IJARESM
INTERNATIONAL JOURNAL OF ADVANCED RESEARCH IN ENGINEERING, SCIENCE & MANAGEMENT

PERFORMANCE ASSESSMENT AND COST ANALYSIS OF PIPING INSULATION FOR STEAM DISTRIBUTION SYSTEM IN DYEING AND PRINTING MILL.

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Abstract: Energy efficiency in industrial boiler steam system can be very low due to old technologies, improper design and non optimal operation of the steam system. Efficiency improvement is necessary term for saving fuel and energy cost. Solutions include efficiency assessment an investment in steam system optimization this work is done on 8 Ton water tube boiler used by dyeing & printing mills. In this study the optimum insulation thickness of pipe used in steam distribution system in Dyeing and Printing mill. Energy saving and payback period are calculated for the three different pipe size at different desired temperature. Mineral wool is used as insulation material and a system of pipe lines with flow of steam. The result show that optimum insulation thickness 27.69 to 86.15 mm with desired temperature 45℃ to 62℃ energy saving vary between 7.49 to 72.83 KW/hour, and payback period vary 0.6 to 2.05 year .depending on the thickness of insulation ,while the optimum desired temp 55 ℃ obtained with insulation thickness 40.08 mm .

Keywords: **Insulation, steam system, energy efficiency, cost analysis.**

I. INTRODUCTION

Purpose of insulation

A thermal insulator is characterized by a low thermal conductivity and is therefore able to keep heat confined within or outside a system by preventing heat transfer to or from the external environment. Insulation materials are porous and contain a large number of dormant air cells. A large amount of heat energy may be lost without insulation or if insulation is inefficient or improperly installed. Thermal insulation, by reducing heat loss, delivers the following benefits:

- Reduction of fuel consumption
- Better process control by maintaining process temperatures at a constant level
- Corrosion prevention by keeping the exposed surface of a refrigerated system above dew Point
- Fire protection of equipment
- Absorbing of vibration In addition, staff working conditions are improved because insulation protects them from exposure to hot surfaces and radiant heat and because insulation reduces noise levels

II. SELECTING INSULATING MATERIALS

Factors that are important in choosing insulating materials are:

- Operating temperature of the system
- Type of fuel being fired
- Resistance of the materials to heat, weather and adverse conditions

- Thermal conductivity of the material
- Thermal diffusivity of the material
- Ability of the material to withstand the various conditions, such as thermal shock, vibration and chemical attack
- Resistance of the material to flames/fire
- Permeability of the material
- Total cost, including material purchase, installing and maintenance

Table: 1 Insulating Materials for various temperate ranges	
Insulation material	**Temperature Range**
Calcium silicate	40°C to 950°C
Thermocol (Expanded polystyren)	-10°C to 500°C
Glass mineral wool	-10°C to 500°C
Expanded nitride rubber	10°C to 300°C
Rock mineral wool	10°C to 300°C

Economical thickness of insulation

Thermal insulation reduces fuel consumption and its cost. Simultaneously we should consider the insulation cost and depreciation and fuel cost. With increase in the thickness of insulation, the fuel cost decreased with increase in the insulation cost. This limiting value of thickness, where total cost is become minimum is known as optimum or economical thickness of insulation.

Various types of fuels and boilers are used in various industries. There are certain parameters that gives the economic thickness of insulation.

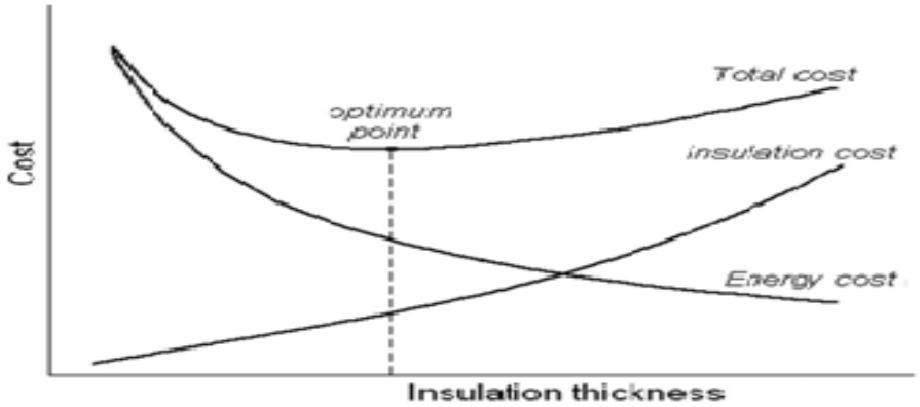

Figure : 1 *Economic thickness of insulation (mm)*

Figure shows that fuel cost and total cost decreases initially as thickness of insulation is increased. But after economic thickness the total cost is increased. The total cost is minimum at economic thickness of insulation.

III. RESULT AND DISCUSSION

Heat set temperature Ti= 170 °C

Ambient temperature Ta= 32 °C

Wall temperature of bare pipe Ts= 152.8 °C

Desired wall temperature of insulated pipe,

Td = 62°C, 55°C, 45 °C

Table 2: Pipe Parameters		
Size of the pipe	Length	Units
8 inch	11.58	Meter
6 inch	135.63	Meter
4 inch	137.50	Meter

Based on the requirement, the material considered for insulation is Mineral Wool.

Properties of Mineral wool

Specific conductivity of insulation at mean temperature	0.04 to 0.044 W/m°C
Surface emissivity	0.9

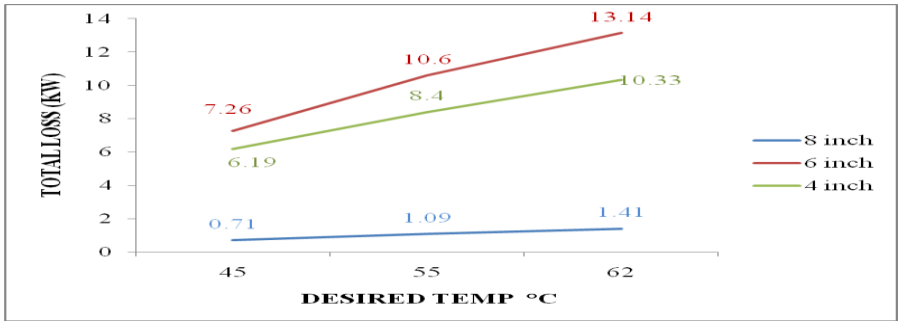

Figure: 1 Desired temp vs. Total loss

From the above Figure 1 it can be concluded that with increase in temperature total heat losses will increased.

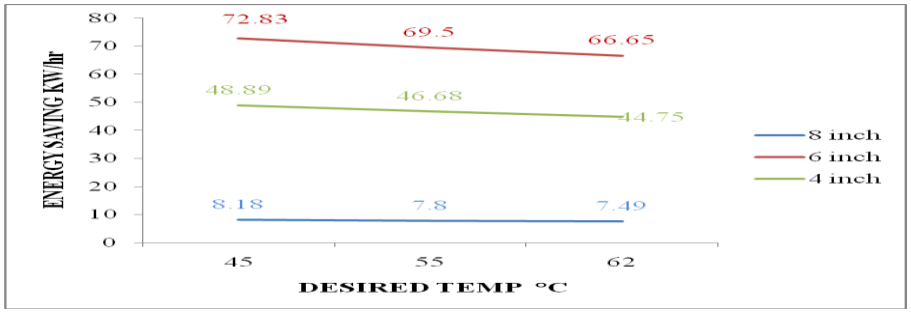

Figure: 2 Desired temp vs. Energy saving

From the Figure 2 it states that with increase in the temperature energy saving decreases.

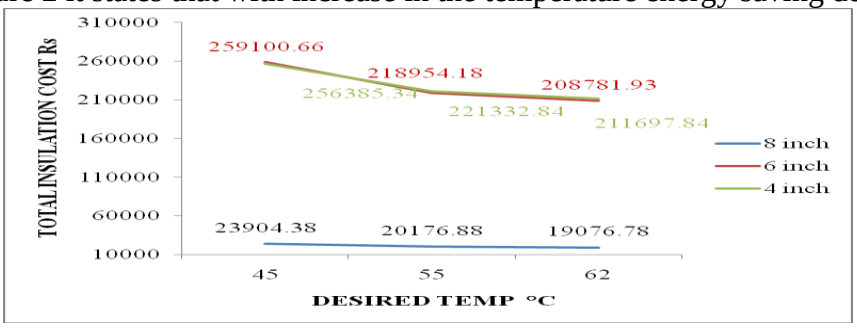

Figure: 3 Desired temp vs. insulation cost

Figure: 3 indicate the total insulation cost at different temperatures with increased in temperature the total insulation cost decreased.

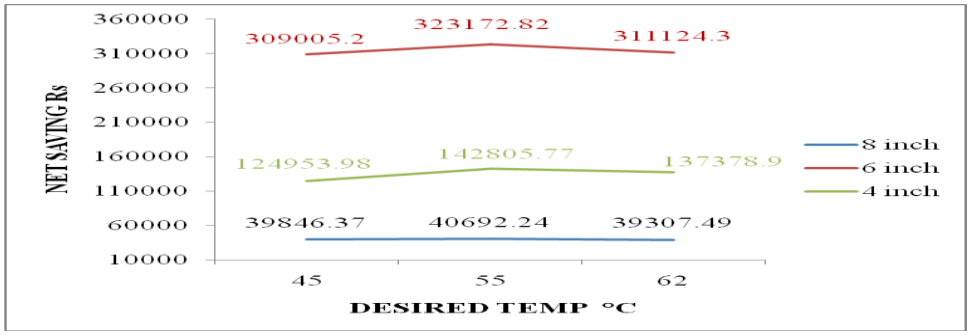

Figure: 4 Desired temp vs. Net saving

From the Figure 4 it is shown that net saving decreases with decrease in desired temperature of after that it increases. Maximum net saving is achieved at 55 °C insulation surface up to 55° C.

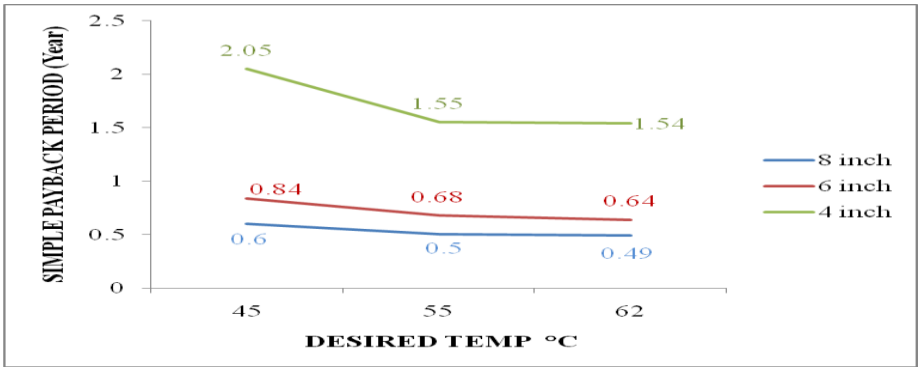

Figure: 5 desired temp vs simpleback period

From the Figure 5 which shows the payback period of insulation at different temperatures on increase in temperatures the payback period decrease the optimum payback period is 55 °C

Conclusion:

For insulation in the steam distribution system, the optimum insulation surface temperature is 55° C with a thickness of 40.80 mm. The payback period is less than 1.5 years.

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