Heat Transfer Analysis of Blast Furnace Stave Cooler

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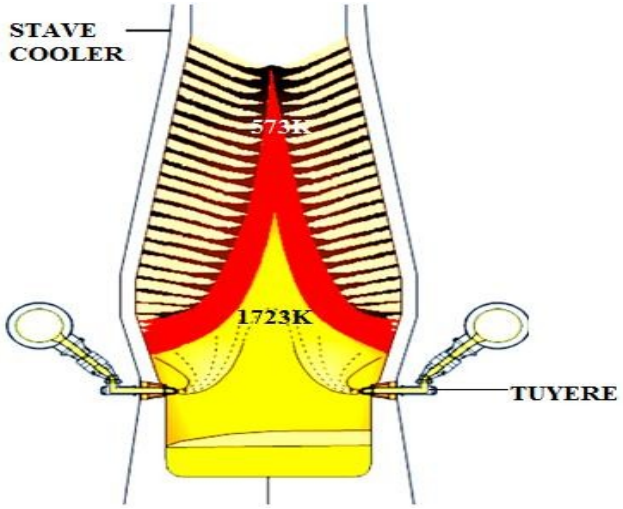
Abstract - Furnace cooling technology is very important for the metallurgical industry as it cansignificantly increase productivity and campaign life of furnaces. A heat transfer mathematical model of a BF staves cooler has been developed and verified by the experiments. The temperature and heat dissipated by stave cooler will be calculated by using ANSYS. The results has corroborated with experimental model used in RSP Blast Furnace.

My Proposed work heat transfer analysis has been done at different temperatures (loads) from 573k to 1723k in order to compare which material of staves has given better results than the other, also nitrogen has used in stave coolers of a Blast Furnace in the place of water for cooling purposes.

Keywords-Stave cooler, Blast Furnace cooling, Lining cooling .

I. INTRODUCTION

A stave is a cooling device having one or more coil,which is used to cool the refractory lining. It is installed in numbers on the inner surface of a blast furnace to protect its steel shell and maintain the inner profile but copper staves have been installed in blast furnaces in the zones exposed to the highest thermal loads, Thrmeal laod of stack to belly shown Fig.1.1.In blast furnace lots amount of heat is generate because of combustion, hence lining cooling by stave technology is one of the products of such efforts. It prevent from the overheating and subsequent burn through. In Cooling system Water is used as a medium for removes the excess heat generated in the blast furnace which keep the lining cooled & prevent it from faster wearing out. Cooling system thus prevent the increase of the shell and lining temperature. Various methods exist for cooling of the shell for the blast furnace. The staves were made conventionally of cast iron. But now days copper staves are used in place of cast iron staves, which is excellent in heat conductivity and heat flux to the copper staves is 50% lower than that to cast iron staves. Cast iron staves are proven cooling elements that are capable of multiple campaign life in areas of the blast furnace which do not experience extreme heat loads. Copper staves are proving to be an effective and reliable blast furnace cooling element that are subject to virtually no wear and are projected to have a longer campaign service life in the areas of highest thermal load in the blast furnace.



Thermal Zone of Blast Furnace

Now a days , cooling boxes of different size, number and design were used for transferring heat of the furnace to a cooling medium in conjunction with spray cooling. Blast furnaces with cast iron cooling staves are operating since 19 century. Cast iron stave cooling was originally a Soviet discovery from where it travelled initially to India and Japan. By 1970, cast iron cooling staves have attained world wide acceptance. Since the introduction of these cast iron stave coolers, the development work of blast furnace cooling got accelerated and today a wide variety of coolers are available for the internal cooling of the furnace shell to suit extreme condition of stress in a modern large high performance blast furnace.

II. LITRTURE SURVEY

Y. KO et al. [1]have analyzed the Thermal Behavior in Tap-Hole Area. They found that the thermal properties of mud-core, cast able and brick and the convection heat transfer coefficient of spool have a significant effect on the tap-hole area temperature distribution they developed hearth model, which can predict the trend of thermal behavior by adjusting material thermal properties and they found temperature distribution of the tap-hole area.

Akash Shrivastava and R.L. Himte [2] – have studied stave cooler of blast furnace using heat transfer analysis. They

had used two different types of skullin the lining material of the cooling stave in a blast furnace as well as two different types of bricks is considered, in which the first they had taken imperceptible thickness and the other had taken certain thickness, which is considered in millimeter (mm), so, with these two different type skulls, the heat transfer analysis did at different gas temperatures loads from 773k to 1573k they found that lining is better than other for heat extraction.

Anil Kumar et al. [3] have modeled three dimensional blast furnace cooling stave and this analysis he has taken two different types of lining material i.e. high alumina brick and silicon carbide brick . These lining materials are used at different gas temperature from 773 K to 1573 K as well as stave with skull is used at this gas temperature. They has chosen water temperature 303 K. They found that thermal stress and maximum temperature of hot face are lowest in alumina brick and highest in silicon carbide brick and. so he got silicon carbide brick is better for lining.

W.Lijun et al.[4] have analyzed three dimensional model stave of blast furnace using ANSYS. They found that reducing the temperature of water and increasing thevelocity of water would be uneconomical. They controlledthermal stress and maximum temperature in the stave by properly adjusting operating conditions of the blast furnace, operating conditions are the coating layer, gas flow, lining material and cooling channel inter-distance and gas clearance and Diameter.

W. Zhou et al. [5] have studied on the hot face of blast furnace stave cooler. They have used two equivalent convection coefficients between gas flow and inlaid brick, and gas flow and stave body. They found that equivalent convection coefficient increased the accuracy of heat transfer numerical calculation.

W.Lijun et al.[6] have studied on intelligent monitoring methodology based on the mathematical model of blast furnace stave and developed intelligent simulation technique this intelligent simulation model of cast steel stave cooler is based on correction factor of parameters obtained by training the samples of test data of the cast steel cooling stave. They found that the data of intelligent simulation model is nearly consistent with that of experiment.

III. OBJECTIVE

Objective of Present Work

1.To analyze the behavior of stave material at different loads

2.Design a Three Dimentional Model stave cooler .

3.To determine Temperature difference from Exeperiment

4.The Numrical results is corroborate with experimental model used in Vizag steel plant Blast Furnace.

5.Nitrogen is use in the place of water for cooling.

IV. PROPOSED WORK

My Proposed work heat transfer analysis has been done at different temperatures (loads) from 573k to 1723k in order to compare which material of staves has given better results than the other, also nitrogen has used in stave coolers of a Blast Furnace in the place of water for cooling purposes.

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