МІНІСТЕРСТВО ОСВІТИ І НАУКИ УКРАЇНИ

Іноземна мова (англійська) за професійним спрямуванням

Методичні вказівки до виконання самостійної роботи

для здобувачів освітньо-кваліфікаційного рівня молодший спеціаліст

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Зміст

Вступ

Дана методична розробка призначена для самостійної роботи для студентів III курсів спеціальності Будівництво та цивільна інженерія. Метою розробки є формування у студентів навичок самостійної роботи з професійно-орієнтованими текстами, розширення термінологічного словника і розвиток умінь і навичок спілкування в рамках своєї майбутньої професії.

Розробка складається з 13 фахових текстових матеріалів різного рівня понятійної та мовної складності, метою яких є розвиток умінь і навичок аналітичного читання, техніки перекладу. Тексти, зокрема, дають можливість розширити лексичний запас і кругозір студентів по кожній темі.

Навчальною метою розробки є формування у студентів умінь спілкуватися на професійну тематику, читати іншомовну спеціальну літературу за фахом середнього рівня складності з безпосереднім розумінням прочитаного, здобувати необхідну для виробничої практики інформацію. Для досягнення визначених цілей у посібнику передбачена регулярна навчальна діяльність, метою якої є створення словника активної лексики, що включає як найбільш вживані для даної спеціальності поняття, так і загальні терміни технічного профілю.

Text 1. Building Materials

The mortars used in bricklayers' work consist of an admixture of lime, or Portland cement, and sand. A knowledge of the properties of these materials is very necessary to the craftsman, if he is to obtain the best results from his labours.

Lime is manufactured by the calcination, or burning, of a carbonate of calcium, of which chalk is the commonest example. During calcination, decomposition occurs, and carbonic acid and water arc driven off, an oxide of calcium (quicklime) remaining.

If water be added to lumps of quicklime, rapid combination ensues, great heat and volumes of steam being generated. The lumps disintegrate with a series of small explosions, and are eventually reduced to a very fine powder. This process is termed slaking; and when making mortar it is highly necessary that it should be thoroughly carried out, as any unslaked particles subsequently expand and seriously damage the work.

Limes may be divided into three distinct classes –

Rich limes.

Poor limes.

Hydraulic limes.

Rich Limes contain not more than G percent of impurities, slake very rapidly, and are entirely dependent on external agents for setting power. They are chiefly used for interior plasterers' work.

Poor limes contain from 15 percent to 30 percent of useless impurities, and possess the general properties of rich limes, only to a lesser decree. They are only fit for unimportant work.

Hydraulic limes contain certain proportions of impurities, which, during calcination, combine with the lime, and endow it with the valuable property of setting under water, or without external agents. The proportions of these impurities determine whether a.lime is eminently, moderately, or only feebly hydraulic. The principal limes used in making mortar for constructional work are of the Greys tone variety. These have hydraulic properties, and will take a large proportion of sand, without weakening their setting powers. The usual proportions are from two to four parts of sand to one of lime.

The setting of lime depends largely upon its absorption of carbonic acid from the atmosphere. The particles return to their original form of a carbonate, and crystallize. These crystals have a tendency to adhere to anything rough, such as sand or the surfaces of a brick.

Pure lime mortars built into thick walls never harden in the interior. The crystallization of the exterior of the joint when set prevents access of carbon dioxide to the inside of the wall. For this reason, pure lime mortars should not be used for constructional work, only those which are not entirely dependent on external agents. For more important work, where great strength is required, Portland cement is used instead of lime.

Portland Cement is an artificial cement, manufactured by calcining chalk and clay, or river mud containing certain chemical constituents in definite proportions. The chalk and clay are ground and mixed into a slurry, which after being strained through very fine sieves, is pumped into an orifice in the top of an inclined revolving cylinder. A blast of intense flame is directed through this cylinder, which is lined with firebrick. As the slurry drops through the flame, it is burned into small clinkers, which are afterwards ground exceedingly fine in specially constructed mills, and then passed through sieves, having as many as 35,000 meshes to the square inch. The powder is aerated by being spread on wooden floors, with an occasional turning, to ensure the thorough slaking and cooling of all particles. It is then put up in sacks ready for use.

This process of aeration has now been superseded in many cement works by the addition of a small quantity of gypsum (plaster of Paris), which retards the otherwise rapid-setting tendency of a freshly-ground cement.

Sand. – When used for mortar, sand should be angular in grain, free from clay or dirt, and moderately coarse. If too fine, the proportion of lime or cement will have to be considerably increased.

Mixing. – This should be carried out on a close-boarded platform, or stage. In the case of lime mortar, sand is best measured when brought to the stage, and the heap opened out into the form of a ring. The correct proportion of lime is measured into the ring, clean water being added to start the slaking, and more as the process advances. When the generation of steam ceases, the mass should be stirred with a long-handled, hoe-shaped tool called a larry, until a thick, cream-like consistency is obtained. The sand may then be gradually drawn into and thoroughly mixed with the lime by means of the same tool. The mortar should be allowed to stand for some days before use and again well beaten up with larry and shovel.

For cement mortar, the sand is measured and heaped on the stage, and a bottomless box of definite capacity is placed on the top of the sand. This box is filled with cement, and then removed. The dry heap is turned over at least twice and opened out into a ring. Clean water is added in sufficient quantity to wet the whole mass, which is then thoroughly mixed in the same manner as lime mortar.

Cement mortar should be used directly after being made, and should not be subjected to further mixing after setting has commenced. If this is done, the cement rapidly loses its strength, and further repetition would render it practically inert.

The proportions of sand and cement or lime, are from two to four parts ofs and to one part of either, according to the class of work for which the mortar is required.

Another mortar mix which is becoming popular, and which some engineers have proved to be stronger for some classes of work such as reinforced brickwork, is 4 parts of sand to 1 part of Portland cement and l/8th part of lime.

On large works, mixing is usually performed in a mortar mill, which consists of a pair of heavy millstones and a pan, or container into which the measured ingredients are fed. The mill, by reason of its large and rapid output, has a distinct advantage over hand-mixing. It also has many disadvantages unless operated by a reliable man. Grinding may be carried on to such a stage that the sand is ground so fine as to render the original quantity of lime or cement inadequate. Cement mortars may be also ground long after the initial setting has commenced, and thus rendered useless for the required purpose.

Text 2. Building Stones

Classification – Building stones are classified in a general way under the heading of igneous, sedimentary, and metamorphic rocks.

Igneous Rocks. – These are formed by fusion below the earth's surface.
Sedimentary Rocks. – All sedimentary rocks, which include sandstones and

limestones, come under this heading. They are formed in deposits by the agency of water or winds, and are known as stratified rocks.

Metamorphic Rocks. — These may be either of the above when, changed in formation by heat and pressure. Marbles and slates come under this heading.

Granites. – Granites are igneous rocks made up of granular particles, the latter being crystalline, and usually composed of quartz, felspar, and mica.

Granite has never flowed out over the earth's surface as lava, but became consolidated at a great depth under extreme pressure.

Quartz. – The durability of granite depends largely upon the amount of quartz and its combination with other minerals, quartz being practically indestructible. Quartz, sand, and the chemical named silica may be said to be interchangeable terms.

Felspar is the most easily distinguished mineral and its colour varies considerably. The pink felspar is known as orthoclase, and is a potash felspar; this constituent is very characteristic in granite. Sometimes the white soda or lime felspar known as plagioclase is found. Felspars are commonly found with about equal quantities of quartz.

Mica is of two kinds: Muscovite, which is potash mica (light); and biotite, which is a dark brown, iron and other substances being present. The light micas are more stable.

The proportions of mica should be small compared with quartz and felspar. Hornblende and augite sometimes occur and take the place of mica; the stone is then known as a syenite.

Iron pyrites produce oxidation and hydration either in the form of local spots, or as a uniform tinge of brown, and should always be looked upon as a fault.

The characteristics of a good granite are: fineness of grain, the disposition of the various minerals forming the mass, and the high percentage of quartz present.

Sandstones. – Sandstones are formed by the disruption of preexisting rocks due to the action of winds or moving water, the particles being deposited in beds, or strata. The chief constituents are the original quartz crystals (or grains) and the cement that binds them together. The quality of a sandstone depends upon the cementing material. The presence of an inferior cementing material is the chief cause of disintegration upon the exposed surfaces. The cementing materials are numerous, and may be silica, clay, iron oxides, calcite, or dolomite. Usually there is a combination of these substances, but one kind predominates. Sometimes the grains, or quartz crystals, are consolidated by heat and pressure as in quartzite. Sandstones vary from fine grain to coarse grit stone, whilst the colour depends chiefly upon the cementing material. Red, brown, and yellow are due to oxide of iron. White owes its colour to the combination of clear quartz with white argillaceous or clay-containing matter free from iron stains.

If the stone contains a high percentage of mica distributed along the planes of bedding it is known as a micaceous sandstone. Great care should be exercised in placing sandstones in the building so that the laminae are horizontal.

Limestones. – The chief characteristic of limestones is the presence of a large proportion of carbonate of lime. They were formed chiefly by the accumulation of shells or calcareous skeletons of marine or fresh water organisms, which were deposited as sediment in the waters of seas or lakes. The common or chalk limestones are more suited for the production of lime. The oolitic limestones are of marine origin; they arc' composed chiefly of carbonate of lime, with other substances, such as carbonate of magnesia, silica, alumina, and iron. The oolite resembles the roe of a fish, and results from the accumulation of carbonate of lime around the small nuclei of fragmentary shells or grains of mud or sand. They are of spherical or oval shape, and can easily be seen with the naked eye. They vary in hardness and texture; some are fairly fine, others coarse and porous.

All limestones are soft when first quarried, but harden on- exposure to the atmosphere.

The stone should be uniform in colour throughout in the case of both sandstones and limestones.

Text 3. Concrete Structures

Introduction. – Reinforced concrete is an excellent building material, adaptable to many uses. It is strong, lire-resistant, and durable when well made. On the other hand, it is a heavy material, and its use generally results in rather bulky members so that its greatest field of usefulness is in relatively low buildings and in structures where its mass, rigidity, and strength arc advantageous. Tall buildings may be made of reinforced concrete but, when they are more than six or eight stories high, it is desirable to question the economy and advisability of such construction for industrial purposes.

Structures built of concrete should be planned upon the basis of the characteristics of the material itself, and upon the essential nature of the construction processes. Concrete is not a substitute for structural steel in terms of member for member. Architects and engineers, figuratively, should throw away many of their ideas derived from experience with steel-framed structures, then tackle the project at hand on the basis of utilizing the concrete to the best advantage. Many have done this and are now producing plans for concrete structures that are both attractive and practical.

Here, as elsewhere, the designer should make sure that concrete Is the most desirable material for a structure and should give careful consideration to the general proportions of the structure and to the uses for which it is intended. Because of the nature of concrete construction, careful planning is needed in the first place because extensive alterations and radical changes of future use are likely to be both difficult and expensive.

Some General Principles. – The planning and the detail designing of concrete structures are so influenced and circumscribed by practical procedures and considerations that the engineer should attack such problems entirely upon the basis of the best use of this particular material. He should remember constantly that, except for possible precast members, he is creating a structure to be made of "artificial stone", of material placed in position in a plastic state so that it must be supported temporarily by something other than itself, and of a material that will and should conform to every detail of the surfaces with which it is in contact when the plastic concrete is deposited.

Not only does concrete improve with the use of good materials, but its quality depends largely upon the excellence of the workmanship used in its manufacture, the adequacy and thoroughness of its placement, and the care with which it is cured. The attainment of the intended high quality is almost completely in the hands of the artisans, who, in the field, convert heaps of aggregates, barrels of cement, and gallons of water into a structure for the use of man. Not only does its strength depend upon highly skilled labor, but the quality of its surface and the beauty of its appearance do likewise. It is foolish to forget these obvious truths. Yet occasionally such important operations are delegated to unskilled, inefficient workmen. Fortunately, this is the exception. Expert workmen produce surprisingly fine results.

When planning concrete work, an engineer should consider the following matters, along with many others:

1. Poured-concrete structures ordinarily try to act largely as continuous frames. This is inherent in their nature. In fact, if continuity is to be avoided without detrimental or objectionable cracking, special measures generally must be employed. Hence, the advantages of continuity can and should be utilized.

2. Since concrete is especially advantageous in resisting compression, its use is more desirable for columns and walls than for long- span beams. The arch, the dome, the cylindrical barrel, the rigid frame, the flat slab, and beam-and-girder construction are among the types most suitable for the use of concrete.

3. So-called "framed" connection are difficult to make in reinforced concrete. Junctions of beams to beams should be made by pouring the adjoining members monolithically if possible because, otherwise, it is difficult to provide for transverse shearing forces. When beams rest upon walls or columns, the

construction joints should be located so that each beam has adequate bearing upon the supporting member.

4. Not only is simplicity of shape desirable in order to minimize the cost of formwork, but the duplication of parts permits the revise of forms. It is obvious that heavy forms high in the air are costly.

5. Architectural details should be planned with consideration not only for the fabrication of the forms but also for the removal or stripping of them without damage to the concrete, or undue harm to the forms themselves. The details should also be such that the concrete will conform completely and easily to all the contours, projections, and recesses of the forms without spelling, honeycombing, slumping, air-trapping, and surface imperfections.

6. As the desired surface texture of concrete structures is something to determine carefully in advance, the structure should be planned so that the desired effects will be attained. Good effects will not just happen of their own accord; the bad ones do that.

7. The sequence of pours and the location of construction joints should be determined during the general planning of a structure in order to ascertain that what is desired can be built practicably. The volume of concrete that can be placed in one continuous pour depends upon the capacity of the equipment and upon the nature and details of the structure. It is very important to avoid the incomplete placing of a pour by depositing a portion of the concrete at one time, then pouring additional concrete alongside or on top of the first part after the latter has only partly set. Settlement or displacement of forms, an attempt to vibrate or otherwise compact the concrete, and any other operations that disturb the original material after it has partially set but is not yet strong will generally damage the concrete. After the first part has hardened, there is likely to be an unexpected plane of weakness at the junction with that deposited later. Of course, a tall pier shaft may be poured almost continuously and over a period of many hours if the work is performed properly. However, this is seldom easy of accomplishment in the case of extensive foundations, walls, and floors.

Precast Concrete. – The use of precast-concrete members and parts of members is a matter that warrants careful study. The possible savings in formwork are obvious, but the handling of heavy pieces in the field may require special equipment. If portions of a structure are to be precast, the original planning should be based upon this fact, and all details should be worked out accordingly. Precast parts can be incorporated in an otherwise poured-in-place structure, but provision should be made for the support of these heavy pieces during construction. Most poured-concrete structures gain much from the stiffness derived from the continuity secured at the junctions of parts, whereas a building made of heavy, loosely connected, precast parts may be inherently undesirable. It is possible, however, to connect precast parts by means of poured sections at the junctions if proper bonding of reinforcement, is provided. Although such procedures have not been common in the past, their use should be investigated with an open mind. Because of the possibility of appreciable economies, the use of precast parts will undoubtedly increase in the future.

Text 4. Fire Resistance

The ability of a roof to resist fire from without and within the structure is so important that an engineer should consider the hazards very carefully before he uses combustible materials in the construction of roofs of important structures Heavy timber framing with tight, thick sheathing and devoid of "kindling wood" is often so slow burning that it is suitable for various structures; wood may also be treated with chromated zinc chloride or other chemicals that retard its combustion greatly.

The designer should remember that large, flat, tight, horizontal surfaces made of wood will not burn easily; similar surfaces in a vertical or steeply sloping plane will burn more readily. If the air cannot circulate easily so as to provide an adequate supply of oxygen, combustion will be retarded. Exposed platforms, open construction composed of small members with free circulation around them (such as stairways), wooden partitions and floors without fire stops to prevent the flow of air, vertical shafts, and hatchways — thèse are the kinds of construction that may endanger the safety of a wooden building. Therefore, wooden sheathing on a roof may not be too great a fire hazard if the supporting framework is incombustible, and if 'the contents of the building are not highly inflammable.

On the other hand, bare steel, although incombustible, is not fireproof but may soften and yield when heated sufficiently. Concrete of adequate proportions will endure considerable heat unless it becomes badly spalled by the effects of heating and then chilling by cold water, or unless the heating effect lasts long enough to dehydrate the cementaceous compounds. Bricks, tiles, and even ordinary plaster on ; metal lath are, of themselves, fire-resistant to a considerable extent. Most of the ordinary roofings, except wooden shingles and bituminous coverings, will not burn easily, if at all.

Steel Floors. – There are several types of steel floors, and floors with steel parts to carry the loads, where concrete or some other ; material serves as a filler to close up the spaces and to form a suitable surface.

Bare steel plates are frequently useful for platforms, floors that are i subjected to the wear of metallic wheels, floors that are heated severely or subjected to the spatter of molten materials, parts of floors that may have to be dismantled and re-erected frequently, and for the flooring on hatch covers that must be strong and light in order to facilitate handling them. Checkered floor plates are rolled with various patterns, the purpose being to secure a nonskid surface. This is an important feature because flat steel is slippery when wet or greasy. Steel gratings are used frequently instead of solid plates because, for the same weight of steel per square foot, the former are stronger and stiffer. However, the designer should not forget that dirt and small objects dropping through the openings of the grating may be objectionable or even hazardous; furthermore, the passage of smoke, gases, and hot air through them may be disadvantageous. Closing the openings in gratings by filling them flush with concrete or mortar is seldom satisfactory because the latter may eventually drop out unless the grating provides a mechanical lock for the masonry.

Text 5. Steel Mill Buildings

Adaptability of Steel for Industrial Buildings. – Structural steel rightfully holds an important position among the materials that are adapted to use in the construction of industrial buildings. Its prime function is that of constituting the skeleton framework which supports the roof and side coverings together with any other parts or equipment that must be attached to or supported by it. Steel is non-combustible, strong, yet relatively light in weight for its strength; it is ductile, reliable, and generally available; it can be fabricated in advance to form members of the desired strength and dimensions, which can be erected quickly in the field whore strong connections are easily made. Thus, steel is well suited to use in largo plants having long spans, heavy loads, and large clear heights. It is also adapted to use in small structures.

As a material for the framework of industrial buildings, steel has two very important advantages:

Almost any structure within reason may be built of structural steel. This is a tremendous asset because of the great variety of shapes and sizes needed to house various industries. A steel-frame structure may often be remodelled or extended to suit changed conditions, new processes, and even completely new uses. Sometimes this is exceedingly advantageous. By the use of burning, welding, and riveting, extensive alterations may be made in the field without prohibitive expense.

Another slight advantage, which may become important under special conditions, is the fact that the entire building may be dismantled and re-erected elsewhere when circumstances require it.

How can one tell whether to make a building out of steel or some other material? There may be simple but important matters that give the answer; e. g., personal preference, available materials, effect of weight on foundations if the soil is weak, suitability for the purpose, fire hazards, similarity to other buildings previously used and found to be satisfactory, similarity to adjacent buildings to be constructed, and speed and ease of construction. However, the required strength of the material and the relative economy may overrule these other factors when spans are long and loads are heavy.

The term ―mill building‖ as used here denotes a single-story structure having one or more relatively wide aisles of considerable length and large clearance. The siding and roofing may be one or more of a wide variety of materials; generally, however, the whole construction is relatively light. Such a building generally houses large, heavy machinery supported directly on the ground; it may or may not have crane runways, trolley beams, or other overhead equipment for transporting materials. The manufacturing operations within it are usually those which require large areas on a single floor, and the handling of heavy or voluminous objects. Obviously, such buildings require long roof beams or trusses to span the aisles, slender but strong columns to carry heavy vertical loads, and substantial bracing to resist the wind forces against such large exposed wall areas. For all these, structural steel is admirably suited.

When planning the framework of a steel building, one should bear in mind the fact that commercial sections of steel are rolled in various sizes and shapes – but in these only. Unusual, complicated, and built-up members will naturally cost more per pound than will simple rolled sections without large fabrication costs. When special members are needed, however, they can be made up by riveting and welding, but they should be so planned that they can be composed of parts that in themselves are standard shapes,

The variety of shapes, sizes, and details of industrial structures is about as extensive as the needs for which each individual building is designed.

Text 6. Air-conditioning

Air-conditioning is the bringing of air in a building to a desired temperature, purity, and humidity throughout the year to maintain healthy and comfortable atmosphere.

Air-conditioning may be divided into two main sections: one for the processing of materials in industry; the other for human comfort. It has been found that there is an optimum condition o "temperature and humidity at which the processing of different materials may be carried out with the minimum of wastage and the maximum of goods of specification quality. The system is therefore designed to produce air of predetermined temperature and moisture content and to keep it so despite all external influences. Such air is filtered free of foreign material.

Conditioning air for human comfort may also be divided into two main sections — winter and summer. Frequently, the systems installed in office buildings provide control during both seasons. Complete air-conditioning provides the following services.

First, filtration of the air both in winter and summer to remove dust.

Second, circulation of the air at low velocity and with proper diffusion to prevent draughts and maintain a uniform temperature and humidity at all parts of the inhabited space.

Third, introduction of enough fresh air from the outside atmosphere.

Fourth, heating of the air in winter.

Fifth, cooling of the air in summer below the outside atmosphere.

Sixth, humidifying the air in winter to a relative humidity of at least 20-25 per cent.

Seventh, dehumidifying the air in summer to a relative humidity not exceeding 55 per cent.

The basic pieces of equipment are the filters, preheat coils, humidifiers, 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.

Air conditioning for human comfort is employed in both large and small installations, such as theaters, office buildings, department stores, residences, airplanes, railways, cars and

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.

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 through open windows. When this is done, air in the house can be expected to be changed completely every two or three minutes. 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.

Text 7. Different Methods of Heating and Ventilation

Various methods of healing have been evolved and are in use at the present day, and a knowledge of the characteristics and relative costs is necessary in making a selection of the most suitable type for any particular building.

There are two main divisions of heating systems: direct and indirect.

Direct systems are those in which the fuel is consumed in the room to be heated.

Indirect systems are those in which the fuel is consumed outside the room, the heat being conveyed to the room by a medium such as steam or hot water.

Direct systems

Direct systems are chiefly used for intermittent heating, or for heating isolated rooms.

There are many forms of direct heating, such as gas and electric overhead radiant heaters, in which a metallic plate is heated to a high temperature so as to emit strong heat radiation; and gas and electric unit heaters in which air is delivered to the room by a fan and is warmed in its passage through the unit by heated elements. There are also low-temperature gas and electric radiant panels for fixing to walls, ceilings, etc., also electric tubular heaters for fixing near skirting level. These systems are generally more expensive in first cost than those enumerated above.

Indirect systems

Indirect systems are chiefly used for the continuous heating of a number of rooms or large buildings from one central source, hence the name "central heating". This does not necessarily imply that the heating source is strictly central, indeed it may be at a considerable distance from the building.

This class of system finds its greatest application in large buildings of all types.

The advantages of the indirect system are –

(a) Fuel and ashes are kept outside the occupied spaced.

(b) Individual flues are not required.

(c) Cleanliness.

(d) Equable temperature maintained in all parts, easily controlled automatically.

The disadvantages are –

(a) Heat is lost from main piping where this is outside the occupied rooms. This loss can be minimized by proper insulation of the pipes.

(b) Labour is required for stoking and removal of ashes. This applies only with solid fuel and can be greatly reduced with automatic firing.

The medium employed for the transmission of heat is either steam, hot water, or heated air.

Steam. – In this system steam is generated in a boiler partly filled with water, and the steam is conveyed through pipes to radiators, unit heaters, etc., in the rooms to be heated. The steam is herein condensed into water which is preferably returned to the boiler through a system of return piping.

The advantages of steam are – low heat capacity, hence quick heating up and cooling down; low cost due to high temperature of heating surfaces.

The disadvantages are the burning effect on dust particles in the air due to the excessively hot surfaces, and the lack of regulation. To overcome the latter the vacuum system has been developed which permits of temperatures in the radiators being maintained below the boiling point of water.

The lack of regulation referred to means wastage of heat in mild weather, hence higher fuel consumption and running cost than with a carefully controlled hot water system.

Text 8. Pipes

Copper pipes are permitted for use inside premises subject to the gauge complying with water company's regulations. Such pipes are simple to fix and have a neat appearance.

Galvanized wrought-iron pipes may or may not be permitted. Some authorities will only allow such pipes on the outlet side of a metered supply. Where the water is of a hard nature they may safely used, owing to the formations of an insoluble coating of carbonate of time. Galvanized wrought-iron pipes, though cheap, are little used for domestic supplies, at they are subject to corrosion at the joints and elsewhere where the galvanizing has been disturbed.

There are three grades of iron pipes, known as "gas", "water" and steam" strengths, and for water supplies the steam quality should be specified.

Whatever type of service pipe is laid, it should be at a reasonable depth below the surface of the ground, usually not less than 2 ft. 6 in., to guard against the effects of frost. In addition, any part of the pipe which may be in an exposed situation should be properly protected.

Having excavated the ground to the required depth and exposed the water main, the next step is to apply to the water company, who will make the actual connection by supplying and fixing a ferrule for the connection.

Mains are tapped under pressure by a special machine consisting of a watertight box which is attached to the main by means of a chain. The hole is drilled and tapped, and by revolving the cover it is possible to bring the ferrule directly over the hole, into which it is screwed down.

This method allows the work of a connection to be made without shutting off the water in the main. In some cases, however, the connection may be such that a tee-piece has to be inserted for a large branch. Where this is so, it is necessary to isolate part of the main by shutting off the water by means of the valves in ordor to carry out the work. To cause a minimum of inconvenience, it is best to do the connection late at night.

Where it is intended to use wrought-iron galvanized pipe for the service connection, it is usual to lay the pipe from the stop valve to within approximately 2 ft. 6 in. of the water main. The tapping of the water main is then made by the water company's workmen and a ferrule inserted. Next, about 2 ft. G in. of lead pipe is fixed between the ferrule and the iron service pipe, by means of wiped joints and a plumber's union. The provision of the short length of lead piping is necessary to allow for the pipe to give a little without causing trouble. Where the service pipe is in lead, the connection is made direct to the ferrule with the usual wiped joint.

When laying the main service pipe from the main to the building, care should be taken to avoid laying the service pipe through any drain inspection chambers or through any place where, in the event of the pipe being or becoming unsound, the water would be liable to become fouled or to escape without observation.

The natural tendency is to utilize the same trench as the drain occupies to save excavation, but the best method is to lay the service pipe in a separate trench altogether. In any case, where it may be impracticable to do so, the water company should be consulted.

They may allow the pipe through foul soil, provided the pipe is sufficiently protected from contact with such soil, either by being carried through an exterior cast-iron tube or by some other approved means.

Text 9. Drainage

General Principles Applicable to any Drainage Scheme

1. The diameter of the drains should be 4 in. for domestic buildings, and this size is usually proportionate to the volume of liquid expected through the pipes.

2. Where a number of houses are drained by a single pipe, or in cases of largo buildings, then a 6-in. pipe is generally required for part of the drainage system.

3. Self-cleansing velocities are required, and this means that the drains should be laid to gradients of 1 in 40 for 4-in. and 1 in 60 for 6-in. pipes, where practicable. It is harmful to lay pipes to an excessive gradient or a flat gradient, and care should be exercised to obtain the right fall.

4. There should be means of inspection, usually obtained by the construction of inspection chambers suitably placed.

Separate, Partially Separate, and Combined Drainage Systems

The type of sewage in any given town determines the type of drainage required. If separate, two separate sets of drains are required - one to take off roof water and general paved drainage, usually known as surface water; the other to remove the sewage and wastes from sinks, baths, lavatory basins, etc., named foul water. Separate sewers increase the building costs a little, but the system is favoured, particularly where it is desirable to keep the volume of sewage at a minimum owing to the cost of pumping.

The public surface-water sewers discharge into streams. Consequently there may be quite a number of independent long lengths of surface- water sewers with outlets at convenient positions on the route of a stream or river passing through the district. The foul-water sewers cannot be treated in a similar manner. The sewage must be treated before disposal. The partially separate system still requires two separate sets of drains, end is similar to the separate system, with the exception that part of the roof water may be drained to the foul sewer.

Usually the rain from the rear of the roof is dealt with by the foul drain, while the rain from the front of the roof, pavements, and street surfaces is discharged to the nearest water course. If the system is combined, one set of drains must convey all soil and surface-water drainage.

Where separate drainage systems are called for, the authorities exercise special care with regard to the supervision of the connections to the public sewers. It is most important that no mistake should be made with the identification of the sewers; otherwise a wrong connection causes endless trouble and danger to public health.

If a foul-water drain is inadvertently connected to a surface-water sewer, the faulty discharge may be easily located at the outlet of the sewer to a stream; but the chief difficulty is locating the property wrongly connected once the work has been completed. The danger of wrong connections cannot be ignored; but there is little to fear if the builder makes an inspection before confirming the drain connection to the sewer.

Each system has advantages according to local conditions. Where two sewers are used, the foul-water sewer can be reduced in size. The volume of foul water to be treated is considerably less than the combined system, and where pumping is essential there is a saving in the outlay and annual expense of the pumping installation.

Natural water courses running through a district often effect a great saving on drainage costs, because it is quite reasonable to run surface-water drains to any convenient outlet on the course of stream and save excess piping.

A separate drainage system almost doubles the cost of drainage as compared with the combined system. There is, however, less likelihood of flooding during times of abnormal rainfall.

Drains

Drains and sewers must be formed of good sound pipes of glazed stoneware, heavy cast-iron, or other equally suitable material. The size will vary according[1] to the volume of drainage, but it is essential that the pipes should be of adequate size and laid to a proper gradient, with suitable watertight Joints. The minimum internal diameter for a sewage drain is 4 In., and It Is the usual practice to use this size for most work of a domestic nature where the work consists of separate units with separate sewer connections. House drains should be laid in a similar manner, as already described for sewers. The work, however, is usually less involved, owing to small sizes and shallow depths. It is best to use the sight*rail method for gradients, although frequently a tapered board is used for setting out the fall of the drain.

This method, although not so accurate, is satisfactory for the construction of short lengths of drain. A suitable tapered board cut to the required fall is used with a spirit level for grading the trench bottom.

The following are some general principles:

1. A good foundation is essential; therefore the best method is to lay a 6-in. bed of concrete, even if the soil is firm.

2. Avoid, if possible, passing drains under a building. Where no other means are practicable, then surround the drain with 6 in. of concrete or lay in cast-iron pipes and provide suitable access at each end of any straight length which passes underneath a building. The access, of course, must be provided outside and convenient for rodding purpose

3. Keep the drain about 4 ft. away at Toast from the external wails. Where circumstances will not permit this and the drain is adjoining the wall, make sure That concrete is carried up to underneath the footings of the wall.

4. Where a drain passes through a wall it must be protected against the weight of the wall by constructing a relieving arch or other similar support.

5. If the levels are such that part of the drain is to be above ground, then use cast-iron pipes and construct suitable pier supports adjoining the joints.

Text 10. Natural Ventilation

Small domestic buildings, offices, hotels, and other places with small floor areas are ventilated by natural means depending largely upon the provision of suitable inlets and outlets. The fittings used are too well known to Bet down in detail, but briefly they comprise: windows, lantern lights with sides to open, fanlights, hopper sashes, revolving cowls, draught window boards, valves and air vents, ―hit and miss‖ ventilators, tobin tube inlets, fireplaces, doors, electric fans, etc.

With regard to the tobin tube care should be taken to see that this fitting receives attention, otherwise after a number of years the receptacle may be found full of filth owing to misuse. It is not unusual for careless people to deposit cigarette-ends, waste paper, etc., into the open ends of the ventilator. The usual height of 5 ft. to 6 ft. is convenient for this misuse, particularly as few people realize their real purpose.

This type of ventilator is used mostly in public buildings, church halls, billiard halls, etc., and can be quite efficient if given periodic attention.

Natural ventilation has the advantage of being cheap to install, and provides healthy and stimulating conditions, provided the inlets and outlets have been designed with skill.

Artificial Ventilation. – In the case of large floor areas, such as we have in designs ,for theatres, factories, large public halls, and other similar buildings, it is necessary to resort to artificial ventilation, which may be as follows:

1) Vacuum or exhaust ventilating schemes.
2) Plenum or propulsion ventilating schemes.
3) Some combination of the above systems. These systems will be described in detail.

Vacuum Ventilation. – This is a system of ventilation whereby the internal air is extracted by suitable fans. The ingoing air is induced through windows and other similar inlets already described for natural ventilation, and a steady flow of air is maintained by means of the extraction fans.

Various types of fans may be used. They are generally made of metal of a rotary design and housed in a convenient part of the ductwork. Care must be taken to see that the ducts are fairly straight, and with easy bends if necessary. Avoid right-angled bends, which impair the efficiency of the system owing to friction.

Fans are usually driven by electric motors, but other power may be utilized where electricity is not available.

With the vacuum ventilating system there is no control of the incoming air; therefore this system can only be employed successfully where the surroundings are not noisy and windows can be opened to admit clean air.

Plenum Ventilation. – Control over the incoming air is an important feature of this type of ventilation. Where the conditions are such that the surroundings are noisy and the air is fouled by smoke and dust, the plenum system can be contemplated to provide clean air at the correct temperature and humidity. The air is drawn : into the building by a fan, and is discharged through ductwork at suitable positions; conveniently placed outlets abstract the vitiated air through ducts controlled by an extraction fan or smaller power than the inlet fan. A slight pressure is created owing to a large rate of incoming air than that which is extracted, and consequently any leakage must be outwards.

The plenum system of ventilation is costly to install, owing to the necessity for expensive apparatus consisting of propulsion and extraction fans, air heaters, washers and filters (these vary according to circumstances), and distributing ductwork for the incoming air and outgoing air.

A typical arrangement of plenum heating suitable for a large auditorium is as follows: The air coming in is heated by a heater battery, fed from an independent boiler, feeding wrought-iron gilled tubes which have a good radiating surface. In summer, however, the air can be cooled by passing through the same battery fed by an ammonia refrigerating plant supplying cold water instead of hot water from the boiler.

Text 11. Ventilation and Water Heating

Adequate ventilation of buildings has received increased attention during the last few years. Low ceilings, small window areas, back-to-back houses, and excessive densities are things of the past, and now every endeavour is made to ensure a free circulation of air about buildings for the purpose of efficient ventilation.

Building byelaws prescribe the minimum heights of rooms and amount of open space to be provided in the front and rear of every building. The size of windows is controlled by the floor area of each room, and usually windows in habitable rooms should be equai to at least one-tenth of floor area. Rooms without fireplaces are to be ventilated to take the place of the chimney flue, which is usually regarded as a good ventilator. Another important clause controls the minimum heights of rooms.

It will be seen, however, that the building byelaws in this respect are useless unless some control is exercised over the grouping of building units. It is absurd to insist on suitable means of ventilation if it is permissible to construct buildings close to one another; thereby impeding the circulation of fresh air. It is now impossible to crowd dwellings together and consequently the byelaws with regard to ventilation have greater significance.

The constituents are mainly nitrogen and oxygen and suitable means have to be adopted to ensure a constant supply of air of this composition for the maintenance of life.

From experience it is found that approximately 3,000 cu. ft. of air per person per hour is required in enclosed spaces in order to maintain healthy conditions. This figure forms a basis for calculating the size of efficient mechanical ventilating schemes.

Take a room 10 ft. wide by 10 ft. broad and 10 ft. in height. The air we breathe is at first taken from common stock. When the air is breathed back it contains gaseous impurities which contaminate the remaining air until the time arrives when the air becomes so foul as to be dangerous to health. The carbon-dioxide content is increased and 0.06 percent is about the maximum allowance. Therefore a room of 1,000 cu. ft. capacity really requires three air changes per hour in order to maintain the percentage of CO_2 within reasonable limits.

Text 12. Hot-Water Supply

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 hotwater 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.

Pipe Sizes. 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 half 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 a bath, so that 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.

The cold-water rising main of 12 mm diameter, being under pressure, is quite capable of replacing the water taken from the supply tank by gravity flow under such low ―pressure head‖.

The overflow pipe and outlet should be sufficiently large to take the full output of the ball tap in case of failure. A 19 mm pipe is mostly used, but a 25mm diameter overflow would give a more satisfactory margin of safety.

Heating by Hot Water. The term ―central heating‖ applied to the heating of domestic and other buildings indicates that the whole of a building is heated from a central source. Usually an independent boiler, fired by solid fuel, gas, electricity or fuel oil.

The boiler is generally placed at the lowest available point in the building, having regard at the same time to convenience of stoking and delivery of fuel.

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 situ* whilst the latter are usually of the ―packaged‖ type, having all auxiliary components together with the boiler assembled as one unit ready for erection.

Designing a Heating System. 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.

Circulating Head or Pressure. 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 will 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 of 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 radiators can be taken out for repair without having to run off the whole of the water in the system.

An air-cock is fitted to each radiator so that pockets of air can be freed. These cocks are used. When the system is being filled with water. The usual practice is to let out the air floor, by floor, beginning at the lowest. Each air-cock should remain open until water appears, when it can be closed. Periodically the radiators should be freed of air which may have collected at the top. An air-cock is usually fitted with a loose key which fits on to the square end of the spindle.

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 plumber's work, but in latter 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.

The stand should be fixed on the level concrete foundation, and it is a good plan to raise the stand either on a course of brick-work or on a concrete curb of similar height. This gives a deeper ash-pit, which allows a considerable accumulation of ashes.

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.

Radiators. Most radiators 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 care 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 ribs 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 chalked 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.

When assembling radiator sections, the nipples should be cleaned and smeared with a good jointing paste. When coupling up radiators in a heating system, it is most efficient to supply hot water at the top, and take the return water from the bottom at the opposite end. In this way the convection principle is utilised and more positive circulation is obtained.

Sanitary Filtings. Appliances used in the collection and disposal of human and domestic waste products. They comprise commonly: water-closets, lavatory basins, baths, sinks, and urinals.

Baths. Most baths are of vitreous-enamelled 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.

Sinks. 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 75 mm from the front of the sink and be cut diagonally. For the same reason, they should be well away from the ends.

The back of the sink should be bedded in cement against the wall, so that the nuisance of water running down the wall is avoided.

Stainless-steel sinks are fitted with pillar taps or mixer units and require the same treatment as lavatory basins. They have a great advantage over glazed earthenware, in that less heat is taken from the water by the sink. This factor removes the need for using an enamel bowl for washing dishes, a practice so common with large earthenware sinks.

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-cleansing.

Lead waste pipes are jointed by means of wiped joints. Whenever lead pipe is used, it should be properly 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.

The Combined or "One-pipe System". In the "one-pipe system" all sanitary fittings discharge into tne 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.

Text 13. Air Quality Study

Foundry Air Quality Study. (An analysis of existing conditions along with proposals for improving both the air quality and space heating in various foundry buildings) Foundries require sufficient ventilation and adequate means to remove the airborne contaminants generated by various processes if industrial hygiene requirements are to be met. Ultimately, the study led to the recommendation that a central boiler plant be constructed to handle the makeup air and space heating loads.

Plant Ventilation. To establish the adequacy of the existing ventilation systems, a thorough visual inspection was made during normal foundry operation. No measurements of air contaminants were taken. Observations gathered by the inspection team were reviewed with foundry personnel to further establish existing conditions. All observations were made during summer operating conditions. Foundry personnel provided needed insight into winter deficiencies.

With the buildings wide open in summer, air flowed through the buildings from space to space in an indeterminate fashion. This created many areas of discomfort and because such random air flow can upset ventilation systems installed to capture contaminants, produced the potential of creating some hazardous areas. To assure satisfactory environments, it would be essential that total plant ventilation be controlled.

Warehouse. No apparent ventilation problems existed in this area during summer operation. Since no contaminants are generated in the ware-housing operation, there should be no special ventilation requirements in winter. This area should be provided with a balanced or slightly positive air supply to avoid cross-contamination from other areas.

Molding Room. This space was provided with main cooling fans for summer ventilation, and a hood was provided at the line muller. Makeup air for the hood would have to come from adjacent spaces in winter since none was supplied to the spaces. This would again cause contaminants to move into the molding room, especially from the shake-out area.

Heating Systems. The heating and air conditioning system for the office and comfort facilities areas consisted of three heat pumps and a ducted air distribution system. This system allowed for operation completely separate from the foundry buildings.

The warehouse was heated by a gas fired unit heater, which did not have enough capacity to maintain a satisfactory temperature at outdoor design conditions, especially when trucks were being loaded at the shipping docks. No protection was provided against cold air infiltration during truck loading.

The molding room was heated by a gas fired unit heater hung in the space.

No heated outside makeup air was provided at the work stations.

Thermal Insulation. The several buildings comprising the foundry were insulated with various amounts of insulation from none in walls and roofs to$1^{1}/_{2}$thick blanket insulation.

1) Building 1, the new foundry, was a prefabricated building constructed as a structural steel frame with sheet metal siding and roof above a poured concrete wall approximately 8 ft above grade. The sheet metal panel walls and roof were insulated with $1^{1}/_{2}$ thick glass fiber insulation blanket. Roof insulation was exposed aluminum finished plastic covering.

2) Building 2, the original foundry, had concrete block sidewalls and exposed sloping roof without any thermal insulation.

3) Building 3A, the molding room, had concrete block walls and a steel framed sloping roof with no insulation.

4) Building 5, the warehouse, had concrete block walls and metal framed pitched roof. In the office section of this building, ceilings had been installed, and in several rooms wood paneling had been applied to the block walls.

Air Quality Improvement. Systems were proposed to improve our quality, summer and winter, in each area of the foundry included in the study. The recommended systems included high levels of ventilation for summer relief cooling and heading for winter conditions. The proposed systems reflected the following considerations:

Capture of contaminants at their sources of generation is the most effective from the viewpoint of industrial hygiene and the least expensive in terms of energy.

Certain exhaust gas streams may be returned to work spaces after removal of particulate matter. This permits effective exhaust system operation without the cost (energy) burden of heating makeup air. When processes generate gases or vapors injurious to health, recirculation must be avoided.

Temperature control systems would be designed to minimize energy consumption through reduction of outside air when the spaces were unoccupied and to be responsive to useful heat gains from cooling hot molds.

Heat Recovery Vs. Economizer Cycle. (Some insights to aid you in the complex evaluations required to determine whether one or the other, or a combination, will be most cost effective in a given situation.) With the great construction industry are constantly striving to design buildings and their air conditioning systems to consume the least amount of energy.

Energy can be conserved by designing well insulated and shaded building envelopes that have minimum heat gains and losses. Non- depleting energy sources can be used to conserve depletable energy sources. Energy can also be conserved by choosing the appropriate energy conserving air conditioning systems.

Characteristics of the Systems. One popular form of heat recovery in building air conditioning is the use of the refrigeration cycle to "pump" rejected heat from spaces requiring cooling to those requiring heating. When rejected heat exceeds the heating load, the excess heat is rejected to the atmosphere through a cooling tower or air cooled condenser. With this scheme, as long as there is rejected heat to satisfy the heating needs, the heat is considered free.

Both refrigeration cycle heat recovery and the economizer cycle are designed to conserve energy. The concepts of these two energy conservation schemes are basically not compatible, however. The economizer cycle saves cooling energy. It is most effective when the refrigeration plant is shut down. On the other hand, the heat recovery scheme saves heating energy, and it relies on the operation of the refrigeration plant to transfer the rejected heat to satisfy the heating needs.

In reality, however, refrigeration cycle heat recovery and the economizer cycle can be used harmoniously in a building air conditioning system to obtain maximum operating economy.

Depending on the location and the type of building, the availability of energy sources may vary. Under different conditions, coal, oil, natural gas, propane and electricity can all be considered as primary energy sources. Where two energy sources are available, such as gas and electricity, the costs of the sources will influence the choice of systems.

There are no simple rules for deciding what energy conserving scheme should be used in a given building. The evaluation process can be so complex that computer programs may be needed to help speed up what otherwise would be an almost impossible task. In such cases, the engineer should recognize that because of the complexity involved, he must have a complete understanding of, and agreement with, the algorithms used in the computer programs to be able to claim that he, not the author of the program, performed the evaluation.

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