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A general paper on optimization of fuel and energy(cost saving) by insulation (calcium silicate) in boiler

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ABSTRACT

This paper revolves around the impact of insulation in Indian thermal power plant. In this we are using calcium silicate as a nano-material rather than resin bonded glass wool. The main benefit use of calcium silicate, heat loss in boiler will be less as compare to glass wool because convection and conduction loss will be less, resulting less fuel consume. Using with nano material boiler fuel saving increasing. Resulting cost saving & fuel saving & energy saving.

Over all cost saving of the boiler will be increase use of nano-material (calcium silicate).

1. INTRODUCTION

The envelope of insulation has increased since the 1920 . Insulations are defined as those materials or combinations of materials which reduce the flow of heat energy by giving one or more of the following functions:
1. Save energy by decrease heat loss or gain.
2. Surface temperatures control for personnel protection and comfortable.
3. Facilitate temperature control process.
4. Prevent vapour flow and water condensation on cold surfaces.
5. Increase operating efficiency of heating ,cooling, boiler steam, observed in thermal power plant and chemical industrial installations.
6. Prevent or reduce damage to equipment from exposure to fire or corrosion.
7. Less emissions of pollutants to the atmosphere.

The temperature range for which **"thermal insulation"** will apply from -80°C to 815°C.

Insulating things diffence health from mold, airborne pollutants, and allergens. This study takes three main types of insulation: fiberglass, cellulose, and spray foam insulations. For the comparison of the three types of insulation, seven different categories are considered. They categories are:

1. Cost

2. Thermal efficiency
3. Sound transmission
4. Health aspects
5. Easy installation
6. Resiliency absorber to water
7. Environmental impacts

The insulation industry starts to make new products to meet the growing demand for specialized Products in thermal power plant in boilers.
Thermal insulation is ahead divided into three main temperature ranges as Given below:

A. LOW TEMPERATURE THERMAL INSULATION

1. 15°C through 0°C - i.e. Cold or chilled water.
2. 0°C through -40°C - i.e. Refrigeration or glycol.
3. -40°C through -75°C - i.e. Refrigeration or brine.

B. INTERMEDIATE TEMPERATURE THERMAL INSULATION

1. 16°C through 100°C like as Hot water and steam condensate.
2. 100°C through 315°C like as Steam, high temperature hot water.

C. HIGH TEMPERATURE THERMAL INSULATION

1. 315°C through 815°C like as Turbines, boiler ,stacks, exhausts.

Previously **glass wool** we used in this types of glass looks and comes in mostly two colors: pink and yellow. Glass insulation is made up by of small fibers of glass. Previously customer for conservation, manufacturers have been growth the amount of recycle glass used in power plant, probably 40% of the fiberglass by weight is made up from recycled glass. Fiber glass insulation, when we use, saves above than 12 times the production energy cost,the most common type of insulation in stock will most probably be fiberglass. This is because of its ease of installation and cost effectiveness in comparison with other insulation types such as cellulose and spray foam. Fiberglass found in two different types: batts and rolls. Fiberglass comes in specified sizes as--pre-cut lengths and widths. Installation of the fiberglass is relatively straight . additional advantage of fiberglass insulation includes the fact that it is a natural flame retarder so noncombustible because of its make-up of mostly recycled glass and sand. As a sound insulator, fiberglass is mostly effective. The sounds transmission coefficient of fiberglass has been shown to be approximately 40, with bare wall at 36. it means fiberglass will block sixteen times more sound than not giving any type of insulation. The downside of fiberglass comes with the insulation of small hard to reach areas of the boiler. Because fiberglass mostly found in large cut sizes. and it is resiliency to water and moisture is nearly weak.when installation it's important that the environment is controlled so that little or no moisture leaks into the wall. When the fiberglass gets wet, it squeezing up together and starts sag. This leaves gaps in the walls with air and heat to penetrate.

2. LITERATURE REVIEW

As we are using here **calcium silicate** as its heat loss tendency is short as compare to glass wool. **High-temperature insulation wool** (HTIW), which is known as **calcium silicate wool.** It can tolrate the temperature up to 1200 ’c. Calcium silicate insulation is made mostly of hydrous calcium silicate which mainly have reinforcing fibers; it is found in molded and rigid forms. Service temp. range from 35°C to 815°C. Flexural and compressive strength is best. Calcium silicate have water absorbent properties. It will be dry without deterioration. It is the non combustible material and used mostly on hot piping in boiler and surfaces. Calcium silicate is particular applied on high-temperature pipe in boiler and equipment in power plants. Since it is a rigid material that have a relatively flat thermal conductivity curve, highly compressive strength, extremely high flexural strength. Because of its high compressive strength, high flexural strength, and resistance to fracture from tumbling, its ability to maintain these properties up to 1,200°F, calcium silicate can tolerate considerable physical abuse without loss of insulating efficiency. and, calcium silicate can withstand vibration induced by high-temperature steam flow around internal pipe obstructions, such as internal part of valve, measuring devices and instrument, and flow restriction orifices.
Calcium silicate is usually used as a safe alternative for asbestos for high temperature insulation materials.

Properties of Calcium Silicate insulation board and pipe insulation

- light weight
- less thermal conductivity
- high temp. and chemical resistive

Calcium silicate are used here in high temperature boiler tube and processes.

Calcium silicate evolved about 1950 in past high-temperature thermal insulations: 85% magnesium carbonate and pure asbestos insulation. initialy, calcium silicate insulation was particularly reinforced with asbestos fibers. At end of 1972, North American manufacture company had switched to glass fiber, plant fibers, cotton linter.

3. METHODOLOGY

Here we are using calcium silicate as previously we are using glass wool. In this paper we calculate the value for **600 MW thermal power plant**.The methodology in calculate by formula. The required value took from running plant.

4. CALCULATION

Cost saving calculation with help of energy loss saving

TABLE-1

S.NO.	DESCRIPTION	WATER WALL TUBE		SUPER HEATER TUBE		REHEATER TUBE		ECNOMIZER TUBE	
		CALCIUM SILICATE (Modified)	GLASS WOOL (Existing)	CALCIUM SILICATE (Modified)	GLASS WOOL (Existing)	CALCIUM SILICATE (Modified)	GLASS WOOL (Existing)	CALCIUM SILICATE (Modified)	GLASS WOOL (Existing)
1	PIPE OUTER DIAMETER	65	65	65	65	65	65	65	65
2	PIPE LENGTH	36746	36747	113963	113963	57814	57814	123860	123860
3	PIPE SURFACE AREA	7500	7500	23260	23260	11800	11800	25280	25280
4	AMBIENT TEM. Ta	30	30	30	30	30	30	30	30
5	PIPE TEM. Th	400	400	550	550	550	550	360	360
6	DESIRED WALL TEMP WITH INSULATION Tc	45	95	70	122	70	122	40	88
7	SURFACE HEAT TRANSFER COEFF. IF HOT SURFACE h={.85+.005(Th-Ta)}10(W/SQ.mt C	27	27	34.5	34.5	34.5	34.5	25	25
8	SURFACE HEAT TRANSFER COEFF. IF HOT SURFACE AFTER INSULATION h'={.31+.005(Tc-Ta)}10(W/SQ.mt C	3.85	6.35	5.1	7.7	5.1	7.7	3.6	6
9	THICKNESS OF INSULATION(MM)	25	25	25	25	25	25	25	25
10	INSULATED PIPE AREA (SQ. M)	13268	13268	41152	41152	20876	20876	44725	44725
11	TOTAL LOSS FROM PIPE SURFACE Q=hxAx(Th-Ta)/1000 KW	132547.32	132547	738267	738267	374515	374515	368981	368981

12	**TOTAL LOSS FROM PIPE INSULATED SURFACE Q'=h'xAx(Tc-Ta)/1000 KW**	766	5476	8395	29152	4259	14789	1610	15564
13	**POWER SAVED BY PROVIDING INSULATION P=Q-Q'(KW)**	131781	127071	729872	709115	370257	359727	367371	353417
14	**ANNUAL WORKING HOURS n**	8000	8000	8000	8000	8000	8000	8000	8000
15	**ENERGY SAVING AFTER PROVIDING INSULATIO E=Pxn (KWH/YEAR)**	1054248744	1016567624	5838974976	5672918426	2962053888	2877815053	2938969200	2827335600
16	**HEAT ENERGY COST P (RS/KWH)**	1.11	1.11	1.11	1.11	1.11	1.11	1.11	1.11
17	**ANNUAL MONETRY SAVING (RS)**	1170216106	1128390063	6481262223	6296939452	3287879816	3194374709	3262255812	3138342516
SAVING(RS)		**41826043**		**184322771**		**93505107**		**123913296**	
TOTAL SAVING(RS)		**443567217**							

Cost saving calculation with the help of fuel consumption saving

TABLE-2

S.NO.	DESCRIPTION	WATER WALL TUBE		SUPER HEATER TUBE		REHEATER TUBE		ECNOMIZER TUBE	
		CALCIUM SILICATE (Modified)	GLASS WOOL (Existing)	CALCIUM SILICATE (Modified)	GLASS WOOL (Existing)	CALCIUM SILICATE (Modified)	GLASS WOOL (Existing)	CALCIUM SILICATE (Modified)	GLASS WOOL (Existing)
1	**PIPE OUTER DIAMETER**	65	65	65	65	65	65	65	65
2	**PIPE LENGTH**	36746	36747	113963	113963	57814	57814	123860	123860
3	**PIPE SURFACE AREA**	7500	7500	23260	23260	11800	11800	25280	25280
4	**AMBIENT TEM. Ta**	30	30	30	30	30	30	30	30
5	**PIPE TEM. Th**	400	400	550	550	550	550	360	360

6	**DESIRED WALL TEMP WITH INSULATION Tc**	45	95	70	122	70	122	40	88
7	**THICKNESS OF INSULATION(MM)**	25	25	25	25	25	25	25	25
8	**INSULATED PIPE AREA (SQ. M)**	13268	13268	41152	41152	20876	20876	44725	44725
9	**Heat loss s=[10+(Ts-Ta)/20]x(Ts-Ta) Kcal/hr-sqm**	161	861	480	1343	480	1343	105	748
10	**Total heat loss in system =sxA**	2139465	11427065	19752960	55275366	10020480	28040643	4696125	33463245
11	**Reduction in heat loss**	9287600		35522406		18020163		28767120	
12	**No of hours operation in year**	8000		8000		8000		8000	
13	**Total heat loss (Kcal/year)**	74300800000		284179251200		144161305600		230136960000	
14	**Calorific value of coal Kcal/kg.**	3500		3500		3500		3500	
15	**Boiler efficiency %**	87		87		87		87	
16	**Yearly coal saving =Total heat loss/G.C.V.xboiler eff.(Kg/year)**	24400920		93326519		47343614		75578640	
17	**Yearly coal saving(tonn/year)**	24401		93327		47344		75579	
18	**Price of coal Rs/tonn**	2200		2200		2200		2200	
19	**total saving/year**	53682023		205318342		104155952		166273009	
TOTAL SAVING(RS)		**529429326**							

5. CONCLUSION

In the table-1 Energy saving after modified insulation and existing insulation difference is too much. The cost of saving 44.35 cr.

In the table-2 fuel saving after modified insulation and existing insulation difference is too much. The cost of saving 52.94 cr.

Total cost saving by insulation **97.29 Cr**. in the the boiler. We have saved the energy and fuel that is covert in rupees by cost value of fuel and energy with the help of calculation.

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