, pH < 7; neutral water, pH = 7; alkaline water, pH > 7**. Copper and plastic pipes and fittings can be used in acidic water regions. Hard-water areas are generally alkaline. Water treatment for large boiler plants includes chemical injection to reduce corrosion from dissolved oxygen, and the **pH** value is raised to **11**. Galvanized metal can be used where the **pH** value is **7.4** if the carbonate hardness is greater than **150 mg/1**. Users of large amounts of water may have a treatment plant that removes or converts hardness salts to less harmful salts.

Base exchange

Raw water from the mains passes through a tank of zeolite chemicals where a base exchange takes place:

calcium carbonate + sodium zeolite —> sodium carbonate + calcium zeolite

(in water) (in tank) (in water) (left in tank)

Similar base exchanges occur between the zeolites and other hardness salts in the raw water, turning them into non-scale-forming salts. On complete conversion of all the sodium zeolite, the filter bed is backwashed with brine (sodium chloride solution) which undergoes exchange with the calcium zeolite. The normal flow direction can then be resumed. The running cost of the system is limited to consumption of common salt, a small pump, periodic replacement of the zeolites and a small amount of maintenance work. Steam boilers accumulate the salts passing through the treatment plant, and if they were allowed to become too numerous they would be carried over into the steam pipes and clog safety valves and pressure controllers. Either continuous or intermittent blow-down of boiler water to the drain is designed to control salt concentration. The high-pressure blow-down water is cooled before being discharged into the drains, and the heat is recycled.

Demineralization

Complete removal of mineral salts is very expensive, but it is essential for power station steam boilers, high-performance marine boilers and some manufacturing processes, where the presence of impurities is unacceptable. Raw water is passed through chemical filters in several stages to complete the cycle.

Reverse osmosis

Reverse osmosis is a filtration technique in which untreated water is pumped alongside a semi-permeable membrane in a pipe system. Clean water passes through the membrane. This method is used to produce drinking water in desert regions.

Solar distillation

Solar stills consist of glass-covered water troughs in which solar radiation evaporates the water, which then condenses on the cooler sloping glass roof and is collected in channels. This method can be used in hot locations.

Cold-water services

Mains water is used in two ways: direct from the main and as low-pressure supplies from cold-water storage tanks.

Mains supplies

At least one tap per dwelling and taps at suitable locations throughout large buildings are connected to the main for drinking water. The main also supplies ball-valves on cold-water storage tanks and machines requiring a high-pressure inlet.

The economical use of water is important for safety, environmental and cost control reasons. The manual flush control of WCs and the tap operation of other appliances allows responsible usage. Urinals present a particular hygiene and water consumption contradiction. The user has no control over the flushing of water through the trough or bowl. The absence of flushing water leaves the urinal unpleasantly odorous and discoloured. Cleaning staff may counteract this by the excess dumping of deodorant blocks into the urinal. Perfumed toilet blocks are up to **100% paradichlorobenzene**. Toilet-cleaning fluid contains phosphoric acid. These toxic chemicals are passed to the sewage treatment plant through the drain system. Uncontrolled flushing when the urinals remain unused, particularly overnight, results in wasteful water consumption and no benefit to the user. In the United Kingdom the supply of potable water plus the removal of waste water from consumers costs **J1.17 per m^3 (Southern Water Services Limited, 1993/94)** from a meter on the supply inlet pipe. An uncontrolled urinal cistern of 91 would flush, say, four times per hour, 24 h per day for 365 days in a year and consume **315 m^3 of water** costing up to **J369**.

The installation of a water inlet flow control valve to a range of urinals will only allow flushing when appliances have been used, saving consumption. The valve may be operated from a passive infrared presence detector, discharge water temperature sensor or a variation in the water pressure within the same room. A short-term water flow to a WC or basin causes the stored water pres-

sure within the bellows to exceed the pressure in the pipeline. The water quantity that is passed can be adjusted to avoid wastage.

Low-pressure supplies

Static water pressures in tall buildings are reduced by storing water at various levels. Sealed storage tanks are used for drinking water. Open water tanks become contaminated with airborne bacteria and are only used for sanitary purposes. Cold-water services are taken to taps, WC ball valves, hot-water storage cylinders and equipment needing low-pressure supplies. A separate cold feed is taken to a shower of showers to avoid the possibility of scalding. Tanks are sized to store the total cold-water requirement for a 24 h period.

The minimum mains water pressure available in the street is **100 kPa (1 bar)**, which is **1 atmosphere gauge or 10 m height of water**. The water supplier may be able to provide **300 kPa**, or enough pressure to lift water to the top of a building 30 m high; however, allowance has to be made for friction losses in pipelines and discharge velocity, which effectively limits the vertical distance to between two and six storeys.

Separation of the contaminated water being used within the building for washing, flushing sanitary appliances, circulating within heating and air-conditioning cooling systems, evaporative cooling towers, ornamental fountains, agricultural irrigation or manufacturing processes from potable mains water is achieved by using the following:

1. a storage tank with ball valve (break tank);
2. a permanent air gap between the tap discharge and the contaminated water level (e.g. wash basin);
3. a single-seat non-return valve (check valve);
4. a double-seat check valve.

The Water Byelaws 1989 classify the risk of contamination from the building reaching upstream into the water main in three groups, each having its own protection.

Cold-water storage tanks are expected to contain water of similar quality to that supplied from the main and so must be covered to exclude foreign mat-

ter, insects and light as well as being thermally insulated and not contaminating the stored water themselves. Tanks are generally not larger than **2 m long by 1 m wide by 1 m high**, and pipe connections must ensure that water flushes through all of them to eliminate stagnation.

Servicing or isolating valves are located on the inlet to all ball valves on storage tanks and WC cisterns to facilitate maintenance without unnecessary water loss or inconvenience to the occupier. A servicing valve is required on all outlets from tanks of more than 151, that is, larger than a WC cistern.

The drinking and food-rinsing water tap at a kitchen sink must be connected to the water main before any water softener enters and a check valve is required between this tap and the softener.

Service entry into a building is via an underground pipe passing through a drain pipe sleeve through the foundations and rising in a location away from possible frost damage. An external stop tap near the boundary of the property is accessible from a brick or concrete pit. A ground cover of **760 mm** is maintained over the pipe. A stop valve and drain tap are fitted to the main on entry to the building to enable the system to be emptied if the building is to be unoccupied during cold weather.

A water meter is the next pipe fitting. This has a rotary flow sensor which is used to integrate the quantity of water that has passed. The cubic metres of water that are supplied, and charged for, are assumed to be discharged into the sewer. A separate charge is levied for the supply of potable water and for the acceptance of the contaminated discharge foul water. The consumer normally has no choice but to pay both the charges.

In tall buildings the pressure required to reach the upper floors can be greater than the available head, or pressure, in the mains. A pneumatic water-pressure-boosting system is used. Float switches in the storage tanks operate the pump to refill the system and minimize running times to reduce power consumption. A delayed-action ball valve on the cold-water storage tanks can be used. This delays the opening of the ball valve until the stored water has fallen to its low-level limit. System pressure is maintained by a small air compressor and pneumatic cylinder.

The controller relieves excess pressure and switches on the compressor when the air pressure falls. During much of the day, water is lifted pneumatically at much lower cost than if it were pumped.

Cold-water storage to cover a 24 h interruption of supply **(CIBSE, 1986)** ranges from **451/person for offices** to **901/person for dwellings** and **1351/person for hotels**.

Hot-water services

Hot water can either be generated by the central boiler plant and stored, or produced close to the point of use by a more expensive fuel.

Central hot-water storage

The low-cost fuel used for the central heating plant is also used for the hot-water services boiler. This is located within the main boiler house and a large-volume storage cylinder is employed. A small power input boiler is run almost continuously, winter and summer, under thermostatic control from the stored hot water. Primary circulate pipes are kept short and well insulated.

This system can meet sudden large demands for hot water. Secondary circulation pipes distribute hot water to sanitary appliances. A pump is fitted in the seconds return; its function is to circulate hot water when the taps are shut and it does not appreciably assist draw-off rates from taps. Connections from the secondary flow the tap are known as dead-legs and are limited to **5 m of 15 mm diameter pipe**. This minimizes wastage of cold water in the non-circulating pipework when running a tap and waiting for hot water to arrive.

Decentralized system

The decentralized system is mainly for small hot-water service loads distributed **over** a large building or site where it would be uneconomic to use a central storage cylinder and extensive secondary pipework. Electricity or gas can be used in small storage or instantaneous water heaters located at the point of use. They are connected directly to the water main.

Electric instantaneous heaters have power consumptions of up to **6 kW** and produce water at **40 °C** and up to **31/mm** at **100% efficiency**. Immersion heaters are controlled by time switches and thermostats and are connected in **3 kW** stages.

The indirect hot-water system

This is the basic layout of the combined central heating and indirect hot-water service system. The cylinder is insulated with **75 mm fibre glass** and should have a thermostat attached to its surface at the level of the primary re-

turn. Water is stored at **65 °C**, and when fully charged the thermostat closes the motorized valve on the primary return. This «off» signal may also be linked into the pump and boiler control scheme to complete the shut-down when the central heating controls are satisfied.

Hot-water pipes are insulated with a minimum of **25 mm** of insulation, as are tanks exposed to frost. The primary system feed and expansion tank has a **minimum capacity of 501**, and the cold-water storage tank has a capacity of at least 2301.

Hot-water storage requirements at **65 °C** are as follows: **office, 51 per person; dwelling, 301 per person; hotel and sports pavilion, 351 per person (CIBSE, 1986).**

Materials for water services

Corrosion protection is provided by ensuring that incompatible materials are not mixed in the same pipework system, by recirculating the water in central heating systems to reduce fresh oxygen intake, and by adding inhibiting chemicals to the water. Hot and cold-water service systems are continually flushed with fresh water, making it necessary to use galvanized metal, copper or stainless steel.

Copper and galvanized steel should not be used in the same system because electrolytic action will remove the internal zinc coating and lead to failure. A galvanized cold-water storage tank can be successfully used with copper pipework as the low temperature in this region limits electrolytic action. Heat accelerates all corrosion activity.

Black mild steel is used in recirculatory heating systems, and an initial layer of mill, which is metal oxide scale formed during the high-temperature working of the steel during its manufacture, helps to slow further corrosion. Discoloration of the central heating water from rust to black during use shows steady corrosion. A black metallic sludge forms at low points after some years. Large hot-water and steam systems have the mill scale chemically removed during commissioning and corrosion inhibiting chemicals are mixed with the water to maintain cleanliness and avoid further deterioration.

The formation of methane gas in heating systems during the first year of use is due to early rapid corrosion, and radiators need frequent venting to maintain water levels. Proprietary inhibitors should be added to all central heating

systems. These control methods of corrosion are anti-bacterial. Without them, steel boilers and radiators can through in 10 years.

Block B

Lexical exercises

I. Answer the questions:

1. What do you know about the sources of water and the methods used for its storage and treatment?
2. What pollutants are present in naturally occurring water and where do they come from?
3. What do the terms “temporary” and “permanent” hardness mean? List their characteristics.
4. Which water distribution methods do you know?
5. What are the factors involved in the provision of a pipework system for the conveyance of drinking water within a cartilage?

II. Join parts of the following sentences:

1. Black mild steel is used…
2. The low-cost fuel used for the central heating plant is used…
3. Mains water is used…
4. Permanent hardness of water is due…
5. The solar distillation method can be used…

a) for the hot-water services boiler.

b) in direct from the main and as low-pressure supplies from cold - water storage tanks.

c) the presence of the non-carbonate salts calcium sulphate, calcium chloride, magnesium chloride and other sulphates and chlorides.

d) in hot locations.

e) in recirculatory heating systems.

Block C

Experimental work

1. Sketch the layout of a water services system in a house, showing typical sizes of equipment and methods of control. Show how wastage of water is minimized.
2. Sketch and describe a suitable cold-water services installation for a 20-storey hotel where the mains water pressure is only sufficient to reach the fifth floor.
3. A cold-water storage tank in a house with five occupants is to have a capacity of 1001/per person and be fed from a water main able to pass 0.251/s. How long will it take to fill the tank?
4. A bank building is to house 115 male and 190 female staff. Recommend a suitable allocation of sanitary accommodation.
5. Draw cross-sections through four different types of pipe joint used for water services, showing the method of producing a water seal in each case.
6. Describe the corrosion processes that take place within water systems and the measures taken to protect equipment.

Block D

Creative work

Present the projects of modern water treatment installations.

Chapter 5

Soil and waste systems

Block A

<u>Key terms and concepts:</u>

access

air static pressure

connection to stacks

discharge stack

drain

flow surge

induced syphonage

maintenance

blockage

grease and residues

inspection

lime scale

materials and jointing

ranges of appliances

rodding

self-syphonage

sewer

slope

solid deposition

testing

air pressure

inspection smoke

trap seal loss

vented systems

waste pipe

water seal

Fluid flow in waste pipes

The discharge of fluid from a sanitary appliance into a waste, soil or drain pipe is a random occurrence of short duration exhibiting a characteristic curve.

Flows in waste pipes occur as surges, or plugs of fluid, which last for a short time. The pipe flows full at some time and a partially evacuated space ap-

pears towards the end of discharge. Separation between the water attempting to remain in the P-trap and the plug falling into the soil stack causes an air pocket to form. The static pressure of this air will be subatmospheric. Air from the room and the ventilated soil stack bubbles through the water to equalize the pressures and a noisy appliance operation results. The inertia of the discharge may be sufficient to syphon most of the water away from the trap, leaving an inadequate or non-existent seal.

The problem is avoided by using **32mm basin waste pipes** when the length is restricted to **1.7 m at a slope of 20 mm/m run.**

The sloping waste pipe can be up to 3 m long if its diameter is raised to **40 mm** after the first **50 mm of run**. This allows aeration from the stack along the top of the sloping section. Longer waste pipes with bends and steeper or even vertical parts have a **25 mm open vent pipe**. Vertical soil and vent stacks are open to the atmosphere **900 mm above the top** of any window or roof-light within **3 m**. Underground foul sewers are thus atmospherically ventilated. Water discharged into the stack from an appliance entrains air downwards and establishes air flow rates of up to a hundred times the water volume flow rate. Air flow rates of **10-1501/s** have been measured. The action of water sucking air into the pipe lowers the air static pressure, which is further reduced by friction losses.

Water enters the stack as a full-bore jet, shooting across to the opposite wall, falling and establishing a downward helical layer attached to the pipe surface. Restricted air passageways at such junctions further lower the air static pressure by their resistance to flow. Atmospheric pressure will be re-established at the base of the stack because of the flow of air into the low-pressure region. The falling fluid tends to fill the pipe near the base and positive air static pressures can be generated. Appliances connected to such a region may have their water seals intermittently forced out.

The maximum permitted pressure is **375 Pa** as this is equivalent to the recommended trap depth of **75 mm water gauge** for single-stack drain installations. When suction of this magnitude is applied to a **75 mm water seal**, some of the water is sucked from the trap, leaving about **56 mm**. This is sufficient to stop fumes entering the building.

Loss of water seal from a trap can occur through the following mechanisms:

1. Self-syphonage: this can be avoided by placing restrictions on lengths and gradients and venting long or steep gradients.

2. Induced syphonage: water flow past a waste pipe junction in a stack or along a sloping horizontal range of appliances can suck out the water seal. This is overcome by suitable design of the pipe diameters, junction layouts and venting arrangements.

3. Blow-out: a positive pressure surge near the base of a stack could push out water seals of traps connected in that region. Waste pipes are not connected to the lower **450 mm** of vertical stacks, measured from the bottom of the horizontal drain.

4. Cross-flow: flow across the vertical stack from one appliance to another. Waste pipes are not connected to soil and vent pipes where cross-flow, particularly from WC branches, could be caused.

5. Evaporation: this amounts to about **2.5 mm** of seal loss per week while appliances are unused.

6. Wind effects: wind-induced pressure fluctuations in the stack may cause the water seal to waver out. The vent terminal should be sited away from areas subject to troublesome effects. Wind-tunnel tests using smoke as a tracer are performed for large developments.

7. Bends and offsets: sharp bends in a stack can cause partial or complete filling of the pipe, leading to large pressure fluctuations. Foaming of detergents through highly turbulent fluid flow will aggravate pressure fluctuations. Connections to the vent stack before and after an offset equalize air pressures. A bend of **minimum radius 200 mm** is used at the base of a soil stack to ensure constant ventilation.

8. Surcharging: an underground drain that is allowed to run full causes large pressure fluctuations. Additional stack ventilation is required.

9. Intercepting traps: where a single-stack system is connected into a drain with an interceptor trap nearby, fluid flow is restricted. Additional stack ventilation is used.

10. Admission of rainwater into soil stacks: when a combined foul and surface-water sewer is available, it is possible to admit rainwater into the dis-

charge stack. Continuous small rainwater flows can cause excessive pressure fluctuations in buildings of about 30 storeys. Flooding of the stack during a blockage would cause severe damage.

11. Pumped or pneumatically ejected sewage lifting: the discharge stack is gravity-drained into a sump, from where it is pumped into a street sewer at a higher level. A separate vent is used for the sump chamber and pumped sewer pipe to avoid causing pressure surges.

12. Capillary: lint or hair remaining in a trap may either block the capillary or empty it. Additional maintenance is carried out in high-risk locations.

13. Leakage: leakage can occur through mechanical failure of the joints or the use of a material not suited to the water conditions.

When excessive suction pressure occurs in the waste pipe, some of the water in the trap is syphoned out. When the central ventilation passage becomes uncovered, it connects the inlet and outlet static air pressures. This returns the waste pipe to atmospheric pressure and the syphonage ceases. Sufficient water remains in the trap to maintain a hygienic seal.

Drainage installations should remove effluent quickly and quietly, be free from blockage, and be durable and economic. They are normally expected to last as long as the building and be replaced only because of changed requirements or new technology. Blockages occur when the system is overloaded with solids, becomes frozen, suffers restricted flow at poorly constructed bends or joints, or has building material left inside pipe runs. Each section of discharge pipework must be accessible for inspection and internal cleaning.

Transport of solids from WCs is the controlling problem in the design, installation and maintenance of sloping drains. Swaffield and Wakelin **(1976)** showed that, to maintain the flow from a WC and avoid deposition of solids in the drain, the ratio of the length **L** of sloping drain (metres) to the gradient **G** must be

$$\mathbf{L/G = 35^2}$$

Pipe bends produce rapid deceleration of solids downstream, followed by velocity regain as the remaining flush water catches up with and accelerates the solids with minimal loss of inertia. When minimum gradients are used, solid deposition could occur at a bend. To avoid this, the equivalent length of a bend

can be taken as **5 m** of straight pipe in design calculations. Solid deposition can also occur at a top entry into a sewer. Branch connections should be at **45 degrees** to the horizontal.

Pipework design and pipe sizing

A pumped WC discharge unit enables the use of a **22 mm diameter** copper pipe to run long distances, and upwards, to connect into the soil and vent stack at a convenient location. The intermittency of discharge from appliances necessitates the use of discharge units that relate to the flow volume, flow time and interval between flows from sanitary fittings in a similar way to the demand units for water supplies to such fittings.

A **100 mm diameter** stack can carry **750 discharge units**, **125 mm diameter stack** can carry **2500 discharge units** and a **150 mm diameter stack** can carry **5500 discharge units**.

Disposal of surface-water

Surface-water can be removed from a site by one or more of the following methods.

Sewer

Where the local authority agrees that there is adequate capacity, surface-water is drained into either a combined sewer or a separate surface-water sewer. Surface-water from **garage forecourts and car parks** is run in open gullies to an interceptor chamber. Ventilation of explosive and poisonous **petrol vapour is essential,** as **a concentration** of **2.4%** in air is fatal. It is illegal to discharge petrol, oil or explosive **vapour into** public sewers. The interceptor chamber is an underground storage tank of concrete and engineering bricks, which allows separation of the clean water from the oily scum remaining on its surface. It is intermittently pumped out and cleaned. The discharge drain to the sewer is turned downwards to near the bottom of the interceptor and three separate chambers are used in series.

Soakaway

Ground permeability is established using borehole tests to measure the rate of natural drainage within a curtilage. If running underground water is

found, a simple rock-filled pit can be used. Slow absorption is overcome by constructing a perforated precast concrete, dry stone or brick pit, which stores the rainfall quantity. The stored volume is found from an assumed steady rainfall of **15 mm/h over a period of 2h**. This is exceeded around once in 10 years, so there may be occasional flooding for short periods. A soakaway pit is circular with its depth equal to its diameter.

Storage

An artificial pond or lake, or even an underground storage tank, will be necessary if the expected run-off from a curtilage is at a greater rate than could be accommodated by a sewer or watercourse.

Materials for drainage pipework

Traditionally, glazed vitrified clay (GVC) pipes have been used because they represent an efficient use of UK national resources. The finished internal surface of GVC pipes offers less frictional resistance to flow than that of concrete pipes and is resistant to chemical attack and abrasion. Rigid joints consist of a socket and spigot cemented together. The brittle nature of such pipe runs has led to the introduction of flexible joints, which can withstand ground movement due to thermal and moisture variations and settlement of buildings. Plastic and rubber sealing ring joints allow up to 5° of bending and longitudinal expansion and contraction. Pipe sizes range from 75 to 750 mm in diameter.

Spun concrete drain pipes of diameter up to 1.83 m with oval cross-sections, which maintain flow velocity at periods of low discharge, are used. Plastic sleeves with rubber sealing rings give joints flexibility and a telescopic action.

Asbestos cement pressure pipes in lengths of up to 4 m have been used because of their lower weight. Flexible sleeve joints with rubber ring seals are used. Diameters from 100 to 600 mm are produced.

Pitch fibre pipes are formed by impregnating wood fibre with pitch. They are lightweight and can be used for some drainage applications. Lengths of 2.5 m are easily handled and can be hand sawn. Push taper joints are made using a hand-operated chamfering tool. Pipelines have flexibility and require well-selected backfill and careful protection during site work. Hot fluid or chemical discharges may lead to the early collapse of the pipe from ground

pressure. Plastics are used for bends and other pipe fittings. Diameters are in the range 75-200 mm.

Cast iron drain runs are used for overground sections and where the ground movement might otherwise cause fracture. Pipework beneath buildings can either be cast iron encased in concrete or short lengths with flexible joints. Rigid socket and spigot joints are caulked with tarred yarn and then filled with hot lead or lead wool.

Plastics have increasingly replaced naturally occurring materials owing to their low weight and high degree of prefabrication. Complete systems from the sanitary appliance to the sewer, using one supplier and material, are common. Such materials are derived from crude oil and their higher cost needs to be compensated by reduced site time. Smooth bore drain systems can be assembled with minimum skill and they are highly resistant to corrosion. Thermal expansion is greater, and telescopic joints are used. Short-term discharges from some appliances (e.g. some types of washing machine) can be at temperatures of 80 °C or higher. Polypropylene and acrylonitrile butadiene styrene (ABS) pipes are suitable for the high-temperature applications.

Block B

Lexical exercises

I. Answer the questions:

1. State the meaning of the term «discharge unit». How many WCs can be connected into a discharge stack of diameter 100 mm?

2. Under what circumstances may drains and sewers become damaged during their construction and service periods?

3. What cases can pitch fibre pipes be used in?

4. What actions are taken at the construction of the water disposal system?

5. What is the sloping waste pipe's diameter?

II. Communication activities:

1. Describe the types of fluid flow encountered in drainage pipework.
2. State the meaning of the following terms: «bedding», «combined system», «drain», «sewer», «manhole», «separate system», «stack», «discharge pipe», «vent».
3. List the techniques used for subsoil drainage systems.
4. Describe the features and maintenance requirements of surface-water drainage systems for car parking, garage forecourts and large paved areas in shopping centres.
5. List the principal requirements for an underground drainage installation.
6. Explain, with the aid of sketches, the differences between the following types of drain and sewer system: separate, combined and partially separate.
7. Describe the materials and jointing techniques used for below-ground drain systems.

Block C

Experimental work

1. Sketch the pipework layout for a typical group of sanitary appliances in a dwelling, where they are all connected into a stack. Show suitable pipe sizes, slopes and details of the connections at the stack.
2. A range of WCs is to be connected into a common branch pipe of outside diameter 125 mm fitted within a false ceiling 300 mm deep. It is intended that the furthest WC should be 18 m from the stack. The branch has a 90° bend between the last WC and the stack. Determine whether the proposed arrangement would be satisfactory. If it is not, calculate the maximum distance that could be allowed between the furthest WC and the stack.
3. Storage soakaway pits 2 m deep are to be used to dispose of rainwater from a roof of dimensions 10 m x 8 m. Determine a suitable size and number of pits.

4. A building has four 100 mm discharge stacks, which connect into a common underground drain. The stacks have discharge unit values of 400, 500, 600 and 700. Find the diameters of each part of the collecting drain if it has a gradient of 1 in 100.
5. A 100 mm PVC drain runs for 30 m to connect between a discharge stack and the sewer. If its gradient is 1 in 80 and it commences its route with minimum ground cover under a garden, what will its invert be at the sewer connection if the ground is level?
6. There are 236 houses on a new development. Each has a group of sanitary appliances with a discharge unit value of 14. The common drain is laid at a gradient of 1 in 100. Find the diameter of the common drain and the maximum possible number of houses that it could serve.

Block D

Creative work

Draw a suitable sanitary pipework installation for a 10-storey block of flats with two groups of appliances on each floor connected to one stack. Show pipe sizes and routes.

Chapter 6

Gas

Block A

Key terms and concepts:

density

flue systems

gas burner controls

gas flow rate

gas meter

gross calorific value

ignition and safety controls

manufactured gas

natural gas

pipe size

pressure drop

pressure governor

specific gravity

U-tube manometer

Gas service entry into a building

The gas service pipe from the road main should slope at **1 in 20 up** to the entry point to the building, at right angles to the road main and entering the building at the nearest convenient place. Ground cover of **375 mm** is maintained and new pipework is made of plastic. When old steel services are renewed, the plastic pipe can be run inside the steel.

A meter compartment can be built into the external wall in housing installations and the service clipped to the wall under a cover. This facilitates meter reading without entry to the property. Computer monitoring of energy meters using a telephone link to the supply authority will eventually replace manual reading.

Where the meter compartment is inside the building, the service should pass through the foundations in a pipe sleeve, plugged to stop the ingress of moisture and insects but allowing for some movement. A **300 mm** square pit is provided in a concrete floor to allow the service to rise vertically to the meter. The pit can subsequently be filled with concrete.

The meter compartment must not be under the only means of escape in the event of a fire in a building where there are two or more storeys above the ground floor unless it is located in an enclosure having a minimum fire resistance of half an hour.

Gas service pipes, meters and appliances should always be in naturally ventilated spaces, as dilution with outside air is the best safety precaution against the accumulation of an explosive mixture with air. Early detection of

leaks is essential, but ventilation assists the dilution of leaks. Gas detectors can be provided as an additional precaution.

Domestic credit meters pass up to **101/min, 0.171/s** and are **212 mm wide, 270 mm high and 155 mm deep**. Their overall space requirement is approximately double the width and height measurements for pipework, valve and filter. Industrial meters have flanged steel pipework up to **100 mm in diameter** and a bypass to allow uninterrupted gas flow in the event of meter breakdown. **A 5001/s meter** is **2 m wide, 2.25 m high** and **1.6 m deep**. Due allowance must be made for doorways and access for replacing the meter during the building's use. A separate meter room is recommended, which should be secure, accessible, illuminated and weatherproof with no hot pipes or surfaces.

Manufactured town gas came from the conversion of coal or oil. It had a high hydrogen content and flame speed but its cross-calorific value was half that of methane. In future, **substitute natural gas (SNG)** may be manufactured from hydrocarbons as indigenous reserves become exhausted. **SNG** will come from the chemical conversion of coal, tar sand or crude oil and will have characteristics similar to those of methane.

Gas pipes or meters should usually be spaced **50 mm** from electrical cables, conduits, telecommunications cables or other conductors. Electric and gas meters may be accommodated in a single compartment if a fire-resistant partition separates them.

The meter is divided into three compartments by the horizontal valve plate near the top and the vertical division plate. Bellows formed by a metal disc surrounded by a leather diaphragm are located on each side of the division plate. The gas enters the upper chamber X through the inlet port, from which it is led to the inside or outside of the bellows depending on the position of the slide valves.

Gas flow to the appliance causes the bellows to move sideways and this movement is connected via linked rods, levers and gear wheels to the sliding valves and the meter dials.

The **Gas Act 1986** compels British Gas to supply, and to continue to supply, gas to any premises within **25 yards (23 m)** of a gas-distributing main. The cost of making a connection, laying the service pipe and maintaining it up to a **maximum length of 9 m** on public land is met by British Gas, and any remainder on public land, and all on private land, by the applicant.

Flue systems for gas appliances

Gas appliances can be flued by a wide variety of methods, as the products of combustion are mainly water vapour, carbon dioxide, nitrogen and oxygen, at a temperature-of about **95 °C** after the draught diverter. The function of the draught diverter is to discharge flue products into the boiler room during a down-draught through the chimney. Such reverse flows occur infrequently for a few seconds during adverse wind conditions. Diversion ensures that the correct combustion process is not interrupted. It stops the pilot flame from being blown out, with consequential shut-down of the appliance until manual ignition is arranged. The draught diverter also dilutes the products of combustion by entrainment of room air into the flue. A carbon dioxide concentration of **4%** by volume is found in the secondary flue after the diverter. The primary flue pipes are those before the diverter.

Brick chimney

New masonry chimneys must be lined with vitrified clay or stainless steel pipe. Existing chimneys may incorporate a stainless steel flexible flue liner, which can be pulled through an existing chimney with a rope and rounded plug. The liner has the same diameter as the appliance flue outlet, often **125 mm** for domestic appliances, and is built into the top of the chimney with a plate to form a sealed air space between the liner and the brickwork. This acts as thermal insulation to maintain flue gas temperature. If the flue gases were allowed to cool to below about **25 °C condensation of the water** vapour would occur and deterioration of the metal and brickwork would reduce serviceability. Asbestos cement or glazed earthenware pipes can be built into new chimneys for protection of the brickwork. A cowl is fitted to the flue to reduce the ingress of rain and the possibility of down-draughts.

The pipe will be either asbestos cement or double-walled stainless steel with thermal insulation between the inner and outer pipes. A flue pipe taken through a roof is fitted with a lead slate to weatherproof the junction. The terminal should be **600 mm** from the roof surface and clear of windows or rooflights. An internal flue from a small domestic appliance can be connected to a ridge terminal. An externally run asbestos cement flue pipe has a branch tee junction at its emergence through the wall. A **25 mm copper drain pipe** takes condensation to a drain gulley.

Balanced flue

The balanced-flue system used for boilers, warm air units, convectors and water heaters is used for appliance ratings up to around **30 kW.** External wind pressure is applied equally to the combustion air inlet and the flue gas outlet parts of the combined terminal. The only pressure difference causing air flow through the appliance is that caused by combustion. The flue terminal should not be underneath a window or within **0.5 m** of a doorway or openable window. It should not be located in a confined corner where external air flow might be restricted. Fan-assisted balanced flues have been used and these allow more flexibility in siting the appliance further away from the terminal. Balanced-flue appliances are also called room-sealed appliances.

Se-ducts and U-ducts

Room-sealed appliances in multi-storey flats are connected to a vertical precast concrete shaft extending from the fresh air inlet grille at ground level to a terminal on the roof. Combustion air is taken from the duct by each heater and its flue products are passed into the shaft. The duct is sized so that sufficient ventilation is provided for the whole installation. With a U-duct a separate combustion air inlet duct takes air from

The pipe will be either asbestos cement or double-walled stainless steel with thermal insulation between the inner and outer pipes. A flue pipe taken through a roof is fitted with a lead slate to weatherproof the junction. The terminal should be **600 mm** from the roof surface and clear of windows or roof-lights. An internal flue from a small domestic appliance can be connected to a ridge terminal. An externally run asbestos cement flue pipe has a branch tee junction at its emergence through the wall. A **25 mm copper drain pipe** takes condensation to a drain gulley.

Block B

Lexical exercises

I. Answer the questions:

1. How are the room-sealed appliances called?
2. What is the function of the draught diverter?
3. Why are the asbestos cement or glazed earthenware pipes built into new chimneys?
4. What is the liner's diameter as the appliance flue outlet and where is it built?
5. How can the electric and gas meters be accommodated?

II. Communication activities:

1. Describe the gas service entry and meter compartment arrangements for housing.
2. Explain how a gas meter measures gas flow rate and total quantity passed during a year.
3. List the methods of fluying gas appliances and compare them in relation to their application, complexity and expected cost.
4. Explain the sequence of operation of safety and efficiency controls on gas fired appliances.
5. Explain how to choose suitable gas pipe sizes.

Block C

Experimental work

1. The pipe from a gas meter to a boiler is 18m long and has elbows that cause a resistance equivalent to 25% of the measured length. Calculate the maximum allowable pressure loss rate for the pipeline.

2. A gas boiler of 43 kW heat output and 75% efficiency is supplied from a meter by a pipe 23m long. The resistance of the fittings amounts to 25% of the pipe length. Find the gas supply pipe size needed.
3. Calculate the actual gas pressure drop through a 22 mm pipe carrying 0.81 l/s when the pipe length is 12m and the fittings resistance amounts to 20% of its length.

Block D

Creative work

1. **Organize the business-like play «At the exhibition of gas appliances.**
2. **Present the project «Gas supply in modern Russia».**
3. **Prepare the abstract according to the topic «Gas's types».**

Часть III.
Итоговый тест

Final test

I. Translate the texts from Russian into English:

a) Металлопластиковые трубы становятся все более популярными как в системах холодного и горячего водоснабжения, так и в скрытых водопроводных инженерных коммуникациях. При этом особое внимание уделяется местам соединения трубопроводов, где традиционно используются два вида фитингов – резьбовые и пресс-фитинги. Недавно была разработана новая система «Multi-fit», включающая диапазон фитингов для труб диаметром от 12 до 28 мм и обеспечивающая надежность на уровне пресс-соединений. Надежность обеспечивается конструкцией из 3-х элементов: гильзы, надевающейся на зачищенную трубу, конусовидного штуцера, ввинчивающегося в гильзу и гайки, которая соединяет фитинг с трубой. Монтаж трубопровода с помощью «Multi-fit» легок и осуществляется с помощью обычного шестигранного ключа.

b) Циркуляционный насос используется для работы в системах отопления, горячего водоснабжения и охлаждения. В таких насосах применен синхронный электродвигатель с постоянным магнитом и номинальной частотой вращения 3000 об/мин. Устройство обладает плавной рабочей характеристикой, что позволяет экономить до 40% электроэнергии. Ротор двигателя защищен от блокировки известковыми отложениями в перекачиваемой воде. При затрудненном вращении включается особый режим прочистки.

II. Read the text and do the following tasks:

Heating and cooling systems

1. The development of refrigeration machines for food storage played a role but the key element was Willis Carrier’s 1906 patent that solved the problem of humidity removal by condensing the water vapour on droplets of cold water sprayed into an air-stream. Starting with humidity control in tobacco and textile

factories, Carrier slowly developed his system of "man-made weather" finally applying it together with heating, cooling, and control devices as a complete system in Graumann's Metropolitan Theatre, Los Angeles, in 1922.

2. The first office building air-conditioned by Carrier was the 21-story Milam Building (1928) in San Antonio, Texas. It had a central refrigeration plant in the basement that supplied cold water to small air-handling units on every other floor: these supplied conditioned air to each office space through ducts in the ceiling. The air was returned through grills in doors to the corridors and then back to the air-handling units.

3. A somewhat different system was adopted by Carrier for the 32-story Philadelphia Savings Fund Society Building (1932).

The central air-handling units were placed with the refrigeration plant on the 20th floor, and conditioned air was distributed through vertical ducts to the occupied floors and horisontally to each room and returned through the corridors to vertical exhaust ducts that carried it back to the central plant. Both systems of air handing (local and central) are still used in high-rise buildings.

4. The Great Depression and Word War II reduced the demand for air-conditioning systems. It was not until the building of the United Nations Secretariat in New York City in 1949 that Carrier produced a method of air conditioning that could deal effectively with the large heat loads improsed by the building's all-glass curtain walls. The conditioned air was delivered not only from the ceiling but also through pipe coil convector units just inside the glass wall.

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1. Define the affirmation to be:

1) Carrier was a pioneer in the field of air-conditioning.

- True
- False
- No information

2) The conditioned air passed through wall ducts in the 21-story Milam Building.

- True

- False
- No information

3) Ventilation in industrial buildings was done with operable windows.

- True
- False
- No information

4) The building of the United Nations was equipped with unique air-conditioning systems.

- True
- False
- No information

2. Find the text's paragraph (1, 2, 3, 4):

1) The method of vertical exhaust ducts played an important role in building atmosphere controlling.

2) Carrier's first experience was connected with the system of factory humidity control.

3. Answer the question:

What was the peculiarity of air-conditioning system in Metropolitan Theatre?

- It was a complete system combining heating, cooling, and control devices.
- The conditioned air was supplied through ducts in the ceiling.
- The conditioned air was delivered through pipe coil convector units just inside the glass wall.
- The central air-handling units were located on the upper floor.

4. Define the main idea of the text:

- The Great Depression and World War II decreased the demand for air-conditioning systems.
- It was an American engineer who made a great contribution to an artificial system of air conditioning.
- The first office building air-conditioned by Carrier was the 21-story Milam Building.
- Both local and central system of air-handling are employed in high-rise buildings nowadays.

III.*Translate the text from Russian into English:

Системы отопления загородного дома. Виды систем отопления

Отопительные приборы (тепловые панели, радиаторы, котлы, теплые полы) являются элементом системы отопления, предназначенным для передачи теплоты от теплоносителя воздуху ограждающим конструкциям обслуживаемого помещения.

Расход топлива обуславливается теплопотерями помещений и правильностью настройки оборудования. При оптимальном режиме работы (КПД - 91%) расход, например, дизельного топлива составляет 5-8 литров на м3 отапливаемого помещения в год в зависимости от теплопотерь помещения.Для приблизительного выбора отопительного оборудования (без проведения точных расчетов теплопотерь) возможен подбор необходимой мощности котла по усредненным данным: 0.035 кВт на 1 м3 объема отапливаемых помещений.

К отопительным приборам обычно выдвигается ряд требований, на основании которых можно судить о степени их совершенства и производить сравнения:

Санитарно-гигиенические:

отопительные приборы по возможности должны обладать более низкой температурой корпуса, иметь наименьшую площадь горизонтальной поверхности для уменьшения отложений пыли, позволять беспрепятственно удалять пыль с корпуса и ограждающих поверхностей помещения вокруг них.

Экономические:

отопительные приборы должны иметь наименьшие приведённые затраты на их изготовление, монтаж, эксплуатацию, а также обладать наименьшим расходом металла.

Архитектурно-строительные:

внешний вид отопительного прибора должен соответствовать интерьеру помещения, а занимаемый ими объём должен быть наименьшим, т. е. их объём, приходящийся на единицу теплового потока, должен быть наименьшим.

Производственно-монтажные:

должна обеспечиваться максимальная механизация работ при производстве и монтаже отопительных приборов. Отопительные приборы должны обладать достаточной механической прочностью.

Эксплуатационные:

отопительные приборы должны обеспечить управляемость их теплоотдачей и обеспечивать теплоустойчивость и водонепроницаемость при предельно допустимом в рабочих условиях гидростатическом давлении внутри прибора.

Теплотехнические:

отопительные приборы должны обеспечивать наибольшую плотность удельного теплового потока, приходящегося на единицу площади.

Обзор электрических систем отопления:

Конвективные

Эти обогреватели могут быть с естественным теплообменом (простейшие конвекторы, настенные панели) или с принудительным обдувом (тепловые пушки, тепловентиляторы и т. п.).

Лучистые

Лучистая система отопления принципиально отличается от конвективных систем. Ее достоинства:

- высокий КПД – 90%, связанный с прямым преобразованием электроэнергии в тепловую энергию, требуемую на отопление. Лишь около 10% энергии уходит на бесполезный прогрев воздуха под потолком;
- быстрый нагрев помещения по сравнению с общепринятыми системами обогрева;
- поддержание температуры при отключенной системе за счет аккумуляции тепла в элементах конструкции помещения и предметах;
- отсутствие интенсивных воздушных потоков, связанных с конвекцией, в связи с чем уменьшается циркуляция в воздухе пыли и других загрязнений;
- удобство терморегулирования;
- бесшумность;
- мобильность: быстрый монтаж, перенос, наращивание, демонтаж и т. д.;
- экономия затрат на эксплуатацию, включая затраты на электроэнергию. Потребление электроэнергии снижается на 30-70% по сравнению с традиционными обогревателями. Этот тип обогревателей делится на два подкласса:

    - длинноволновые;
    - инфракрасные.

Инфракрасные обогреватели отличаются от длинноволновых спектром излучения в связи с разной температурой нагрева рабочего элемента. У инфракрасных обогревателей ТЭН раскаляется до 700-800 град., в отличии от длинноволновых, где температура рабочей пластины, которая выполняет роль излучателя, порядка 200-250 град. В связи с этим использование инфракрасных обогревателей с открытым ТЭНом в закрытых помещениях, а тем более в жилых, становится невозможным. Именно длинноволновый обогреватель (иногда его ошибочно называют инфракрасным) является пожаробезопасным прибором в эксплуатации, не выжигающим кислород и дающим «мягкое» тепло, благоприятное для человеческого восприятия.

«Теплые полы»

Существует еще один тип отопления, который нельзя однозначно отнести ни к первому, ни к второму подклассу – это «теплые полы». Эффективность «теплого пола» гораздо выше, чем у конвективных обогревателей, более того, она близка к эффективности лучистых систем обогрева. Но «теплые полы» очень дороги в монтаже, который требует полностью вскрывать полы для укладки теплокабеля и проводить ремонт в помещении, кроме того, система «теплый пол» немобильна (демонтаж, перенос, перераспределение системы невозможны).

Излучающие пленки

Это низкотемпературные излучающие пленки с напыленным сетчатым инфракрасным нагревателем. Они являются своеобразной альтернативой «теплому полу». Температура на поверхности от 50 до 90°. Выпускаемые мощности этих изделий ограничиваются пределом в 600 Вт, да и энергоэффективность их гораздо ниже, чем у длинноволновых обогревателей той же мощности. Ограничение высоты до 3 метров снижает область их применения.

Часть IV.

Тексты для дополнительного чтения.

Supplementary reading

Boilers

The boiler may be one of a number of types. It may be a solid one-piece casting, rectangular in form; it may be sectional; or it may be conical in shape and wrought or cast iron. For smaller systems, the first and last-named types are both cheap and suitable. The sectional boiler has the advantage of the possibility of added sections should more heat be needed subsequent to initial installation. Sectional and shell type boilers are almost invariably used for bigger installations. The former are cast iron and can be built up in site, whilst the latter are usually of the "packaged" type, having all auxiliary components together with the boiler assembled as one unit ready for erection.

In general, a heating system should be designed so that the water will circulate by gravity. In some installations, circumstances are such that a pump or accelerator must be used to achieve a satisfactory circulation. This should be avoided if possible.

When designing a heating system for a large building, it is usual — in the interests of economy and to ensure efficient heating — to first calculate how much heat will be needed to maintain the building at the desired temperature. Then the size of the boiler and the amount of pipe and radiator heating surface required to give out this heat will be estimated. For small systems, "rule-of-thumb" methods and past experience are generally a sufficient guide.

The overhead drop-feed system shows how the hot water from the boiler is carried as high as possible in the building, from where it falls in cooling, through the various branch pipes and radiators, back to the boiler. In this type of system, the maximum amount of "circulating head" or pressure would be obtained.

Erecting and fixing boilers

No difficulties exist in the fixing of independent boilers. A good level concrete foundation is needed, and common-sense fire precautions should be observed.

Sectional boilers can be almost any size to as much as, 5 or 6 tons in weight. They are usually delivered in separate parts requiring assembly. Heating by hot water is traditionally plumbers work, but in later years specialist heating engineers have evolved and it is true to say that larger, heating jobs have become mainly their concern. However, a great deal of domestic heating and other smaller systems are carried out by the plumber; some of this work involves the use of sectional boilers.

It is advisable to assemble the sections on the floor rather than on the stand so that it will not get pulled about and maybe damaged. If, however, the boiler is a heavy one, it can be assembled on the stand if care is taken. The front of the stand can be removed for assembly of the front section.

Most radiator are sectional they can be extended and damaged sections can be replaced. A trade catalogue will readily indicate the many different patterns of radiator which can be had.

The majority of radiators have left- and right-hand malleable nipples connecting the sections together. This is a very useful arrangement, but it calls for some tare on the part of the dissembler. To remove a section of a radiator, the plugs must first be removed from the ends. Now a special tool designed to grip the fibs formed on opposite sides of the inside of the nipple, is inserted from the end, the depth, to which it must go having already been chalk on it by trial against the outside of the radiator. The air-cock tapping is made on the return end of a radiator, which is left-hand threaded inside. A moment's, thought will show that an anti clockwise turn will screw the nipple out of the left-hand threaded end section and also out of the right-hand second section. Working from the other hand, the reverse will be the case; that is, a clockwise turn should be used.

Circulating head

In any gravity system of heating (i.e. no pump), circulating head is extremely important. Briefly it is due to the difference in weight of a given volume of water in the flow and return circulators. This factor governs the speed of the circulation, and it should be borne in mind that the rapidity of the circulation would determine the amount of heat, which will reach a given radiator.

It will readily be seen that if a pipe were taken from a boiler and carried around a room horizontally and back to the boiler, no circulation would take

place – provided the boiler connections were on the same level. If one pipe were connected to the top and the other to the bottom of the boiler, a slow circulation would be found to exist. If instead a pipe leaving the top of the boiler were to be taken to the top of the room, allowed to circulate around the room and return to the bottom of the boiler, a rapid circulation would be evident. This principle should be borne in mind in the design of any heating system. Most heating installations are a compromise between what is ideal and what is practicable, in consideration of possible pipe runs, radiator and boiler positions, and the shape of any particular building.

There are a few rules, which should be observed:

1. The boiler must be big enough for the job it has to do.

2. The pipes should be of a size sufficient to convey the volume water required to give up the needed heat.

3. Pipe runs should be as direct as possible.

4. A system should be planned to provide enough heat. In the worst possible conditions.

5. The occupants of rooms should be given a means of controlling the heat output in the room by means of valves.

From the point of view of heat control, one valve only is needed and this can be fixed on either pipe although in practice it is usually fitted to the return or lower pipe where it is out of the way. It is useful to fit a valve on each pipe so that radiator can be taken out for repair without having to run off the whole of the water in the system.

Cold water supply and distribution

All the water we use derives initially from the oceans and is made available to us by the rain cycle. The heat of the sun, to rise and form clouds of water vapour evaporates water at the surface of the ocean. These clouds are swept towards the land by the incoming sea breezes. Where there are hills the clouds are carried upwards into a cooler atmosphere and condensation takes place in the form of rain. The cycle is completed when the water so falling on the land drains away to streams and rivers and is carried back to the sea. Some of the rainwater, of course, evaporates from the surface of the earth, from rivers and lakes. Some of the rain-water soaks into the earth and is held in underground basins of impervious rock strata, from where it can be raised by means

of wells. Some of this water out pours from faults in the rock stratum and is available as a spring. Many towns and cities use water direct from rivers and lakes. London uses the water of the Thames; Glasgow the water of Loch Katrine; Manchester the water of Thirlmere. Under such conditions of supply, very great-care has to be taken that pollution is avoided and that there, is sufficient purification. Most local authorities, however, have not a, large lake or river to draw upon. They find it necessary to set aside a suitable area in close proximity to the town as a catchment's area, or gathering ground, from which the water can be collected and impounded in a reservoir – usually a valley having a dam thrown across it. From here the water, is usually – but not invariably – piped by means of a large sized conduit to a service reservoir on the edge of the town. At this point any needful purification or softening is generally done. The water from wells and borings is generally hard, i.e. it contains the salts of lime, either calcium carbonate, causing "temporary" hardness which can be removed by boiling, or calcium sulphate, causing "permanent" hardness which, cannot be removed by boiling but only by a system of water softening; the base exchange method is typical.

Heating and air conditioning

People are comfortable when they are neither too cold, nor too warm and when the air about them is neither too dry, nor too damp and is not stuffy or dusty. To bring about these desirable conditions the heating or air-conditioning apparatus must be capable of maintaining the following conditions inside the house, whatever the conditions outside may be. For adequate heating when it is cooled outside the heating plant, including the necessary ducts, registers, piping, radiators, etc., must be able to keep all the rooms at 70° Fahrenheit, even if it is 20 or 30 degrees below zero outside. To avoid stuffiness, the air should be given a certain amount of motion. Under winter conditions this must be sufficient to distribute the heat uniformly throughout the rooms. It must not be too cold at the floor, not too hot at the ceiling. A stove causes the hot air around it to rise up toward the ceiling and cooler air to flow toward the stove. A radiator acts in this respect like a stove. Warm-air registers bring heated air into a room with a certain motion or velocity, which imparts movement to the air already in the room. An outlet for this air should be provided in order to have good ventilation. In summer time much greater air motion is needed, enough to change the air in a room completely

from three to ten times-per hour. Sometimes a fan is placed in the attic to blow the warm air out and to cause the cooler night air to flow in through open windows. When this is done, air in the house can be expected to be changed completely every two or three minute. When air is brought into a house from outside, heated in a furnace and distributed through all the rooms, it ought to be cleaned by passing it through "filters" before it enters the furnace. These filters must be capable of straining out from the air all dust, soot, pollen and other impurities. Filters should be so installed that they can be easily replaced. Cleaning the air this way prevents the dirt from entering the house and soiling the walls and furniture. In summer, or in hot climates, cooling of the air in a residence is desirable and is often done, special refrigerating equipment being installed to do the job. The air in the rooms should be maintained at a temperature not more than about fifteen degrees lower than the thermometer readings outside at all times, in order to prevent discomfort from too sudden a change for persons going into or leaving the house. This cooling must for comfort be accompanied by movement of the air and regulation of the humidity, so that a clammy feeling will-not be experienced.

Plumbing

For many centuries plumbing was unknown, except in the places and houses of the great wealthy. Amid the rums of some cities of ancient Roman times evidences have been found of the use of piping systems to a very limited extent in private houses and to a much greater extent in connection with public bath houses. Step by step during a long period of years modern plumbing has been evolved. Water is brought into house from the street mains (water pipes), through pipes. The branch pipes supplying water to a bathroom and lavatory will be 1/4 inch for both cold and hot water. A branch which supplies a kitchen sink and laundry tub will be 3/4 inch for either cold or hot water. Water-supply pipes inside houses are made of galvanized iron, wrought iron and of brass.

Drainage pipes outside of the house itself, that is, between the house the sewer in the street, are called the house sewer. They are usually of glazed vitrified tile, but if the ground on which the sewer is laid is not absolutely firm and solid, cast-iron pipe should be used, as it is much stronger than tile, which is liable to be broken by any settlement. Drainage pipes inside the house in the basement or underneath the basement floor are called the house drain. Drainage pipes should be of cast iron.

Sanitary fitting

Sanitary fittings are those appliances used in the collection and disposal of human and domestic waste products.

They comprise commonly: water-closets, lavatory basins, baths, sinks, and urinals.

Most baths are of vitreous-enameled cast-iron; they have a square top and are fitted with panels on any exposed sides. There is a growing tendency to use pillar taps instead of the lately common globe-type taps, fixed on the vertical end of the bath. By using pillar taps, the bib or outlet can be, raised above the flood rim of the bath, and any danger of water pollution in the service pipes – due to back siphonage – is made less possible. The taps are secured as in a lavatory basin, It is important that before any tap is fixed, the tap top should be removed and reassembled. It often happens that tap tops are abnormally tight, and a lavatory basin or any other fitment might be damaged.

When the tap end of a bath is close to a wall, it is necessary to couple up the farthest tap first, then the overflow, and finally the near tap. Here again a cranked spanner is useful.

The bath waste should be fitted before the bath is lifted into position, and the waste pipe should be in place and complete with trap, so that only a horizontal nut remains to be tightened.

As sinks are heavy and are often well loaded, they need good support. In the old days brick pillars were often used, but they are to be deprecated. The support should be such that there is no difficulty in cleaning the wall and floor. For this reason cantilever brackets' should be used. Special brackets can be bought, but two pieces of angle- or tee-iron, will do admirably; they should be well fastened in the brickwork preferably by building in. For neatness, the brackets should finish about 75nut from the front of the sink and be cut diagonally. For the same reason, they should be well away from the ends.

Valves

In general, the use of valves should be avoided where possible on hot-water systems. It is useful however to place a valve or tap in the cold-water feed pipe immediately under the cistern. It should be a full-way type gate valve providing no impediment to the flow of the water. When this valve is closed, the hot water; supply is immediately stopped, all distribution pipes can be emptied and most repairs can be executed. If it is deemed necessary to control the

heating of the hot water in the cylinder, a valve can be inserted on the return circulator. In no circumstance should two valves, be used otherwise the boiler and pipes will be enclosed and an explosion might follow.

To determine pipe sizes in larger hot-water installations, calculations based on the quantity of hot water needed should be made, although previous experience generally provides satisfactory "rule of thumb" guidance. Any system providing hot water is known as "domestic", we must limit our concern to the average small-house installation. In general, the back-boiler used measures about 250 mm in length, is about 200 mm from back to front, and 150 or 180 mm deep. With an ordinary fire, a boiler of this size provides enough heating surface to keep the cylinder supplied with hot water. The primary circulation pipes are normally 19 mm diameter lead or copper pipes. They should not be less and, if the cylinder is a large one, 25 mm circulation pipes should be used. The expansion pipe must be equal in size to the circulation pipes, and is usually 19 mm in diameter. The cold feed-pipe is often specified as one and a halt times the diameter of the largest draw-off. In practice, equally sized feed and draw off pipes are found to be efficient. In an ordinary house system they are usually both 19 mm in diameter. There should be no restrictions in the supply pipe to bath, so mat a 19 mm pipe to a 19 mm tap is needed. The branch drew-off pipes to sinks and lavatory basins are generally 12 mm diameter to 12 mm taps.

Waste pipes

Waste pipes from lavatory basins, baths, and sinks may be executed in lead (traditional), copper, and cast-iron. Individual waste pipes should take the shortest path, sharp bends should be avoided, and they should be of such size that they will generally run fairly full and thereby be self-cleaning. Lead "waste pipes are joined by means of wiped joints. Whenever lead pipe is used, it should be property supported to avoid sagging. Copper waste pipes, being more rigid than lead, require less support. Copper tube can be bent to requirement. Cast-iron, pipes are sometimes used. They should be of heavy-quality, treated inside and out with a special, bituminous solution. The joints should be caulked with tow

and lead-wool or molten lead. Waste pipes should be laid to proper falls, and access should be provided in order that each length of pipe can be rodded. Soil pipes are those which convey the contents of water-closets and urinals to the drains. The vent-stack which is normally carried above the roof is also included in any discussion of soil pipes.

In the "one-pipe system" all sanitary fittings discharge into the same soil pipes with an economy of pipe work, and a simplification of layout. A few precautions need to be taken. All lavatory basins, baths, and sinks must be fitted with deep-seal traps or with anti-siphonage pipes. The anti-siphonage pipe can be returned into the vent shaft at a point not less than 1 m above the highest soil pipe junction. The main anti-siphonage pipe must, in certain circumstances, be carried down and connected into the main soil stack below the lowest inlet branch. This precaution is necessary where fittings are situated on two or more floors and discharge into a common stack.

Water main

Water mains are those pipes, which distribute the water from the reservoir. They vary in size from huge conduits of many feet diameter to fractions of an inch. Those of concern to the plumber are generally of cast-iron; asbestos-cement, lead, or copper, cast-iron pipes of 100, 75 and 500 mm (4, 3 and 2 in.) diameter should be considered. They may be had in lengths varying from 2 to 4 m, (6 to 12 ft) and conform to a British Standard specification. A protective coating of a bituminous kind, which is applied whilst the casting is hot, is applied inside and out. Suitable fittings such as bends and junctions are available for use where there is a change of direction or branch to be made are lighter than cast-iron and can be had in correspondingly longer lengths. Like cast-iron, they are treated with a protective coating to prevent the development of vegetal growths. Such growths would by their roughness increase the friction between water and pipe, producing a loss of pressure. Specially designed joints are used on these pipes, which have spigots at both ends and loose collars with rubber rings. A special tool is used to fit the collar and rings in position. Immediately inside the house, or any building, a consumer's stop tap should be fitted, so that all cold-water pipes in the building are under quick and easy control. This tap must be of the screw down type, as must every other hand-operated tap on town's

water. It might be mentioned here that all taps, valves, and cisterns used on water services, including hot-water services and services on meter, must be tested and stamped by the water authorities. Most water authorities provide a constant supply of water, but some few find it necessary to intermit supply for various reasons such as inadequacy of mains, capacity and demand at peak periods. This system is known as intermittent supply and for its operation householders have to have a large storage cistern to cover their needs in periods when, the supply stops.

Air conditioning refrigerant

Refrigerant is a substance used in refrigeration to make or keep cold or cool. All air conditioning systems must have air conditioning refrigerant in its system in order to absorb excess heat and result in cool air blowing through the air filters in your home, office or building. A chemical refrigerant is placed inside the air conditioning system to absorb the unwanted heat which in turn is pumped through an outside unit that will blow the heat to the outside and transfer the outside air to cool air inside your home. Chlorofluorocarbon, a colorless, nearly odorless liquid is what comprises the refrigerant, also referred to as R-11. When it's placed at room temperature, the liquid starts to boil and can be used in air conditioning systems to assist with heating and air conditioning. If your air conditioning system is low on air conditioning refrigerant , you might need to contact an air conditioning company or an air conditioning contractor . Often times, the air conditioning refrigerant can be undercharged during the time of an air conditioning installation or there might be a refrigerant leak. Adding more refrigerant will not solve the leak. A reliable air conditioning company will test to see where the leak is coming from and repair the air conditioning part and change the air conditioning to its proper level. This is essential for the very best in air conditioning and refrigeration. If you live in hot zones, replacing your air conditioning filters on a monthly or bi-monthly basis gives all air conditioning parts the very best in functionality and performance, including the air conditioning refrigerant . Just like your car, the more you use air conditioning in your home, the more often you will need to replace the refrigerant . Normally, a technician will set the air conditioning to its proper level and add to the air conditioning refrigerant if needed

Air conditioning filter

The air conditioning filter is one of the most important air conditioning parts in the air conditioning system. Without it, your air conditioning system would be dirty and the air you breathe would be filled with pollutants. All air conditioning parts, from the ductwork to the air conditioning refrigerant, need the air conditioning filter to be clean and replaced to ensure you're getting the very best in central air conditioning. If an air conditioning filter is left dirty, over time, it can lead to higher energy costs and short equipment life due to all the air conditioning parts relying on each other. One can not work without the other. Overall, your heating and cooling will not be as effective and you will need to invest in more air conditioning repair and air conditioning maintenance.

An air conditioning filter should be changed every month or every two months for home air conditioning systems and every couple of weeks for certain commercial or industrial air conditioning since it's running almost 24 hours a day, 7 days a week. Doing this as a routine in your monthly chores and not waiting until you see dust matted on the air conditioning filter will ensure you and your family the very best health as well as a smooth running air conditioning system. Dust particles can not always be seen so even if you see a little dust on the air filter, clean it as you normally would.

Since there are a variety of air conditioning filters, how quickly one gets blocked versus another depends on the brand - most air conditioning filters are sized 1 ½ to 2 square feet for each ton of capacity for a home or commercial property.

You can judge a filter**'s** ability to clean by using MERV ratings - Minimum Efficiency Reporting Value - which is a rating of how efficient an air conditioning filter is from 1-12. The higher the rating, the more effective it is at removing particles such as animal dander, pollen, dust, mold and other allergens, and the better the protection for your air conditioning equipment. Most air conditioning filters screen out particles measuring from 3 to 10 microns in size.

The common types of air conditioning filters are:

- ***Conventional fiberglass disposable filters*** (1" and 2"): These are common in most homes and small industrial air conditioners and commercial air conditioning systems**.** Since they are disposable

and have an adhesive coating that traps the dust, you should not clean the filters . This may damage the filter's ability to remove particles by damaging the adhesive coating and/or the underlying mesh work. They are both not as effective as other types of filters even though they are lower in cost.

- ***Pleated fiberglass disposable filters*** (1" and 2"): The 1" are generally used in many residential and commercial settings and are made of materials that can vary in the effectiveness. Usually, they are more densely woven to increase the efficiency of removing dirt. These have a larger surface area to lead to increased trapping of particles as compared to conventional filters. They must be specified for your air conditioning system or this can lead to increased demand on your air conditioning components. Thereby, a mismatch can be counterproductive on the health of the air conditioning system and possibly lead to higher air conditioning maintenance and service cost. You should check with the air conditioning manufacturer as to the appropriate type of pleated filter for your system. A filter spray can also be applied after the cleaning and drying of the air conditioning air filter .
- ***Electrostatic filters***: Different in design and performance, since there are so many varieties, it is rather difficult to determine which is the most efficient. They are commonly advertised as allergy-free air conditioning filters. These filters also come in the 1" and 2" sizes. Air that moves through the filter creates a static charge that collects any dust in the filter. They may require more cleaning and more blower power.
- ***Electronic filters*** *:* Connected to an electrical power source and usually wall mounted, electronic filters come with a pre-filter that can collect larger particles and only need to be cleaned every six months.
- ***Carbon filters*** : These filters contain carbon that can control any odor problems you might have within the air conditioning system . They can also be useful in homes with pets.

Air conditioning filter installation

When placing the appropriate air conditioning filter in to the system, the filter should be placed in the correct direction as indicated by the arrow located on the side or face of the filter. Air should flow in the proper direction which is

in the same direction as the arrows. This allows the filter to work appropriately, as the air exits the filter in the most reinforced part of the filter. The air conditioning filter should fit tightly. A perfect seal is necessary to prevent unfiltered air from entering and damaging your air conditioning system. Without a perfect seal and appropriate sizing, the filter is useless. Additionally, the non-conventional filters may have a higher efficiency and may not fit your system. This should be checked with an air conditioning company, contractor, or air conditioning supply company.

Air handler

The outdoor unit, or condensing unit, is part of the air conditioning system and is there to provide your home with central air conditioning year-round. But the outdoor unit also has an indoor unit, called the air handler. It is usually used in place of a gas furnace and is just as cost efficient. The air handler is the unit that circulates all of that lovely air we crave in the summer and the heat that's essential for those living in colder environments and it does so evenly throughout the home. One unit cannot work without the other, they work together to provide central air conditioning**.**

Air handlers operate in conjunction with an air conditioning or heat pump system, are simple to the naked eye and are generally used instead of a furnace. An air handler is a box made of sheet metal, with holes on each side and a fan that circulates the air. It also houses essential air conditioning parts, such as an evaporator coil and an air conditioning filter.

There are various sizes and efficiency ratings of air handlers, mainly due to the different air conditioning systems. Both are matched together to provide the very best central air conditioning for the size of the home or office building. Basically, it's the part of the air conditioning system that solely focuses on the cooling of the house, while the condensing unit, or "outdoor unit," focuses on the heating. Both have the same parts yet concentrate on different functions to provide both heating and air conditioning.

The air handler can also be referred to as an "indoor unit." Whenever you have to replace the outdoor air conditioning unit, you also have to do the same with the air handler because both are designed to provide the very best air conditioning system**.** Not matching these two air condition parts can result in insuf-

ficient heating and air conditioning you come to expect of your central air conditioning**.**

Something not entirely new to the market but an added perk are variable speed air handlers**,** which pretty much operate the same as the standard but have an added bonus: a variable-speed blower that can cool (or heat depending on if you have an added heating coil) in varying speeds throughout the home instead of an on/off stronger flow that is expected of the standard air handler.

Thermostat

Nowadays there are many advancements, programmable digital thermostats are completely digital versus the old fashioned thermostat with a side switch dial indicating the temperature. Larger homes and commercial property can require a variety of **thermostats** throughout the home or building, so each temperature can be different in various areas at the same time. For example, if someone builds a wine room, the room needs to always be between 50-60 degrees. There would need to be a specifically programmed thermostat with that temperature programmed in. Any air conditioning company or air conditioning contractor can come in and install a digital thermostat specifically for this purpose.

Digital thermostats are easy to program and offer numerous features, all to provide the very best in heating and air conditioning. And the controversy about how these programmable thermostats are too difficult to program is a myth - technology has created them for a reason: all come with manuals and your air conditioning company can show you how they work.

Some programmable thermostats can be programmed up to seven days in advance. It can show the time of day and even adjust to daylight savings time. You can also purchase remotes that can control the temperature in any room from your favorite arm chair. Prices can start from $50 and can go up to $200, depending on your specific needs.

Digital thermostats use either a relay or a semi-conduct device called a triac that acts as a switch to control the air conditioning unit. Some even come with touch screens to serve the utmost in convenience. All thermostats contain a thermometer to control temperatures.

Normally, thermostats never have to be replace, especially digital thermometers. All come with limited-time warranties. Your air conditioning company can suggest the right thermostat for your needs.

Remember to keep your air conditioning filter always clean to ensure the thermostat doesn't get overused. Usually, if you think it's not working, it's because the air conditioning system is dirty and needs to be cleaned.

Portable air conditioning

Whether you're at home, in the office or renting an apartment, portable air conditioning could be the answer to your air conditioning and air circulation needs. Easy to move around, portable air conditioning can be transported room to room with hardly any effort. It's also ideal for those oddly shaped windows your spouse was so crazy about when you built your house.

A portable air conditioning unit provides the same heating and air conditioning as an air conditioning system, however, the quantity or the area it cools/heats is smaller and targeted. These rooms could be converted office space (ideal for keeping computer hardware cooler), attics and basements or even a garage.

Portable air conditioners are also recommended for people with allergies because of the easy-to-replace carbon air condition filters**.** These filters help to remove pollen, bacteria, animal dander and dust. Portable air conditioners are not to be confused with a portable air cooler. The portable air cooler uses water and evaporation to cool, the same as an evaporative swamp cooler – so only the outside air is used to cool the room. Portable air conditioners actually use Freon to cool and are more effective in their ability to cool rooms while keeping the humidity at a low level. Although more expensive than evaporative swamp coolers or a window fan, portable air conditioning gives you the feel of central air conditioning with the advantage of generally low air conditioning maintenance. There are no air condition parts to worry about or any air conditioning repair needed. Cleaning the air condition filter is very hands-on and easy to manage – just wipe the air condition filter clean with a soft, damp cloth about every two weeks.

Most portable air conditioners range from 29" to 36" and weigh no more than 85 pounds. Prices usually range from a little under $300 and can go up to $700.

Portable air conditioning is the perfect solution for:

- Those that are renting an apartment and need more of a concentrated cooling system.
- For a house or apartment that you don't want to put nails or holes in as you would with an outside air conditioning unit.
- For senior citizens or the physically challenged who want a simple solution to their air conditioning and central air conditioning needs.
- Oddly shaped windows or areas that are not receiving enough air circulation.
- Industrial or commercial air conditioning needs, in specific areas (such as computer rooms, etc.)

Heat pump

A heat pump is simply an air conditioner that contains a valve allowing it to let you decide whether you want heat or cool air to circulate throughout your home. The heat pump valve can be adjusted based on your specific needs - providing you with a cool breeze or reversing its flow of Freon, located in the air conditioning refrigerant, and delivering a toasty feel to the room. The heat pump is an electric component that has come a long way from the proprietary gas furnace.

Most people are at least familiar with heat pumps and how it can be a cost-effective way to provide the very best in central air conditioning**.** Depending on your climate and your heating and air conditioning needs, choosing an advanced heat pump system can range anywhere from $2,000 up to a top-of-the-line, more popular brand that is around $8,000. Some of the best heat pumps can be very expensive but are very quiet and are sure to give you more "bang for your buck".

Maintaining your heat pump system so it can last you years, comes from taking care of the entire air conditioning system and air conditioning parts. Cleaning the air conditioning air filter at least once a month properly (some air conditioning systems now even have disposable air conditioning filters), doing

an annual air conditioning inspection with a creditable air conditioning company, and simply paying attention to the heat pump thermostat are all ways to make your heat pump air conditioner last.

If you are shopping around for a new heat pump thermostat, look for one that has a variety of features to deliver an overall performance that will give you the best in temperature control. There are two main types of heat pump thermostats and the options are simply based on preference. There are electro-mechanical and electronic heat pump thermostats, used for residential purposes. The electronic heat pump thermostats can provide any temperature you'd like and are entirely programmable, where you can set it to 60 degrees at night and then have it programmed to be at a comfortable 70 degrees when you wake up in the morning. Electro-mechanical thermostats contain a bi-metal coil or strip that are two different types of metals, which expand and contract at different rates. When this takes place, the coil or strip moves and connects to a device that will provide the electrical circuit. They are set at standard temperatures and you adjust them with a little switch to the appropriate temperature.

All-year Air Conditioning, Ventilation, Gas Supply

Air conditioning implies the control of temperature, humidity, purity and motion of the air in an enclosure. In our modern world of science and highly developed technology air conditioning is of a great significance for industrial processes as well as for human comfort. As an example it must be mentioned that during the manufacture of extremely delicate equipment such as inertial guidance systems for rockets, airplanes or submarines both temperature and humidity must be closely controlled and air purity provided at an extremely high level.

Air conditioning for human comfort is employed in both large and small installations, such as theatres, office buildings, department stores, residences, airplanes, railways, cars and submarines. According to their purpose air conditioning systems may be described as winter, summer and all-year systems. Considering their basic design they are called unit or central air conditioners.

All-year air-conditioning systems must provide means for performing all the processes required for winter and summer air condi-

tioning. The basic pieces of equipment are the filters, preheat coils, humidifiers, dehumidifiers, reheat coils, additional cooling coils, fans and controls. The control of air purity can be achieved in various degrees. As a minimum control some sort of filtering must be done near the entrance of the air-conditioning system. Possibly the most efficient filtering device is the electrostatic precipitator.

In order to establish the size and operational requirements of an air-conditioning system, the maximum probable heating and cooling demands have to be calculated. The maximum probable heating demand is usually for winter air conditioning and it involves heating and humidifying. The maximum probable cooling demand is generally for summer applications and requires cooling and dehumidifying. The inside design conditions depend entirely upon the purpose for which air conditioning is used. Certain industrial process requirements and human comfort are the two major factors to be considered. With ever increasing tendencies to use air-conditioning a building engineer must have sound knowledge of the subject.

As far as ventilation is concerned the modern theory to this effect can be summed up in the statement that for places of general assembly the purpose of ventilation is to carry away excess heat and odours and that normally 10 cu. ft per minute of outside air per person is sufficient to accomplish this objective. In buildings such as homes, the leakage of air through cracks in doors and windows is usually sufficient to meet this requirement. Although ventilation was formerly concerned with the supply of fresh air to and the removal of hot and contaminated air from the space it gradually came to be associated with cleaning of air.

Industrial buildings often present special problems in ventilation. There are certain industrial processes that are accompanied by the production of air-born dust, fumes, toxic vapours and gases which are hazardous to the health of workers. Three types of ventilation are in use so that to control dangerous gases and dusts: exhaust systems, dilution systems and combinations of both. The contaminated air is exhausted at high velocity from hoods which have sufficient entrance velocity to pick up the contaminants.

Another indispensable part of modern amenities is gas supply. It has come now to be of a very wide use. With an intensive exploration of finding natural gas it has gradually replaced the manufacture in its utilization. At the present time natural gas is put to large-scale economic use. The principal utilization of natural gas is as a clean, convenient, economical source of heat. In homes it is used for cooking, water heating, refrigeration for food as well as for space heating. Nowadays most of the homes are heated by natural gas and the number of gas-supplied homes was increasing at a rate limited chiefly by the ability of the steel industry to produce the pipe through which the gas is transported. Natural gas supply is used also as a heat source in commercial establishments such as restaurants and bakeries for cooking and in stores, offices and other commercial buildings for heating and comfort cooling.

Principles of air-conditioning

The term air-conditioning has been so widely and loosely used that the student should be careful in trying to understand its true meaning. For many years we have introduced air into buildings after heating, dehumidifying and, in some cases, cooling it, and we have called that process ventilation. In recent years much greater stress has been laid on the treatment of air as compared with circulating it merely through the building, and we now call the process air-conditioning. Air-conditioning, then, may be said to be the treatment of the air in the building so as to make it more comfortable or healthful for human beings or more suitable for manufacturing processes.

The factors which are of importance in air-conditioning are many, and unfortunately the term is sometimes used to refer only to minor factors such as cleaning and circulating of air. It is important that the engineer should exactly realize what an air-conditioning system does and what it does not do, and that he should make clear to others what results can be expected from the system.

Complete air-conditioning is known to involve the simultaneous control of the following factors: temperature, humidity, air motion, air distribution, dust, bacteria, odours, toxic gases. Of these the first three, temperature, humidity and air motion, are most important, and no air-conditioning system deserves the name unless it satisfactorily controls those three factors. Thus it follows that air-conditioning involves heating as well as cooling.

The general problem of maintaining comfortable conditions in an occupied room has been the subject of study for many years. Early investigators believed the atmosphere of a crowded room to cause discomfort through its effect on the lungs, and carbon dioxide, being the principal product of respiration, was looked upon as the harmful element. Air-conditioning, or ventilation, as it was formerly called, was therefore considered for many years to be a problem of supplying sufficient fresh air to dilute the carbon dioxide content.

Experiments led engineers to give up this theory. Severn I men were placed in an airtight chamber until the carbon dioxide content increased and the oxygen content decreased considerably. They suffered great discomfort; but when the air was set in motion by fans, the discomfort at once disappeared. Other men outside the chamber experienced no discomfort from breathing the air from the chamber through tubes, but those within the chamber experienced no relief from breathing outside air. This experiment demonstrated the concept of air-conditioning, namely, that the cooling effect of the atmosphere upon the skin is of great importance and that comfort depends upon maintaining the proper thermal environment. The men within the test chamber were uncomfortable because their body heat was not being properly removed, and they became more comfortable as the fans increased the rate of heat removal.

From the History of Sewerage

Man's sewerage practice has been known from ancient times. Explorations revealed sewers in Babylon dating from the 7th century before our era. Considerable information is available about the sewers of Jerusalem, works of this class in ancient Greek cities are fairly well known and the great underground drains of Rome have repeatedly been described.

The history of the progress of sanitation in London probably affords a typical picture of what took place quite generally about the middle of the 19th century in the largest cities of Great Britain and the United States. Well into the19th century while London outgrew the narrow limits of the city proper and its adjacent parishes and became a great metropolis, the centre of the world's commerce, sanitation was as little considered as magnetism or the use of steam for power purposes.

The lack of central authority rendered a systematic study and execution of sewerage work impossible. As late as 1845 there was no survey of the metropolis adequate as a basis for planning sewers. The sewers in adjoining parishes were of different elevation so that a junction of them was impracticable.

But the strong feeling that good public health is a valuable municipal asset and depends largely upon good sewerage was the deciding factor in the growing popular recognition of the sanitary importance of a good sewerage system.

The first engineer who made a comprehensive study of metropolitan sewerage needs, thus described the conditions of London basements and cellars in 1847: "There are hundreds, I may say thousands of houses in this metropolis which have no drainage whatever and the greater part of them have stinking overflowing cesspools. And there are also hundreds of streets, courts and alleys that have no sewers." After 2 outbreaks of cholera a royal commission was appointed to inquire into sanitary improvements of London. In 1855 Parliament passed an act for the better local management of the metropolis which laid the basis for the sanitation of London.

In the continent a marked progress in sewerage began in 1842 when a revere fire destroyed the old part of the city of Hamburg. The portion ruined was the oldest and it was decided to rebuild it according to the modern ideas of convenience. As a result Hamburg was the first city which had a complete systematic sewerage system throughout built according to modern ideas. The system proved so well designed and maintained that twenty five years after the sewers were completed they were found by a committee of experts to be clean and almost without odour.

At the present time the problem of good sanitation is closely connected with that of protecting the purity of natural water reservoirs, since often the same body of water must serve both as a source of water and as a recipient of sewage and storm drainage. And it is this dual use of water in nature and within communities and industrial premises that establishes the most impelling reasons for water sanitation.

The source of pollution lies largely in the effluents of industry, urban life, agricultural production and transport, the worst pollution being caused by the chemical industry. Modern agriculture which utilizes huge quantities of chemical fertilizers also pollutes the ground water and rivers.

Despite the growing improvement in water treatment methods many regions of the world cannot cope with the rapid rate of water contamination. The highly industrialized countries naturally suffer more than others. Certainly the conditions which existed only a century ago cannot be restored in present or future large cities. But we badly need to find new ways of using the water in industry and agriculture and of radically improving the technology of drainage purification.

International standard of swimming bath

A new indoor swimming-pool of international standard with facilities for champions and children, has been built.

Extensive research was carried out before the design of the building and many of the best features of swimming-pools at home and on the continent have been incorporated in the new pool.

Up to six hundred bathers will be able to use the L-shaped swimming-pool at one time and the spectators' gallery equipped with tip-up seats, can accommodate five hundred.

Glass is used extensively in the new building to give bathers a fine view of the park and an impression of being in the open air. A sunbathing terrace overlooking the lake in the park is also available for the bathers.

The main pool is 110 ft long and 42 ft wide and the depth varies from 3 ft 3 in to 6 ft. The short leg of the "L" forms a 12 ft 6 in deep diving pool, 33 ft by 44 ft, and has one metre and three metre springboards and a five metre firm board. The diving bay allows the bathers to use the full length of the main pool even while diving is in progress.

A separate learners' pool, 41 ft 3 in by 24 ft with a depth of from 2 ft 6 in to 3 ft, with "walk-in" steps at one end is provided in the angle formed by the main pool and diving bay. A walkway runs the entire length of the pool on one side to bring the instructor down to the level of the pool.

A refreshment block with two floors has a kiosk on the ground floor to serve the sunbathing terrace and the park. On the first floor is a 72 seat restaurant and snack bar, which is also open to visitors to the park, and a Baths Superintendent's two-bedroomed flat. Both swimming-pools are heated and a water treatment plant gives a four-hour turnover to the main pool and a

three-hour turnover to the learners' pool. The temperature in the hall is maintained several degrees higher than that of the water and a plenum ventilation supplies $2^1/_2$ changes of fresh air without recirculation. The extract system is planned to give three air changes an hour but can be increased to four air changes. The plenum plant is supplemented by underfloor electric heating.

Superstructure of the hall is steel with lattice girder roof member spanning 115 ft. The refreshment block is also concrete encased steel framed construction and has reinforced concrete floor and roof slabs.

The main pool, diving bay and learners' pool and changing room block are of reinforced concrete construction.

Panel heating

Heating and ventilation are two branches of engineering which are very closely connected, they are therefore treated as a dual subject. Both are concerned with providing a required atmospheric environment within a space, the former with respect to heat supply to produce a desired temperature for maintaining comfort, health or efficiency of the occupants, the latter with regard to supply and removal of air frequently with emphasis on contamination of the air. Air-conditioning is closely related to both heating and ventilation and will therefore be dealt with later.

It is for heating to prevent the too rapid loss of heat from the body. By heating, the ambient air of walls, ceiling or floor the rate of heat loss from the body is controlled. Some old concepts of heating were gradually changed since engineers obtained more precise knowledge about how the body loses heat. Insufficient attention was paid formerly to loss by radiation, which is the transmission of energy in the form of waves from a body to surrounding bodies at a temperature. The human being also loses heat by conduction (through his clothes) and convection, the latter by air currents not only past his skin or outside clothing surface but also by evaporation of moisture from his skin (respiration). The determination of the capacity or size of the various components of the heating system is based on the fundamental concept that heat supplied to a space equals heat lost from the space. The most widely used system of heating is the central heating, where the fuel is burned in one place - the basement or a specially designed room and from which steam, hot water or warm air is distributed to adjacent and remote spaces to be heated.

There are two most common systems of heating - hot water and steam. Both systems are widely used nowadays. A hot-water system consists of the boilers and a system of pipes connected to radiators suitably located in rooms to be heated. The pipes, usually of steel or copper, feed hot water to radiators or convectors which give up their heat to the room. The water, now cooled, is returned to the boiler for reheating. As for steam systems, steam is generated usually, at less than 5 pounds per square inch in the boiler and the steam is led to the radiators through or by means of steel or copper pipes. The steam gives up its heat to the radiators and the radiator to the room and the cooling of the steam condenses it to water. The condensate is returned to the boiler either by gravity or by a pump. The air valve on each radiator is necessary for air to escape. Otherwise it would prevent steam from entering the radiator. Recent efforts to completely conceal heating equipment have resulted in an arrangement whereby the fluid, whether it be hot water, steam, air, or electricity, is circulated through distribution units embedded in the building construction. Panel heating is a method of introducing heat to rooms in which the emitting surfaces are usually completely concealed in the floor, walls, or ceiling. The heat is disseminated from such panels partly by radiation and partly by convection, the relative amounts depending on the panel location. Ceilling panels release the largest proportion of heat by radiation and floor panels the smallest. The proportion of heat disseminated by radiation and convection is also dependent to some extent upon panel-surface temperatures.The basic advantage claimed for a panel heating system is that of comfort.

Application of certain panels is frequently restricted by structural details, other factors to be considered are type of occupancy, furniture or equipment location, large glass areas, heat-storing capacity of building construction, room height, possible change of wall partitions, climate, exposure, and first cost.

Building materials. Metals

All metals are divided into ferrous metals and non-ferrous metals.

Ferrous metals are metals and alloys the main component of which is iron. The classification of ferrous metals includes iron, steel and its alloys.

Metals, in general, and especially ferrous metals are of great importance in various constructions.

Non-ferrous metals are metals and alloys the main component of which is not iron but some other element such as copper (Cu), aluminium (AT) and others. Copper, aluminiun and some other metals are referred to as non-ferrous metals. The properties of ferrous metals:

a) all metals can be easily known by their specific metallic lustre;

b) metals can be forged;

c) metals can be pulled;

d) all metals, except mercury, are hard substances. However, hard metals can be reduced to liquid by heating;

e) being fusible metals can be melted;

i) in general, metals are good conductors of electricity.

These characteristics are possessed by all the metals, but the metals themselves differ from one another.

Steel and cast iron are referred to the group of ferrous metals. They are alloys of iron (Fe) with carbon (C), manganese **(**Mb**),** Silicon (Si) and other components. By the content of carbon in metals we distinguish cast iron, white cast iron, grey cast iron and wrought iron. The carbon content ranges from **0** to 4 per cent.

Cast iron is the cheapest of the ferrous metals. Cast iron contains 1**.7** per cent carbon.

White cast iron is used in those machines which require some resistance to abrasion. The tensile strength of white cast iron is about 30,000 pounds per square inch, its hardness is about 400 to 500 Brinell.

Grey cast iron is an alloy of iron, and carbon in which some of the iron carbide is dissociated to form graphite carbon. Grey, cast iron has its term because of surecial colour of its fracture.

It is quite necessary to regulate the proportion of silicon in the melt and to control the temperature after the grey cast iron has been poured.

Wrought iron is a mixture of very pure iron and silicate slag. Properties of wrought iron such as strength, toughness, ductility have more advantages than cast iron. Wrought iron is quite ductile and can be easily rolled, drawn, forged and welded.

Steel is an alloy consisting of iron and carbon in which the carbon content does not exceed 1.7 per cent. Steel is obtained from cast iron. Steel is hard and malleable. There are different kinds of steel, such as cast steel and forged steel.

Alloyed Steel (or Special Steel) is steel to which elements not present in carbon steel have been added, or in which the content of manganese or silicon is increased above that in carbon steel. This kind of steel is widely used in building.

Stainless Steel is corrosion resistant steel of a wide variety of compositions but always containing a high percentage of chromium (8-25%). Stainless steel is used for cutlery, furnace parts, chemical plant equipment, valves, ball-bearings,etc. Non-ferrous metals

Some of the characteristics of non-ferrous metals are: high electric and heat conductivity, high corrosion resistance, non-magnetic qualities, light weight and easiness to fabrication.

Aluminium is the oldest and best known light metal. An aluminium alloy containing about 8 per cent of copper is stronger than pure aluminium but it possesses less ductility.

Aluminium is a white silvery metal. It does not rust in the air. Aluminium like copper is a soft metal. That is why it is used only when alloyed with other metals. Aluminium alloys are liable to corrosion, particularly by salt water, or in salty atmosphere.

Copper is found in nature in the form of ores but it is sometimes found in pure state. Pure copper is of reddish colour and it has corrosion resistant qualities. Copper is the best conductor of electricity. There are many different alloys with copper. An alloy of copper and tin is called bronze.

Gas pool heater plumbing

If you want to install a swimming pool there are many possibilities available today when talking about materials, shape and size. On the other hand, another very important choice you do need to make is what type of pool heater to install. The most common choice stands in gas and propane pool heaters. They will work on natural gas if your home has it or on propane tanks that can be mounted below or above ground.

Today's gas pool heaters are highly efficient and will only consume as much gas as you want them to. They are controlled with the use of a thermostat

and this means that you simply can' t forget them opened. An on/off switch is always present together with a pressure switch, a gas valve and different high limit switches in safety circuitry, based on model and size. Keep in mind that you will need to properly install and vent gas pool heaters and the linked plumbing so that hazards will never appear.

There are some problems that can appear with gas pool heater plumbing but most of them are easy to solve in most cases. The most common one stands in the fact that the pilot would not light. In most cases we are dealing with low gas pressure, improper venting or an inadequate air supply. You will need to make sure that the gas is turned on and if you use propane make sure that the tank is filled. The water run-off on roofs or sprinklers must also be checked while also making sure that there are no clogs in the gas pool heater plumbing system. Another problem might be that the water will not reach the needed temperature. In this case you might have the thermostat set too low.

Also, if there is heat loss greater than heat input you can get the same problem. This happens when the outside temperature is just too low, the heater does not have a proper gas supply or it might just be too small. A solar cover can be installed to slow heat loss and if you have a faulty high limit switch you should shut off the heater or more problems can appear. If you see that the heater cycle goes off before the desired temperature is reached the water flow might not be adequate, because of a closed valve, dirty filter, reversed water connections, faulty pressure switch or an external bypass. The thermostat must also be checked for possible faulty calibration.

Using solder fittings with plumbing copper pipes

In order to perform this action you will need thin gauge solder, plumbing solder flux and wire wool as materials together with a blow torch, a damp cloth and a heat screen. The first step is cutting all pieces of pipe to the proper length and cleaning every end of them with using a piece of steel wool. Every piece of pipe needs to be slid into the connector while making sure that they go in until reaching the stop in the body. A bind pipe means that there is a distorted end to the pipe (which means you should cut another length of copper pipe), a burr is found on the outside of the pipe (you will need to remove it) or there is an obstruction present in the body (you might need to get rid of the connector or you might use a round file to remove the obstruction if it is found off the solder

ring).Now you will need to apply a thing coating of plumbing solder flux around the pipe. Use a brush to do this as plumbing solder flux will usually contain some sort of acid, which means it must not come in direct contact with your skin. Use a twisting movement to insert the pipe in the connector and assemble the rest of the pipes into the body of the connecter. You should never solder every pipe separately as all need to be linked in the same operation. The heat skin will be utilized to protect the area around the pipes when using the blow torch. Now you will need to light the blowtorch and let it heat up for around 2 minutes. Get the torch to a bright blue flame and you are ready for soldering.

To sold standard plain fittings that do not have built in plumbing solder you have to use solder manually. Evenly apply heat to the whole joint after unrolling a length of solder and play the flame across every joint. Make sure that you move the flame all around it and as soon as you see the solder flux bubbling you have to apply the end of the solder to the joint. Thanks to a capillary action the solder will be drawn between the fitting and the pipe. You can also sold fittings that come with solder that is already placed where it is needed as soon as you apply heat. The solder will fill the gap between the pipe and the fitting. Always apply heat evenly and as soon as a ring of solder will appear in the gap you have to remove the heat source. If you apply to much heat the plumbing solder will get out of the joint and the link will not be established. Allow it all to cool, check for leaks and you are done.

Solving home plumbing problem

Home plumbing problems are bound to appear and it is important to know how to solve the most common ones. This refers to the ones that anybody can fix and, in fact, most of the plumbing problems you will meet during your life will be easy to get rid of. On the other hand, it is equally important that you understand the fact that prevention is better than fixing. Running maintenance on your plumbing system and paying attention to what you do is crucial. For instance, pouring vinegar and baking soda once per week in your drains is a very good idea that will prevent most clogs from appearing. The bad news is that sooner or later there will be some home plumbing problems that we will need to solve. Before calling a professional you could consider solving them yourself. For this you will require information on what to do. Let us think about the best places to find such info about possible home plumbing problems and who to trust.

The truth is that the best place to obtain information on solving home plumbing problems is the Internet. There are basically dozens of high quality web sites that will offer tons of information on a variety of topics that you might want to know about. This ranges from simple tasks like unclogging a drain to more complex actions like replacing pipes that have cracked. A simple search of your particular home plumbing problem on a major search engine like Google or Yahoo will reveal a lot of possible answers and even tutorials on what you can do. The bad news is that there is a possibility that you will not find the results you might want to. In such a case you will need to ask a professional. This is also available through the Internet by utilizing one of the numerous forums and message boards out there. All you really need to do is create an account and ask questions about your home plumbing problems. You will get answers from people that might have been in the same situations or even professional plumbers that will give you inside information about what you can do.

It is important that you understand that some home plumbing problems will require you to phone a plumber. In most cases we are talking about any problem that you are not sure you can fix yourself. It is always better to be safe then sorry so if you think you can not handle the repair you should contact a professional because you might create more damage if you do something wrong.

What is a plumbing snake?

The plumbing snake is probably the most common plumbing tool utilized around the world. It is very unlikely that you will not need one in your life and its main purpose is to remove drain clogs. The best part about it is that using a plumbing snake does not require high plumbing skills. In fact, most average citizens that have little to no maintenance experience can remove drain clogs with the use of this tool. Also, just owning one and using it yourself can save you important amounts of money when compared to calling a professional plumber.

A plumbing snake works in a very simple way. It has a small drill or augur at the end of a long and flexible hose. It is not important how deep the clog is because you can drop the head of the snake down the drain and it will eventually reach the source of the trouble area. The only thing that can happen is not having a long enough snake but they do come in various sizes and it is highly

unlikely that you will not be able to utilize a plumbing snake to reach the area that you want. All you have to do to remove the drain is do a little maneuvering and the clog will be broken down from afar, without the need to break a pipe or remove an element.

The cost of a plumbing snake is less than the amount of money you would need to pay a plumber. To make it even worse when talking about money, the plumber will remove the clog by using a plumbing snake. When purchasing such a tool you will also get an instructions handbook. You can also opt for a manual plumbing snake or one that is electric. This is based on preferences and budget. The drilling element at the end is a rounded coil, which means that no damage will be done to your pipes. Landlords actually find plumbing snakes to be an investment that needs to be made. They can fix the sinks or toilets of the tenants without a need to hire a professional. Snakes are also easier on the environment when compared to some chemicals. We all get drain clogs so a plumbing snake truly is an investment we should do. What do we have to lose? We will spare money and get the job done with a plumbing snake and all is easy and practical!

How to draw plumbing isometrics

Drawing plumbing isometrics can be done in various ways, depending on what is easier for you. The only rule that needs to be respected is that it must be understandable always for both yourself and others that are going to read it. In order to do it properly you could consult an Engineering Aid. They usually suggest that you draw the lines of the room with simple, fine, light lines. Then the pipe diagram has to be drawn with dark, heavy lines in order to create the effect of a transparent room, one that you can see into.

The method mentioned above can be difficult in field sketching. This is because it will require drafting room equipment. On the other hand, we can also visualize the layout of the pipe by removing or sectioning from the drawing the areas that are situated in front of what you actually have to show. In most cases we can notice that plumbing isometrics drawings will leave out of the drawings the ceiling and two of the walls, the ones that are not important.

Another method to draw plumbing isometrics is simpler than the ones men-

tioned above. This is because you will end up showing the room as a partial floor plan view. You simply omit the walls entirely from the drawing. The reason behind doing so is that everybody knows that the walls are there but they are not shown in the isometrics drawing in order to put an emphasis on the plumbing and eliminate every detail that is not necessary. Also, a practical thing that can be difficult to some stands in laying out a 45 degree angle in isometric schematics. In order to achieve this all you need to do is draw a square and then lay out the 45 degree angle. This will make it a lot easier to perform the degrees shift. You can locate the chamfer by measuring equal distances from the corners that should be in the drawing even if they are not.

The key element in drawing plumbing isometrics is to keep trying. You will eventually get a lot better than you are now. Consult various isometrics drawn by professionals and you will soon see that it is a lot easier than you previously imagined it. Practice makes better and this goes for everything related to plumbing and not just drawing isometrics.

How to perform a smoke test on sewer plumbing

Smoke testing is a process that is periodically performed as a part of an ongoing sanitary sewer inspection program. It is utilized in order to identify areas that see clear water entering the system and that could be causing eventual sanitary sewer backups. The test will see a non toxic smoke being forced into the sewer plumbing of the neighborhood or in smaller areas. Keep in mind that direct contact with this smoke can cause minor respiratory irritation so if there are individuals that suffer from various respiratory conditions they should not come in contact with the smoke.

Smoke testing forces air that is filled with smoke in a sanitary sewer line. We are dealing with pressure so it will end up filling the main lines and any other connections. If there are any leaks the smoke will appear on surface, thus revealing possible places that show problems. Not much pressure is needed and the minimum required is enough to overcome the pressure of the atmosphere. If there are openings that can permit the smoke to follow them, smoke tests are effective, no matter the soil type, surface type or the depth of the lines tested. The truth is that the most cost effective and efficient way to find out the loca-

tions of the places where clear water enters the sewer system is smoke testing. The good news is that it is becoming a nationwide requirement in order to locate clear water problems. This is beneficial as such situations can threaten the ability to treat waste water and a lot of money is thus wasted by wastewater treatment facilities. Another positive aspect of smoke testing is that it helps people in locating plumbing leaks in buildings. We all know that sewer gases can cause a lot of health problems so they need to be fixed as soon as they are discovered.

If you want to stop smoke from entering your home you can run water into the drains for around one minute. Smoke would thus enter your home in remote situations like inadequate, defective or improperly installed vents, problems with traps, pipes, connections and seals. If you detect smoke in your home while smoke testing you will need to contact a plumber as soon as possible in order to deal with the problem. We wouldn't want health problems to appear and there is this possibility if smoke enters the home**.**

How to measure copper tubing and plumbing

Measuring copper plumbing and tubing is not difficult but you need to realize that there are other aspects that you need to be aware of besides measurements. This will aid you in getting the job done as fast and as good as possible. The best part about it is that you will get better every time so do not be disheartened if you make a mistake. Just keep your focus and try again. You can not become a plumber over night as you can not get everything right the first time you do it.

The measurement process is fairly simple. In order to realize how much copper tubing and plumbing you need you will have to measure the distance between the new fittings and then add the makeup distance needed to extend into the fittings. This will vary based on joint type: flared, compression, union or soldered. The biggest mistake that people usually make is measuring wrong because of not taking into account these extra needed pieces. After measuring you will need to cut the copper pipes and you should do this by using tubing cutters or a hacksaw although the tubing cutter is better but sometimes there is not enough space to use it so the hacksaw is the only alternative.

Pay attention to not damage the copper as you work because it is soft metal. It is easy to damage so do not utilize vises or wrenches that can actually

crush the metal. In most cases you will join copper tubing by utilizing soldering. Soldered joints are always made by utilizing copper fittings with special smooth interiors and internal stops or shoulders. The actual soldering requires a propane torch, emery cloth, sandpaper, soldering flux, lead free plumber's solder and steel wool. Pay attention to never unite the pipes by utilizing solder that is not labeled lead free when you make various joints that are to be a part of a potable water supply system or DWV system. Also, if soldering is difficult because of the location of the copper tubing and plumbing you should utilize compression fittings. They work well on both soft and hard-temper copper tubes so there is nothing to worry about.

Although measuring is easy, soldering is not. You do need some experience to do it properly so if you think you can not do it or you fail you should call a plumber.

ПРИЛОЖЕНИЯ

Приложение 1

Russian – English Dictionary

A

аварию ликвидировать – to clear an emergency

агрегат автономный для охлаждения воздуха – self-contained air cooler

агрегат вентиляторный – fan unit

агрегат водоохлаждаемый – water-cooled unit

агрегат воздухораспределительный – air distribution apparatus

агрегат воздушно-отопительный – air heater

агрегат компрессорно-конденсаторный с регулированием давления – pressure controlled condensing unit

аккумулятор с ограничением по энергопотреблению – demand-limited storage

аккумулятор теплоты – thermal storage vessel

активация режима мощного охлаждения или подогрева – activate powerful cooling or heating

амортизатор – shock absorber

анализ горючих газов – fuel gas analysis

аппарат направляющий (вентилятора) – guide vane assembly

аппарат газосварочный – autogenous welding apparatus

аппарат для осаждения (коагулянт) – precipitator

аппарат сублимационный коллекторный – manifold drying apparatus

арматура отопительная – heating mountings

арматура смесительная – mixing tap set

арматура трубопроводная – piping accessories

астатическое регулирование – floating control

Б

бак напорный – head tank

бак охладительный – cooling tank

бак подпитывающей воды – feed water tank

бак расширительный рассольный – brine head tank

бак топливный – combustible tank

баланс топливно-энергетический – supply-demand balance

баллон газовый – gas bottle (cylinder)

бандаж трубы – pipe wrapping

банк данных – data bank

барабан фильтра – filter drum

бассейн для коагулирования – flocculator

батарея воздухоохладителя – air-cooler battery

батарея осушения кондиционера – dry air-conditioning battery

батарея кондиционера (теплообменник) – air-conditioning coil

батарея отопительная – heating grid

бесшовный – seamless

блок конденсации – condensing section

блок теплоизоляционный – block – type thermal insulation

блок фильтров – filter bank

болт закрепляющий – fixing bolt

болт натяжной – clamping screw

борат (стекло) – E-glass

брак – deterioration

борьба с задымлением (с шумом) – smoke (noise) abatement

быстродействие – snap action

В

вагон – цистерна – rail tanker

вагонетка загрузочная – charge bogie

вакуум – водяная холод. система – water vacuum refrigerating system

вакуум – провод – vacuum pipe

вал карданный – drive shaft

вал коленчатый – crankshaft

вал насоса – pump shaft

вата минеральная – mineral (slag) wool

ввод домовой – service connection

ввод контактно-замыкающий – contact-closiure input

вертушка гидрометрическая – hydrometric wing

величина гидростатического давления – height of hydrostatic

величина действительная – actual value

величина заданная – set value

величина инфильтрации средняя – average specific infiltration

величина нагрузки – application part-load value

величина натуральная (масштаб 1:1) – full scale

величина начальная – cut-in point

величина недостаточная – default value

величина пороговая предельная – threshold limit value

величина частичной (неполной) нагрузки – part-load value

величина энергии требуемая – energy value target

вентиль вакуумный – anti-siphon valve

вентиль водорегулирующий – pressure-operated cooling water valve

вентиль главный запорный – main stop valve

вентиль двухходовой – two-way valve

вентиль дроссельный – butterfly valve

вентиль для сброса давления – compression release valve

вентиль для спуска масла – oil drain valve

вентиль запорный всасывающего трубопровода – suction line valve

вентиль запорный нагнетательного трубопровода – discharge line valve

вентиль комбинированный – joint valve

вентиль муфтовый – sleeve valve

вентиль обводной – by-pass valve

вентиль парный (для наполнения и опорожнения системы) – companion valve

вентиль продувочный – purge valve

вентиль плавающий – float-valve

вентиль сильфонный – bellows valve

вентиль терморегулирующий – temperature expansion valve

вентилятор бесшумный – quiet – running fan

вентилятор в системе вентиляции – ventilating fan

вентилятор вытяжной – exhaust fan

вентилятор нагнетательный – air blower (plenum fan)

вентилятор приточный (крышный или в стене)– power ventilator

вентилятор пропеллерный осевой – helical fan

вентилятор с двухсторонним всасыванием – double-suction fan

вентилятор системы кондиц. воздуха центр. – central-fan air condition

вентилятор тангенциальный – cross-flow fan

вентилятор теплоутилизационной системы – heat recovery ventilator

ветвь трубопровода – pipe run

вещества взвешенные – solids

вещество вяжущее – binder

вещество горючее – combustion medium

вещество парозадерживающее – water retarder

вещество растворенное – solute

вещество сухое – dried matter

винт – screw

влагоизоляция (гидроизоляция) – moisture barrier

влагорегулятор – humidistat

вода под давлением – pressure water

вода подпиточная – make-up water

вода просачивающаяся – seepage water

вода сточная – waste water

водонагреватель с двойным корпусом – double - wall water heater

водоохладитель автономный – self-contained water chilling

водоснабжение аварийное – emergency water supply

водоснабжение автономное – own water supply

воздуховод – trunk

воздухоохладитель – air cooler

войлок битуминизированный – bituminous felt

волокно пластмассовое – synthetic fibre

врезка – cut-in

время использования устройства (системы) – operating life

всасывание воздуха – air suction

вспенивать – foam

втулка – spigot

вызывать коррозию – cause corrosion

выключатель предохранительный – safety cut-out

Г

градус жесткости – degree of hardness

газ баллонный высокого давления – high-pressure cylinder gas

газ гремучий – getonating gas

газ генераторный – producer gas

газ горючий – fuel gas

газ жидкий природный – liquefied natural gas (LNG)

газ неочищенный – crude gas

газ сжатый – compressed gas

газ сжиженный – liquefied gas

газгольдер – gas container (tank)

газоанализатор Дрэгера – Draeger-CO-measuring apparatus

газовая горелка с дутьем – blowpipe

газовый кран – gas faucet

газогенератор – gas generator (producer)

газодувка – gas blower

газопровод – gas conduit

газопровод магистральный – gas main

газоснабжение – gas supply

гайка – nut

гайка-заглушка – box-nut

гайка – колпачок – cap nut

гарантийное обязательство – surety bond

гарантия качества – quality assurance

генератор дуговой сварки – arc-welding machine

геодезист – land-surveyor

герметизация – pressurization

гидрофор – air compressed water tank

гладкий конец трубы при раструбном соединении – spigot

глушитель - choke (muffler)

горелка – burner

горловина – throat

горючее – combustible

градирня – water cooling tower

график для определения размеров трубопроводов – duct sizing chart

график отопительный – heating curve

грейфер – tongs

грунтовка – prime coat

Д

давление на входе (в систему) – initial pressure

давление на выходе (из устройства) – head pressure

давление пара для отопления – heating steam pressure

давление при расчетном режиме – operating pressure

давление продувочное – blowing-off pressure

давление рабочее расчетное – design working pressure

дальнобойность струи – jet range

дамба защитная – check dam

данные исходные для конструирования – initial design data base

датчик – sensor

демонтаж с сокращением объема оборудования – shrink disassembly

деталь соединительная – connecting-piece

деталь эластичная – O-ring

диаграмма «давление – расход» – pressure-volume chart (p-v diagram)

диаметр трубы внутренний – bore of pipe

длина оребрения трубы – finned length

длина строительная – overall length

дно – sole

добавка – additive

добыча газа – gas yield

дозатор – measuring bin

документация проектная – shop drawing

документация техническая между заказчиком и подрядчиком – specification form client-contrac

допуск – tolerance

доска трубная в теплообменнике – dished end plate of heat exchanger

доступ для технического обслуживания – maintenance access

дросселировать – throttle

духовка газовая – gas baking oven

дымосос – induced draft fan

дымоход домовый – house chimney

E

единица давления – pressure unit

единица измерения – unit of measurement

единица сопротивл. водопроницаемости через материалы – rep pen

емкость теплового аккумулятора – integrated thermal storage capacity

емкость регулирующая – buffer tank

Ж

жалюзи вентиляционные – ventilating louver

жаростойкость – heat proofness

железо оцинкованное – galvanized sheet

желоб водосточный подвесной – suspended channel

жесткость воды – water hardness

жесть – metal sheet

жесть гофрированная –corrugated sheet

жесть толстолистовая – thick sheet iron

жестянщик – tinsmith (tinman)

жидкость паяльная – soldering solution

жидкость рабочая – working fluid

жила кабельная – core

З

забутовка – backfill

завинчивать – screw

заглушать – choke

заглушка воздухозаборного устройства – air intake blank

заглушка клапана – valve plug

заглушка трубы – pipe plug

загружать топливо в топку – stoke

загрузка фильтра – filter bed

загрязнение окружающей среды – environment pollution

загрязнение фильтра – choking of the filter

загрязнять – contaminate

загрязняющий – pollutant

заданный – preset

задвижка запорная – shut-off slide valve

задвижка клиновая – key valve

задвижка муфтовая – socket slide valve

зажигание – ignition

зажим – clamp

зажим обоймы – clamp bracket

зажим соединения – connecting clamp

заземление – bonding (grounding)

зазор – clearance

заиливание – siltation

закаливать – quench

заклепывать – rivet

закон сохранения энергии – energy conservation law

закономерность – regularity

закреплять – fasten

закручивание – torsion

закупоривать – plug

залоговая гарантия тендерного предложения – a bid security

замазка – putty

замазка уплотняющая –sealing putty (stopper, mastic)

заменитель – dummy product

замыкание короткое – electrical fault

запасы – reserves

заплатка – patch

запотевание – sweating

заправлять – charge

зарядка фильтра – filter filling

заслонка запорная – shutting clap

заслонка – движок – slide damper

засорять – clog

затвор воздушный – air pocket

затраты на работу – working charge

затягивать – screw in

зачеканка свинцом –caulking of the lead

защита от коррозии – corrosion protection

защитный клапан – pop valve

звено трубопровода – pipeline section

змеевик – pipe coil

знак качества – mark of quality

зола – ash

зонд – probe

зонт вытяжной – exhaust hood

зубило –chisel

И

избыток – excess

известняк – limestone

изгиб – bending

излом – fracture

изменение нагрузки – load variation

измерение трубы – pipe sizing

износ – abrasion

изогипса (линия уровня) – contour line

индекс отклонения допустимый (качества воздушной среды) – predicated mean vote

индикатор готовности – stand-by indicator

инжекция воздуха (нагнетание) – air injection

инженер теплотехник – heat engineer

инженер-инспектор – field engineer

инженер – проектировщик – project engineer

инженер – сантехник – sanitary engineer

инспектор по охране труда – site agent

инспекция строений – check up inspection

инструмент измерительный – gage

интенсивность тяги (сила тяги) – draught intensity

испарение – evaporation

испытание гидравлическое – hydraulic test (water test)

испытание индуктивным методом – eddy current test

испытание трубопроводов под давлением – pressure test of piping

испытание эксплуатационное – performance test

К

кран фланцевый – flange tap

каркас – horse

калориметр (для измерения теплоты) – colorimeter

камера вентиляционная – fan chamber

камера смесительная (возвратного воздуха распределительная) – return air plenum

камера всасывающая – suction box

камера вытяжная – exhaust chamber

камера климатическая исследоват. – environmental test chamber

канал для прокладки труб – pipe gallery

канал для сточных вод – foul water sewer

канал отопительный – heating flue

канал подачи кондиционир. воздуха – air-conditioning supply duct

клапан аварийный предохранительный – emergency – relief valve

клапан автомат. для спуска воздуха – automatic ventilation valve

клапан без изменения направления течения – direct flow valve

клапан пробковый отопительной системы – firing valve

клапан поплавковый высокого (низкого) давления – float high (low) - pressure valve

ключ гаечный – screw key

ключ разводной – spanner

колено трубопровода – bend

колено трубы – pipe bend

компрессор блок – картерный – monoblock compressor

конденсатор пара – steam condenser

корректировочные расчеты –

коррозийность – corrodibility

коррозионно – стойкий – anti-rust

котел большой производительности – high-capacity boiler

котельная – boiler house

коэффициент полезного действия – performance factor

кран водопроводный – water tap

кран газовый – gas – tap

кран заборный – stop cock (faucet)

кран муфтовый – sleeve cock

кронштейн – stand

крышка лаза колодца – manhole cover

крюк для трубы – pipe hanger

Л

лаз для очистки – cleaning door

лампа бензиновая паяльная – gasoline soldering

линия всасывающая – suction line

линия выбросная (горячая) в холодной системе – hot gas line

линия уравнительная (трубопровод) – equalizing line

лопасть вентилятора – flexible blade

ложе (основание) трубопровода – pipeline bed

люк вентиляционный (отдушина) – breather hole

люк смотровой – manway

лужение – tinning

М

мазут – fuel oil

манжета резиновая – rubber collar

масло отопительное – heating oil

мера чувствительности устройства (прибора) – ratio

место утечки – leakage point

мешок водяной в трубопроводе – water pocket

многотрубный – multitubular

модернизация - retrofit

монтаж (сборка в цехе) – shop assembly

мощность отопительной установки – output rating

мощность полезная для перемещения воздуха – air power

муфта с резьбой – threaded sleeve

муфта сварная – welded socket

муфта трубопровода на стыке – pipe coupling

Н

набор слесарно-монтажных инструментов – machinist’s kit

нагрузка отопительная расчетная – design heating load

нагрузка по газу – gas load

нагрузка тепловая – thermal load

настройка – adaptive control

недостаток воздуха – deficiency of air

неисправность – malfunction

ниппель – nipple

нить накаливания – glow filament

насос циркуляционный – rotary pump

насос шестеренчатый – gear pump

норма теплопотребления – fuel input rate

О

обертывающая теплоизоляция – batt insulation

обеспечение компьютера программное – computer software

обеспечение постоянного давления компрессора – safety cylinder head

обеспечивать бесшумность – improve quietness

область измерения – measuring range

область работы – operating range

облицовка огнеупорная – refractory lining

обмазка – rendering

обновление – renewal

оборудование домовое – house installation

оборудование для охлаждения и нагрева комбинированное – combined cooling - heating equipment

оборудование для очистки воздуха – air cleaning equipment

оборудование пылеочистное – dust separation equipment

оборудование санитарно – техническое – sanitary installation

обоснованность – validity

обработка (очистка) воды – water treatment

образование накипи в котле – scale formation

образование пузырьков пара – nucleation

образование трещин – cracking

обслуживание и профилактический ремонт – maintenance

объем отапливаемый – heated space

окраска антикоррозийная – antirusting paint (protective coating)

основные характеристики – performance data

отбор проб – collecting of samples

отбортовка кромки трубы – beading of the tube end

ответвление воздуховода – branch duct

отклонение температуры – temperature deviation

отключение по лимиту потребления – demand limit tripping

отключение по разности давления – pressure differential cut-out

отрезок трубопровода – duct section

охрана труда – occupational safety and health

оценка качества – quality assessment

оцинковывать – galvanize

П

паз – slot

пайка – solder

пайка – сварка – braze - welding

пакля – oakum tow

пар – steam (vapor)

паронепроницаемый – water-vapor permeable

перепад давления в батарее – battery pressure drop

пенька – hemp

первый закон термодинамики – equivalence principle

перегрузка – overload

перерасход воды – waste of water

период отопительный – heating period

поворот трубы – bent pipe

погрешности – accuracy

поставка топлива – fuel supply

поступление теплоты – heat gain

предотвращение разрыва трубы – pipe burst control

прибор измерительный – gauge

пробка воздушная в трубопроводе – air block

прокладка трубопровода – installation of pipe

Р

радиатор газовый – gaz radiator

радиатор из ребристых труб – finned – tube radiator

расходы накладные – first cost

расчет воздуховодов – duct sizing

резьба трубная – pipe thread

рейка нивелирная – leveling staff

ресивер – receiver

решетка вытяжная – exhaust grille

решетки трубные – pipe grids

решетка трубная фланцевая – raised-face flange

ряд труб – bank of tubes

С

сажа – smuts

сальник – stuffing-box

сборка ручная – setting-up

сборка заводская – factory mounted

сварка (кузнечная) – welding (hammer-welding)

сварка внахлестку – lap-welding

сварка дуговая – arc welding

сварка контактная – resistance welding

сварка плавлением – fusion welding

сварка ручная – manual welding

сварка стыковая – butt-welding

сварка точечная – spot welding

сварка холодная – welding without preheating

сверлить – drill

сверхпроводимость – superleak

свойства эксплуатационные – running ability

связка – bundle

сгон – close nipple

себестоимость – owing cost (prime cost)

седло клапана –valve seat

сеть газовая – gas network

сеть трубопроводов – pipe network

сечение трубы поперечное – cross-section of pipe

сифон – siphon (trap)

скважина буровая – bore hole

слесарь – монтажник – fitter

слив – sink

смазка – lubricant

смета – estimate

соединение быстроразъемное – quick-release coupling

соединение винтовое – screwed joint

соединение воздухопроводов резьбовое – grooved joint piping

соединение гибкое – flexible coupling

соединение заклепочное – riveted joint

соединение муфтовое – hub and spigot joint

соединение пайкой – joint soldering

соединение резьбовое – threaded joint

соединение раструбное – flared joint

соединение типа «труба в трубе» – male connection

соединение фланцевое – flange connection

соотношение компонентов смеси –ratio of components

сопло – nozzle

станок для развальцовки труб – pipe-expanding machine

станок трубонарезной – pipe-threating machine

станция водопроводная насосная – water works

сток – outlet

стояк – down riser

схема трубопроводов – piping diagram

счетчик газовый – gas counter

Т

температура предельная – limit temperature

температура рабочая – operating temperature

теплоемкость – heat capacity

теплоизоляция – thermal insulation

тепломер – heat flow meter

теплоотдача – heat transfer

теплопотребление – thermal input

теплопроводность – conduction

терморегулятор – thermo-hydrograph

течь воды – water leak

труба бесшовная – seamless tube

труба водосточная – drain baffle

труба гофрированная – corrugated pipe

труба дымовая – chimney

трубопровод – conduit

тупик трубы – sack-pipe

тяга дымовой трубы – draught of chimney

У

увлажнитель – humidifier

угол отклонения воздушного потока – air flow angle

указатель уровня поплавковый – float gauge

умягчение воды – water softening

уплотнять – compress

уровень грунтовых вод – ground water level

усиление – amplification

устранение – removal

устройство дроссельное – air splitter

утечка газа – gas leakage

утилизация – recovery

участок трубы – piping tract

ущерб –spoilage

Ф

фактор производительности отопительного сезона – heating seasonal performance factor (HSPF)

фильтр аэрозольный воздушный высокоэффективный – HEPA filter

флюс для пайки (мягким припоем) – soldering flux

флюс для пайки (твердым припоем) – brazing flux

форсунка мазутная – oil burner nozzle

фронт сублимации – sublimation front

Х

хладагент – coolant

ход холостой – idling

ход рабочий – working stroke

хлорирование – chlorination

хомут для труб – pipe clip

Ц

цех сборочный – assembly room

циркуляция воды принудительная – assisted circulation

цикл нагнетания – discharge cycle

цикл постоянного давления – constant-pressure cycle

цикл рабочий – run cycle

Ч

части запасные – appurtenances

часть на трубопроводе фасонная с регулированием потока по ответвлениям – diversion pipe fitting

чертеж – draft

чертеж в двух проекциях – elevation drawing

чертеж предварительный (эскиз) – preliminary drawing

чертеж с размерами – dimensioned drawing

чертеж топографический – topographic survey

чертить график – graph

Ш

шаг резьбы – pitch

шайба – washer

шахта вентиляционная – ventilation shaft

шлак – slag

шлам – dirt

шланг – hose

шпиндель клапана – valve spindle

шток клапана – valve stem

штуцер вытяжной – outlet piece

шунт – shunt

шуруп – screw

Щ

щебень коксовый – broken coke

щелочной – alkaline

щель для прохода воздуха – air slot

щит распределительный – switchboard

Э

экспертиза – review

эксплуатация – maintenance

элемент контрольно-измерительный – control detecting element

элемент нагревательный – heating element

эмаль глазурованная – vitreous enamel

эффект парниковый – greenhouse effect

эффективность поглощения пыли – atmospheric dust spot efficiency

эффективность очистки – clarifying efficiency

Я

ядерно-магнитный резонансный термометр – nuclear resonance thermometer

ядовитый – poisonous

ядро конденсации – condensation core

ячейка – cell

ящик – cas

ящик угольный – bunker

Приложение 2

Symbols:

Symbol	*Description*	*Units*
A	area	m^2
	electrical current	A
Af	floor area	m^2
	physical constant	dB
$\mathbf{A_g}$	cross-sectional area of gutter	mm^2
$\mathbf{A_0}$	area of water flow at gutter outlet	mm^2
$\mathbf{A_r}$	roof area	m^2
$\mathbf{A_w}$	walling area	m^2
AET	allowed exposure time	min
B	building envelope number	
	sound reduction index	dB
Bf	physical constant	dB
b	barometric pressure	bar
C	fuel cost per appropriate unit	
C	carbon	
C1, C2	constant	
Ci	interior air pollution	decipol
$\mathbf{C_0}$	outdoor air pollution	decipol
$\mathbf{C_r}$	room concentration	%
$\mathbf{C_s}$	supply air concentration	%
Ct	concentration after time T	%
C3	electrical load	Wm^2
clo	clothing thermal insulation	
$\mathbf{C_v}$	ventilation coefficient	
CO2	carbon dioxide	%, ppm
D	gutter depth	mm
DI	directivity index	dB
DU	demand or discharge unit	

d	pipe diameter	m or mm
	distance	m
A**p**	difference of pressure	N/m^2
d.b.	dry-bulb air temperature	°C
decipol	air pollution from one standard person	
E	emissivity	
$\mathbf{E_{max}}$	maximum available evaporative cooling	W
EWCT	equivalent wind chill temperature	°C
EL	equivalent length	m
EUPF	energy use performance factor	
F	radiation configuration factor	
Fg	fractional area	
$\mathbf{F_m}$	Marston bedding factor	
$\mathbf{F_s}$	factor of safety	
f	frequency	Hz
G	gradient	
	moisture mass flow rate	kg/m^2
	pollution load	olf/m^2
GCV	gross calorific value	MJ/kg
GJ	energy	gigajoule
G	gravitational acceleration	m/s^2
	air moisture content	kg water/kg dry air
H	height	m
HSI	heat stress index	
Hz	frequency	cycle/s
h	time	hour
J	energy	joule
K	absolute temperature	kelvin
K1 K2	constant	
kg	mass	kilogram
kj	energy	kilojoule
kW	power	kilowatt

kWh	energy	kilowatt-hour
L	load factor	
LH	latent heat of evaporation	kW
l	length	m
LPG	liquified petroleum gas	
M	metabolic rate	W/m^2
MF	maintenance factor	
MJ	energy	megajoule
MW	power	megawatt
m	length	metre
mm	length	millimetre
mu	diffusion resistance factor	
N	air change rate	h^{-1}
	force	newton
	number of occupants	
NR	noise rating	dimensionless
nf	number of storeys	
olf	concentration of odorous pollutants	
P	pressure	pascal
	permeance	kg/N s
P	carbon dioxide production	
Pa	pressure	pascal
PD	percentage of occupants	
	dissatisfied	%
Ps	vapour pressure	pascal
Q	fluid flow rate	m^3/s or 1/s
	power	kW
	geometric directivity factor	dimensionless
Q_c	convection heat transfer	W
Qe	extract air flow rate	m^3/s
Qex	exhaust air flow rate	m^3/s
Qf	fresh air flow rate	m^3/s
Qf	fabric heat loss	W
QHWS	hot water service power	kW

Ql	leakage air flow rate	m^3/s
Q_p	total heat requirement	W
Q_r	radiation heat transfer	W
	recirculation air flow rate	m^3/s
Q_u	heat flow through fabric	W
Q_v	ventilation heat loss	W
q	water flow rate	kg/s
R	resistance thermal	m^2K/W
	room sound absorption constant	m^2
Ra	combined resistance of pitched roof	$m^2K/$

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