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WHAT THE POWER ENGINEER NEEDS TO KNOW ABOUT

Heat Insulation

Insulation a fairly modern problem . . . Even small boiler plants can show savings when insulation is intelligently applied . . . Case study of a plant with one boiler given . . . Savings in one year amounted to $824.50 or nearly three times the total cost of the insulating job . . . Several suggestions given for retaining efficiency of insulation already applied . . . Moisture penetration one of prime enemies of insulation efficiency . . . Excessive vibration can quickly cause loss of efficiency

KEEPING HOT things hot and cold things cold is a problem which has plagued engineers only during the last few decades. Fuel costs have risen so tremendously and the cost of products produced by the heat have been subjected to such a terrific competitive struggle that temperature has been turned into a precise tool—a tool that can be maintained only by the proper use of good insulation.

Savings Not Confined to Big Plants

The savings, even in one-boiler plants, can be huge. One example, quoted by the Industrial Mineral Wool Institute, was found in a plant where the boiler was operating at a steam gage pressure of 120 psi and a temperature of 350 F. The boiler shell had an area of 400 sq ft. The particular plant in which this boiler was installed had been producing at capacity (it was thought) and it was obvious to everyone that new steam generating capacity would have to be installed if the new orders pouring in were to be taken care of.

Someone had the idea that they might look into the possibility of insulating the boiler in order to provide just the additional amount of steam necessary to both take care of the new orders and also heat the building. A careful study revealed to the management that 2 in. of insulation on the boiler shell would increase to the amount necessary the quantity of steam available.

Formulas Used

The method used to discover the approximate amount of insulation needed, the insulated heat loss and the savings in Btu was as follows. The formula for the heat loss of the pipe when bare was: the unit heat loss in Btu per sq ft per hour. (From Kent's pp 3-64) multiplied by the number of hours operated per year multiplied by the area in sq ft. In this particular case the formula looked like this:

798 Btu $\times$ 400 sq ft $\times$ 8,760 hr = 2,796,192,000 Btu per yr. For the heat loss from insulated pipe the following method was used: Unit heat loss in Btu per sq ft per hr through insulation of specified thickness (Kent's, pp 3-67) multiplied by the number of hours operated per year multiplied by the area in sq ft. This made the formula:

64 Btu $\times$ 400 sq ft $\times$ 8,760 hr = 224,256,000 Btu per yr.

The savings in Btu were then calculated by subtracting the number of Btu lost through insulated pipe from the number lost through bare pipe. This resulted in the following:

2,796,192,000 Btu minus 224,256,000 Btu = 2,571,936,000 Btu per yr.

The conversion of Btu saved per year to fuel savings is made by dividing the number of Btu saved per year by the heat content of the fuel (estimated at 13,000 Btu per lb) multiplied by the operating efficiency. Or, as follows:

$$\frac{2{,}571{,}936{,}000 \text{ Btu}}{13{,}000 \text{ Btu/lb} \times 60\%} = 329{,}735 \text{ lb or}$$

164.9 tons of coal saved per year.

Similar calculations can be made for oil or gas. In this particular instance, with coal at $5.00 per ton the saving amounted to $824.50.

The total cost of insulating the boiler shell was $320.00, a cost of 80 cents per sq ft. In other words, it took exactly 4.66 months to pay off the entire cost of insulating the unit. Besides this not inconsiderable saving there was also the added advantage of having a boiler which was able to turn out the necessary additional heat without having to install new equipment. The only question left for the management to ponder was why the boiler hadn't been insulated many years before.

Fig. 1. The insulation on the two companion flanges of this valve will permit maximum return on investment. Insulating cement, which is easily applicable on all irregular surfaces may be reclaimed for reapplication

Retaining Efficiency

Simple suggestions for retaining the efficiency of insulation on pipes and flat surfaces, if followed, result not only in substantial savings but will increase the life expectancy of

Table I. This compilation shows the recommended thicknesses of mineral wool insulation for pipe covering

Steam Pressure or Condition	Temperature	Thickness of Insulation: Pipes 5 in. and Larger	Pipes 4 in. and 4½ in.	Pipes 2, 2½, 3 and 3½ in.
Hot Water		1	1	1
0 to 25 lb	212 to 267 F	1	1	1
25 to 100 lb	267 to 338 F	1	1	1
100 to 200 lb	338 to 388 F	1½	1	1
Low Superheat	388 to 500 F	1½	1½	1
Superheat	500 to 600 F	2	1½	1½
High Superheat	600 to 700 F	2	2	1½
and	700 to 800 F	2½	2	2
Hot Oil Lines	800 to 1000 F	3	2½	2

Note: For outdoor piping increase thickness ½ in.
For underground piping decrease thickness ½ in.

both insulation and equipment. A waterproof jacket properly applied on pipe lines which are exposed to the elements will protect both piping and insulation. This same jacket should be used on inside lines where they are exposed to splashing from process water or other forms of continuous wetting. Insulation also should be protected from moisture entering from the pipe side. Moisture penetration from pipe lines carrying low side refrigerant or cold water can be partially prevented, at least, by sealing the insulation on the pipe side. This requires a more thorough job of sealing than does outside water and weather-proofing. Such lines, when once sealed, should be inspected regularly to make certain no cracks or openings have developed.

When pipe repairs are made replace all covering as carefully as though the entire job were brand new. Make certain that the insulation fits snugly around the pipe. Loose pipe covering will increase the heat loss and may be damaged much more easily than snugly fitting materials.

In many processes insulated pipe lines may be exposed to strong acid or alkali fumes. Jackets are available which will protect the pipe and insulation by resisting these fumes. Such fumes may easily destroy canvas and holding wires or bands and allow the covering to fall from the pipes. Under some conditions the acid fumes may actually attack the insulating materials.

Excessive Vibration

Another thing which can bring about short-insulation life on pipe lines is excessive vibration. Eliminate or minimize all vibration by proper hangers, springs, etc., as constant shaking and jarring may cause joints to open or may reduce the efficiency of the insulation by some other means such as packing. Signs of failure in canvas coverings are oftentimes due to the pipe covering loosening from the pipe. When this happens the covering should be carefully wired back in place and the joints painted with asbestos cement. Replace and paint the canvas. If canvas is not available apply asphalt-saturated felt jackets carefully wired and then cement the laps and joints with lap cement.

Water hammer, remote as it may seem to some, may be caused by insufficient or inefficient insulation. Even if the insulation is not the cause of the water hammer once the cause *has* been discovered and corrected inspect all insulation for damage. The impact of the hammer may open cracks in the covering. Another fruitful source of trouble with insulation can arise when leaks occur in steam or water lines. Steam impinging on pipe covering may cause rapid deterioration. Water from a leak may follow along a pipe for a considerable distance, saturating the covering and thus destroying almost all of the insulating value. At times this has been known to cause the insulation to fall completely off the pipe.

When workmen or maintenance crews are working about the plant do not allow them to load the insulated pipe lines in any manner. Scaffolding, walkways made of boards, etc., may distort the insulation even if it does not crack it outright. Distortion will cause the air cell structure in the insulation to be compressed thus materially reducing its efficiency. The best way to discover for yourself, or to prove to some one else, the efficiency of air space as an insulator is to sit on a pipe carrying high temperature steam and which is insulated with a resilient insulation. The hot seat is an effective convincer.

Reducing Waste

One means of reducing waste is to grind and mix broken pieces of magnesia pipe covering or blocks with water for use as a patching cement. The resulting product is usable but, of course, will not compare in efficiency with the material in its original form. Do not, however, use insulating cement in place of blocks or pipe covering as it is nowheres near as efficient. Insulating cement has been developed for a particular purpose and is only recommended for irregular surfaces where it is not practicable to apply formed materials.

The accompanying tables present information on recommended thicknesses of insulation for pipe covering and for flat surfaces and have been compiled by the Industrial Mineral Wool Institute.

There are many places in the power plant where the advantages offered by properly applied insulation will far outweigh the cost of material and application. One of the least spectacular of these and yet one which will pay the handsomest returns are the many flanged joints which have been left bare in a good many plants.

In one instance reported by the IMWI there were ten sets of 6 in. companion flanges with a bare surface area of 1.82 sq ft each. Steam was passing through the lines at 350 F. Two inches of insulation was applied. The cost of insulation, including some outside weatherproofing, came to $3.00 per flange or a total of $30.00 for all ten. It was later calculated that this seemingly trivial job was saving up to 7 tons of coal per year.

Duct Insulation

Everyone recognizes that proper duct insulation cuts fuel and energy costs, prevents heat from radiating into or being absorbed from work areas, and makes possible greater control over heating and cooling systems.

But not everyone recognizes the importance of following proper and tested installation techniques. Time-tested and approved steps are described to be followed in applying mineral wool insulation to ducts are described in the following:

The three general duct usages

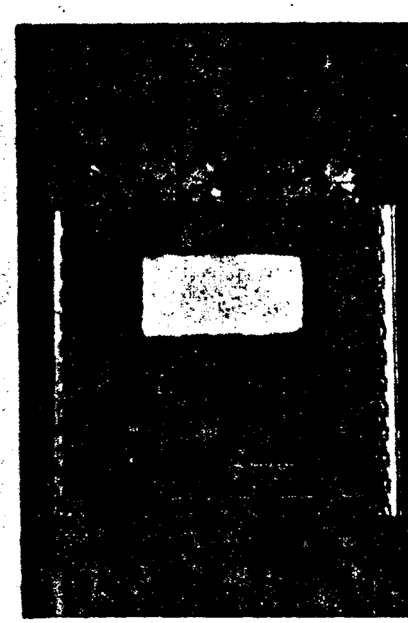

Fig. 2. This photo shows the manner of reinforcing the corners of ductwork insulation by use of metal angles

Table II. Recommended thickness of mineral wool insulation for flat surfaces are given in this table

Operating Temperature Degrees F	Thickness inches
100 to 200	1 in.
201 to 300	1½ in.
301 to 500	2 in.
501 to 700	2½ in.
701 to 900	3 in.
901 to 1100	3½ in.
1101 to 1200	4 in.

which require insulation are 1) carrying hot gases, 2) carrying air for room heating and air conditioning, and 3) carrying cool gases. Insulation of ducts used in ordinary room heating is primarily valuable in preventing heat from being dissipated before reaching its destination. When cool air or gases are carried in insulated ducts, the additional annoyance of deteriorating condensation sweating is prevented. Operating expense, of course, is a factor in every case.

For inside installations, where the temperature gradient is not great, the following procedure is recommended: 1) Clean the duct of all grease and dirt. 2) Cut mineral wool blocks to conform to the area to be insulated. 3) Wire the blocks to the ducts. Galvanized or expanded metal angles are recommended to keep the blocks in line at the corners, as shown in Fig. 2.

When the temperature gradient is greater than that encountered in room heating and air conditioning additional steps are advised. As illustrated in Fig. 3 they are: 1) Trowel a ½ in. coating of mineral wool insulating cement over the surface of the blocks; 2) Follow this with a layer of 1 in. mesh poultry netting; 3) Apply a ¼ in. coating of finishing cement.

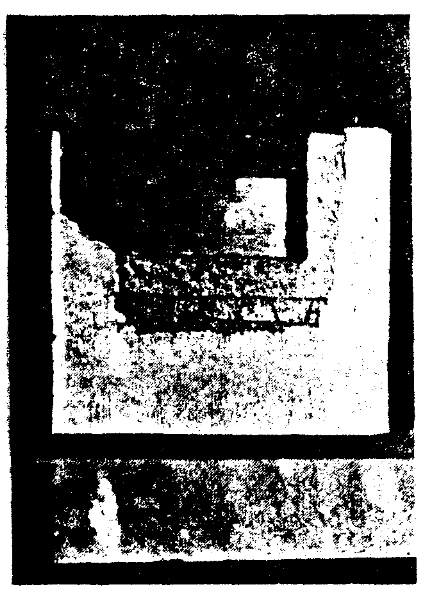

Fig. 3. The various layers of insulation material are shown here. They are: insulating cement, 1 in. poultry mesh netting and a ¼ in. coating of finishing cement

In cases where the contents of the duct are at a lower temperature than the surroundings, an asphalt or other type of vapor barrier must be applied to the insulation exterior. The purpose of the vapor barrier is to prevent atmospheric moisture from permeating the mineral wool and condensing therein, thereby spoiling its insulating qualities. Asphalt is also useful in cementing the mineral wool blocks to the duct before wiring them in place, and for preventing corrosion.

Commercial Standards

Good practice in the installation and use of insulating materials has been published in Commercial Standard CS117—44 issued by the U. S. Department of Commerce and available for 10 cents from the Superintendent of Documents, Washington, D. C. This standard has been voluntarily accepted by a large number of the leading associations and companies in the country.

WHAT IS THE ANMB DOING?

(Continued from page 67)

parts required both in the actual fabrication of the products and the tooling necessary to produce the products.

Naturally the standby facilities which were operated in World War II form an important consideration in this phase of the planning. It has been determined that approximately 100 plants should, if enabling legislation is enacted by Congress, continue to be government-owned. There should also be a number of government-owned plants released for sale with what is termed the "National Security Clause," a clause inserted in the lease which provides for a claim upon the plant on the part of the Secretary of War and/or the Secretary of the Navy in case of an emergency.

In addition to the industrial production required, there is the problem of setting up certain agencies necessary to handle production of goods that might be utilized by the armed services and production of goods that are absolutely necessary for the civilian economy. In addition to this, we are emphasizing over everything we have, the need for a constant revision not only of this phase of the industrial mobilization plan but of all phases. We have a saying in our shop that we will write the 1947 Industrial Mobilization Plan and the minute it is finished we will start on the 1948 Plan; and it is our hope that this will be done every year of our country's life. The economic situation changes and the political situation changes, the weapons change, and any plan of this sort must be written with these changes in mind. The Industrial Mobilization Plan will be revised in the light of a changing situation as weapons become obsolete and new ones will take their place. To illustrate, if the future plane is going to use a fuel entirely different from octane gas, our plants making such gas become obsolete and plants capable of producing the new fuel become all-important.

We would like to have such a plan each year read and noted as produced and would welcome comments from the President of the United States, the Secretaries of the services, heads of important departments of the country, such as Commerce, Interior, etc., and by the heads of the military committees of the Senate and Congress. To us, this seems very important in keeping the responsible administrators of our country familiar with what is going on and with the opportunity, as the plans are formulated, of making whatever comments seem best to them in light of current conditions.

Our schedule or "time table" of preparations may be divided into three different phases: (1) The work that should be done in peacetime preparing the plan to meet an emergency; (2) the actions and steps that will be necessary from the time trouble might appear until it actually descends upon us; (3) the setting into action of all the necessary agencies, bureaus, production, etc., when trouble has actually descended upon us. As I have previously stated, an effective industrial mobilization plan must be a plan by representatives of all Americans. Thus the Board has developed a program of industry advisory committees to assist in the discussions and preparation of the plan.

The Board is trying to visualize a set of conditions that may be ahead of us. No one can possibly write a master plan today which would be effective 25 years from now, but we do believe it possible to write a plan today that could go into effect next year. I emphasize the importance for men of industry, men of science, and the administrators of our country to realize that any Industrial Mobilization Plan must be a changing one, reviewed and revised in the light of current thinking.

INGOTS OF METAL that take pictures of themselves are produced by Westinghouse scientists who inject doses of radio-active atoms into steel, and other alloys. The tagegd atoms shoot out rays and particles at a photographic film. The resulting pictures showing the the position of the atoms are helping determine the causes of rust and brittleness.