Energy Conservation through Advanced system in Steel Ladles.

ABSTRACT

In current steel making technologies effective insulation of most of the equipments are absolutely necessary. The following report describes advantages and applications of Advanced systems in steel ladles. The effective insulation of steel ladles and tundish resulted in reduced steel case temperatures and less heat losses without affecting corrosion velocity of the front lining materials. Hence it will enhance the productivity by reducing the consumption of Kwhr/ton.

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Introduction:

In today's time of raising Carbon foot prints, continuously rising energy and raw material costs, the use of better advanced thermal Insulation materials is more important than ever. These applies in particular to areas where energy-intensive processes are carried out in the Iron & steel industry. Among heat insulation materials, microporous heat insulation materials are extremely important. They possess the lowest thermal conductivity of all types of insulating materials - even below that of still air and are used wherever extreme insulating properties are required in the narrowest of spaces.

Background:

The trials were conducted at cluster market at Jalna where Thermo Mechanically Treated (TMT) bars are manufactured from the scrap. Scarp along with Sponge Iron melted in the Induction furnace in different capacity of 15 to 55 tons in different plants. Metals are melted at 1640 -1655 Deg C in different plants depending on their practice. In all the plants, the current practice of hot face lining is Silica Ramming mass followed 70% Alumina safety brick and Ceramic Fibre board. Typical lining pattern as shown in the table 1.

REFRACTORY	LINING PATTERN	REMARKS
Silica ramming mass	150 – 250 mm	Dry silica ramming mass is lined with former inside the ladle and at every interval of around 110 – 200 heats, ramming mass is changed along with former. Its varies from plant to plant.
Safety Brick	50 – 125 mm	
Ceramic Fiber board	13 and 20 mm	

TABLE 1 EXISTING LINING PATTERN OF STEEL LADLE

Proposal :

With the increase in consumption of power to maintain the melt temperature during ladle travelling, holding and casting, insulation places a critical role to reduce the heat loss of the melt so that the minimum power is consumed in terms of Kw hr/ton. Also through the use of latest technology in ladle, refractory materials of increasingly higher quality are required at the front of the unit with a high level of corrosion resistance to liquid steel - and mostly possessing high thermal conductivity levels. For reasons of energy efficiency and durability – Outer shell of steel Ladles can withstand up to 400°C, over a prolonged period without deforming - the use of best-quality heat insulation materials becomes essential. It is also evident that optimum lining of insulation is required in order to maintain the intermediate temperature within the continuous use temperature.
Experience is that, high-quality refractory materials are capable of being insulated with advanced system without any reduction in durability.
Table 2 shows the proposal lining in comparison to the traditional lining with one of the customer. It is possible to reduce the Shell temperature to minimum 80 C -100 C. This will have further enhance the property of reducing the melting temperature at Induction furnace as it will reduce the drop in temperature from tapping till casting.

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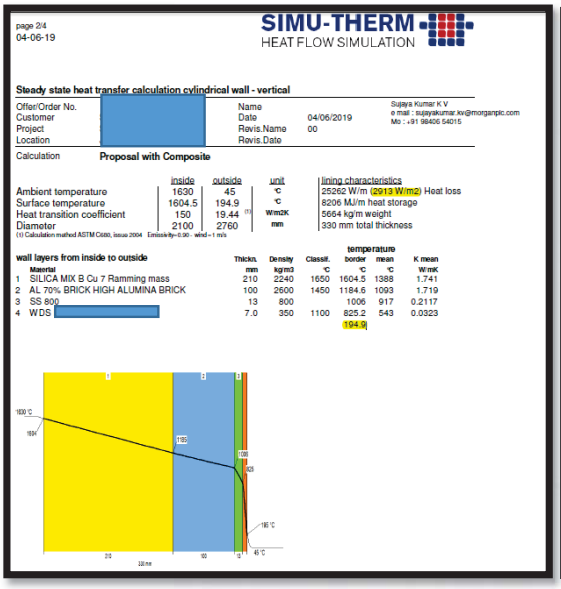
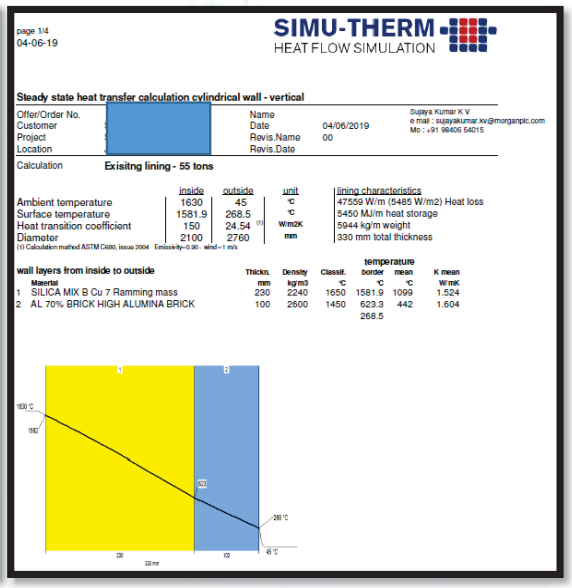
TABLE 2 PROPOSED LINING PATTERN OF STEEL LADLE

EXISTING LINING		PROPOSAL	
With whole lining	After 60 mm of Hot face	With whole lining	After 60 mm of Hot face
Silica Ramming mass – 230 mm 70% Alumina brick – 100 mm	Silica Ramming mass – 170 mm 70% Alumina brick – 100 mm	Silica Ramming mass – 210 mm 70% Alumina brick – 100 mm Insulating board – 13 mm WDS System – 7 mm	Silica Ramming mass – 150 mm 70% Alumina brick –100 mm Insulating board – 13 mm WDS System – 7 mm
Lining thk –330 mm	**Lining thk –270 mm**	**Lining thk – 330 mm**	**Lining thk – 270 mm**
Heat loss – 5.485 KW/m2	Heat loss – 6.777 KW/m2	**Heat loss – 2.913 KW/m2**	**Heat loss – 3.275 KW/m2**
Cold Face temp – 268 C	Cold Face temp – 297 C	**Cold Face temp – 195 C**	**Cold Face temp – 207 C**
	Savings	**73 C**	**90 C**
	Benefit	**Lesser heat loss with less cold face temperature.**	

i. Heat Flow calculation





ii. Theoretical Pay back calculation :

The proposed system is providing the ROI of less than 3 moths where the ladle life with insulation is more than 2 years.

SAVING DUE TO REDUCTION IN HEAT LOSS		
option 1	**55 tons Capacity**	
Ladle section	**Wall**	
Total Area of Ladle in m2	32.00	Sqm
Saving on account of	Heat Loss	
Heat loss as per Old lining design	5485	W/sq.m
Heat loss as per Proposed lining design	2913	W/sq.m
Difference =(old line Heat loss- New Lining heat loss)	2572	W/sq.m
Total Heat Difference	82304.00	Watts
Total Heat Saving in Kcal/hr	70781	Kcal/ Hr
Hours of operation	11.000	Hr
Total Heat Saving in Kcal	778596	Kcal
Total Heat Saving in KWhr	904.900	Kw hr
Total Saving in Kw hr for the entire Year considering 26 days and 12months	282328.693	Kw hr
Total saving in INR considering Rs. 8/unit	2258629.544	INR
Total inverstment on Microporus as back up insulation	400000	INR
Payback period >>>>>>>>>	**0.177**	**Years**
	2.13	**Month**

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Trial details:

A. Cases

Case 1: The ladles were lined with Safety bricks and Silica Ramming mass

Case 2: The Ladles were lined with WDS system along with SS 800 introduced.

We have tabulated all the results to have clear understanding on the performance. Silica ramming mass lining will be relined once after 90-100 heats whereas Safety brick and insulation will remain for minimum 2 years.

Observation:

Comparison Charts: Two Stage data collections are done when ladle was empty, after fully loaded, before casting at CCM.

Stage 1: With IR Camera thermography

Stage 2: Drop in temperature of the metal from tapping till casting to co-relate the performance of WDS system.

Stage 1 : Thermography Reports :

CASE 1 – NO INSULATION		CASE 2 – WDS+SS800			
Ladle No 01 – OLD Ladle		Ladle No 01 – New Ladle		Ladle No 02 – New Ladle	
Yr 2019		Yr 2019, Application date:15/08/19 Thermography date:25/09/19		Yr 2019, Application date:16/08/19 Thermography date:26/09/19	
Heat	Shell Temp	Heat	Shell Temp	Heat	Shell Temp
45	367 C 262 C 318 C	15 , 2nd camp	143 C 146 C 156 C	87	174 C 178 C 180 C

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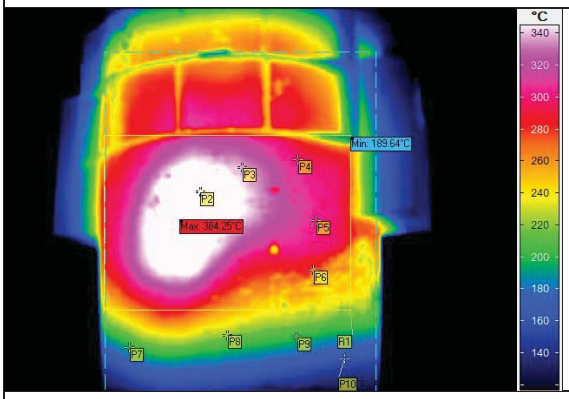
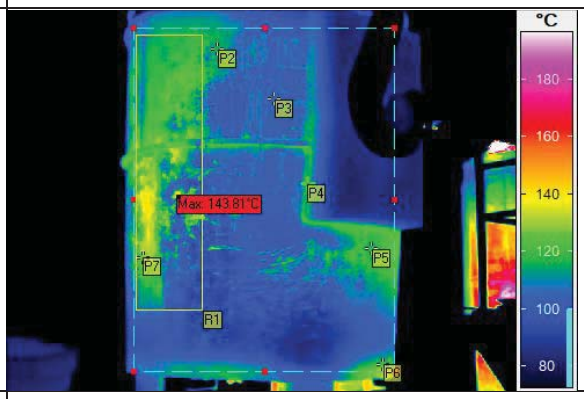
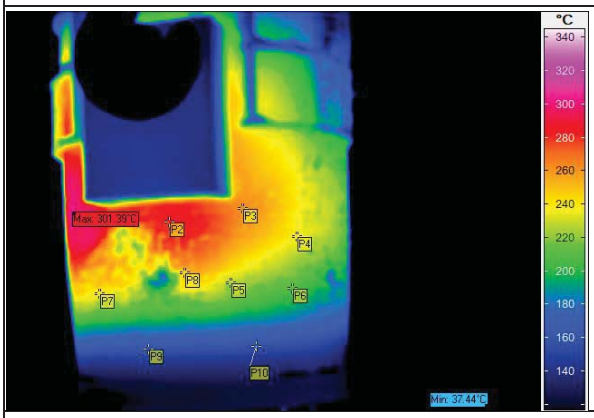
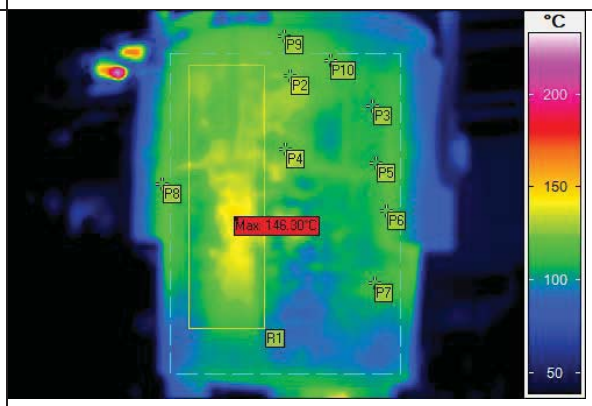
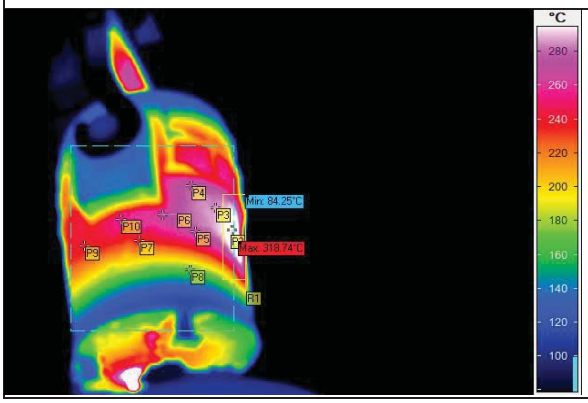
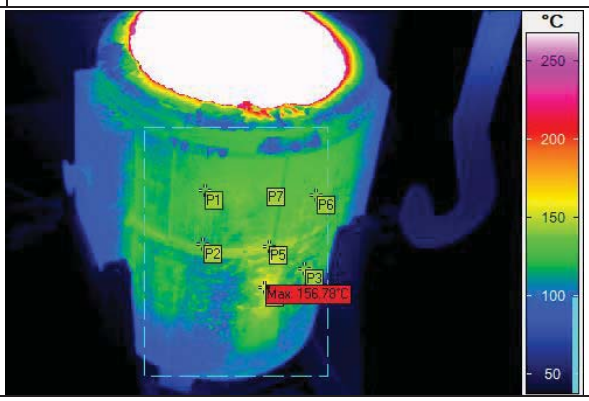
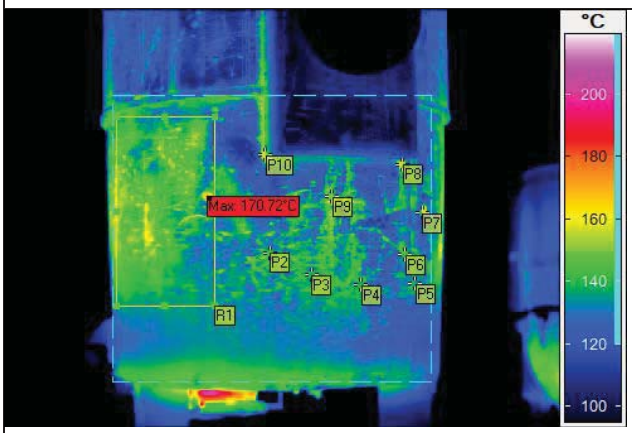
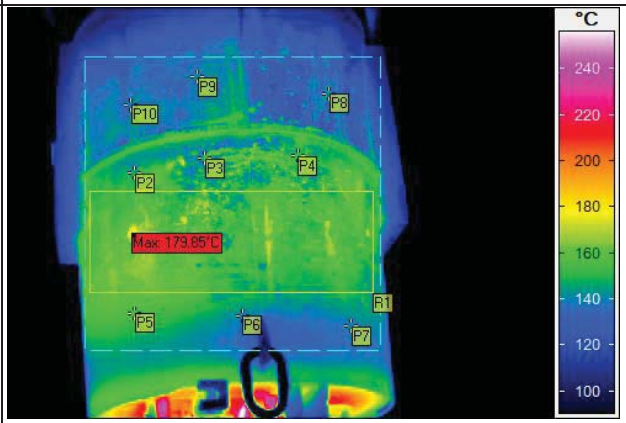
Ladle 01 :Case 1 : Without Insulation, 45th Heat	Ladle 01 :Case 2: With WDS + SS 800 Board, 15th Heat
Max Temp: 384 C	Max temp: 143 C
	
Ladle 01 : Max temp: 301 C	Ladle 01 : Max Temp: 146 C
	
Ladle 01 : Max Temp: 318 C	Ladle 01 : at CCM : Max Temp : 156 C
	

LADLE : 02: With WDS + SS 800 Board : 87th heat	
Max : 170 C after tapping	**Max 180 C before CCM**
	

Stage 2: Liquid metal temperature Observation

WITH OUT INSULATION:

- In Ladle No 01,45th heat within an interval of 50 minutes, the drop in temperature was from 1660 C to 1546 C with the drop of 114 C.

WITH WDS SYSTEM:

- In Ladle No 01, 15th heat within 32 minutes, the drop in metal temperaure noticed was from 1640 C to 1601 C, so the total drop is 39 C. This is inclusive of purging. Also from 4.27 PM, after purging the temperautre drop was from 1626 C to 1601 C, within interval of 23 minutes, the drop was 25 C. Hence the drop per minute is 1.08 C.

- In Ladle No 02, 87th heat witthin 19 minutes, the drop in metal temperaure noticed was from 1620 C to 1598 C, so the total drop is 22 C. This is inclusive of purging.

Conclusion:

Steel ladle insulated with WDS system was compared with un-insulated ladle for last 3 months and multiple campaigns at different plants. An average of 15 – 20 C was reduced in the melting process at Induction furnace which is turn saving to the tune of 150 – 160 kw hr/heat and in a day minimum 12 heats are tapped from the Induction furnace. Also it is evident that with WDS system insulated ladle allows 1 C per minute compared to pervious of more than 2 C – 4 C per minute and hence it is proven system that wherever ladle holding time is more.