Analysis of Blast Furnace Stave Cooler for Heat Transfer &Its Material

Brajesh Kumar Ahirwar[1], Anil Sakya[2]

[1]Mtech Scholar, [2]Assistant proff. Mechanical Engineering Department

Oriental College of Technology, Bhopal

Abstract-Furnace cooling technology is incredibly necessary for the science business because it will considerably increase productivity and campaign lifetime of furnaces. A heat transfer mathematical model of a BF staves cooler has been developed and verified by the experiments. The temperature and warmth dissipated by stave cooler are going to be calculated by exploitation ANSYS. The results has supported with experimental model employed in Bokaro furnace.

In this work heat transfer analysis has been done at completely different temperatures (loads) from 573k to 1723k so as to check that material of staves has given higher results than the opposite, additionally gas has employed in stave coolers of a furnace within the place of water for cooling functions. Keyword:-Stave cooler, Blast Furnace cooling, Lining cooling.

I. INTRODUCTION

A stave may be a cooling device having one or a lot of coil, which is employed to cool the refractory lining. it's put in in numbers on the inner surface of a furnace to guard its steel shell and maintain the inner profile how ever copper staves are put in in blast furnaces within the zones exposed to the very best thermal masses, Thrmeal laod of stack to belly shown Fig.1.1.In furnace heaps quantity of warmth is generate thanks to combustion, there forelining cooling by stave technology is one amongst the product of such efforts. It forestall from the warming and later burn through. In Cooling system Water is employed as a medium for removes the surplus heat generated within the furnace that keep the liner cooled it from quicker sporting out. Cooling system so forestall the rise of the shell and lining temperature. numerous strategies exist for cooling of the shell for the furnace. The staves were created conventionally of forged iron. however currently days copper staves area unit employed in place of forged iron staves, that is superb in heat conduction and warmth flux to the copper staves is five hundredth not up to that to forged iron staves. forged iron staves area unit well-tried cooling components that area unit capable of multiple campaign life in areas of the furnace that don't expertise extreme heat masses. Copper staves area unit proving to be a good and reliable furnace cooling component that area unit subject to nearly no wear and area unit projected to own a extended campaign service life within the areas of highest thermal load with in the furnace.

Now a days , cooling boxes of various size, variety and style were used for transferring heat of the chamber to a cooling medium in conjunction with spray cooling. Blast furnaces with forged iron cooling staves area unit in operation since nineteen century. forged iron stave cooling was originally a Soviet discovery from wherever it traveled at the start to Republic of India and Japan. By 1970, forged iron cooling staves have earned world wide acceptance. Since the introduction of those forged iron stave coolers, the event work of {blast chamber |furnace} cooling got accelerated and these days a {large} form of coolers area unit obtainable for the inner cooling of the furnace shell to suit extreme condition of stress during a fashionable large high performance furnace.

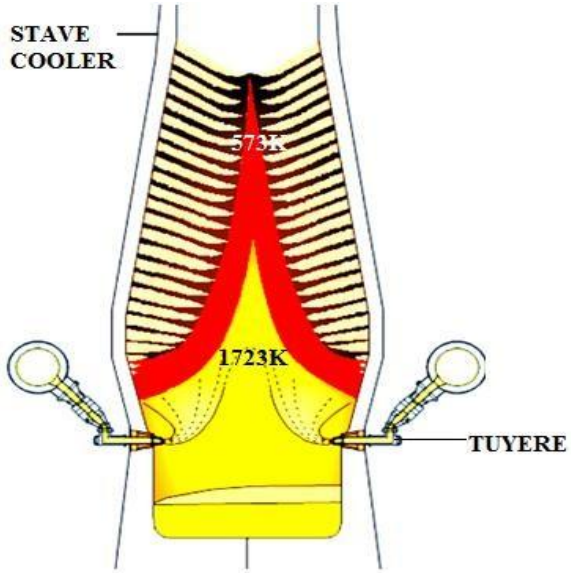


Figure 1.1Thermal Zone of Blast Furnace

1.1 Types of Cooler

1.1.1 Plate Cooler

In Europe plate cooler has been used in all large furnace. Plate coolers are generally made by either welded or cast in electrolytic copper. The usual plate sizes are 500 - 1000 mm long, 400 - 800 mm wide and approximately 75 mm high, which is shown in below Fig.1.2 . Plate cooler has kept in the zones with high heat loads of blast furnace especially in the bosh and lower stack areas ,arrangement of plate cooler shown in below Fig.1.3 and 1.4.Copper flat coolers have a greater uniformity of material properties

over the complete cooling element. These coolers are designed to maintain high water velocities throughout the cooler, thus have an even and high heat transfer coefficient. The copper flat plate coolers generally have multiple channels with on or two independent chambers. One of the designs of capper flat plate cooler has six pass with single chamber. These coolers are mostly welded to the blast furnace shell to ensure gas tight sealing Minimum losses of water pressure are ensured in both the piping and the element itself The figure of a common copper flat plate cooler design.

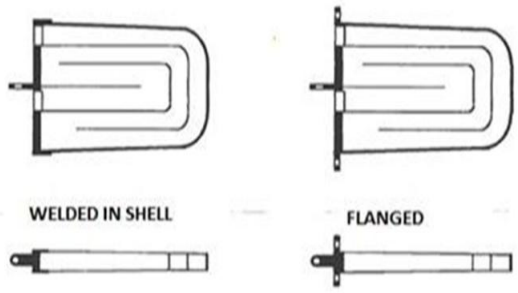


Figure 1.2 Plate Cooler

1.1.2 Cigar Cooler

For special blast furnace applications, Cigar Coolers can be either cast or fabricated in many different dimensions or lengths, the design of Cigar cooler shown in below Fig.1.5 . These are also called as copper jackets. Cigar coolers are used in between the plate coolers when more intensive cooling is required or there is more spacing of the flat plate coolers, which is shown in Fig.1.6. These are also used for improvements to the existing cooling system during a campaign. Cigar cooler is generally machined by solid copper bar to form a cylindrical core and a single channel is added by drilling and plugging. Cigar coolers are normally kept on the centerlines between adjacent flat plate coolers on a horizontal and vertical plane. For the basis of installation of a cigar cooler normally a cylindrical hole is drilled through the furnace shell and existing refractory lining with a core drill. The cigar cooler use increases the cooling system area and prevents the refractory lining to chemical and mechanical attack mechanism.

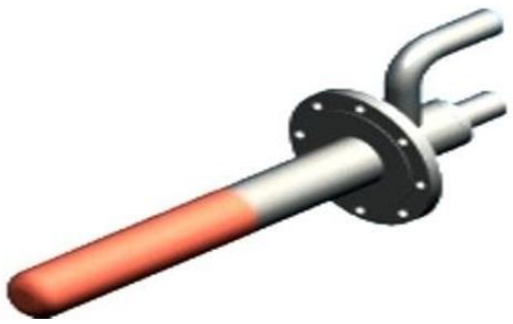


Figure 1.3Cigar Cooler

II. THREE DIMENTIONAL MODELING OF BLAST FURNACE STAVE

The biggest thermal zone of the blast furnace is concentrated within the lower stave region of the blast furnace. Cooling stave bring in major maintenance and repair of a blast furnace. Hence

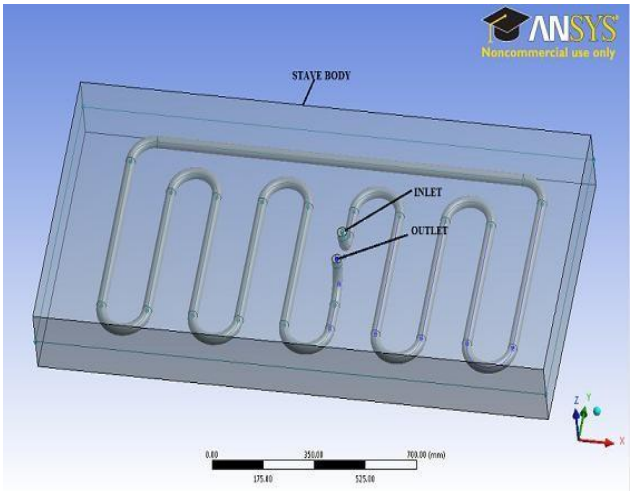
,cooling stave life is a key parameter for the life of the blast furnace. The body of the blast furnace is made of steel and cooling stave is made of cast steel. Cast steel is used because cast steel are like high thermal conductivity, specific elongation, melting temperature ,tensile strength.

2.1 Model of Blast Furnace Cooling Stave

Cooling Stave ar organized during a loop, that ar connected during a series the higher than figure three.3 shown a way to connect 2 or quite 2 stave. during this figure one is recess and another is outlet from recess water is enter to the process of 3 staves and from outlet water or gas is comes.

2.2 Computational Modeling of Cooling Stave

The main objective of the study is to research the behavior of stave material at totally different hundreds mistreatment the warmth [13].The transfer analysis by ANSYS higher than 3 dimensional cooling stave should be shapely by constructing a model that has been shapely within the worktable, the dimension of stave cooler and cooling coil shown in table three.1 and 3.2 with all respect. subsequently the model should be export in .AGDB file. subsequently the three-D model foreign within the Meshing package, In meshing given name of face and created interface in close between coil of stave and body of stave subsequently the model should be export in .MSH file. Then .MSH file import during a FLUENT. during this package condition, material choice, assumptions of stave has given, the table three.3 shown property of fabric. within the below Figure three.1is the cooling stave, there ar 2 holes as shown within the Fig.3.2, represent the cooling pipes, recess and outlet.



III. EXPERIMENTAL AND NUMRICAL ANLYSIS

This work concerning the modeling and numerical analysis of actual stave cooler utilized in furnace of Bokhara steel plant(BSP). It have known a stave cooler for experimental base, that is subjected to most heat load within the chamber. A analytical model has been developed with the assistance of computer code taking on all dimension from plant knowledge base. The model developed is a twin of the particular stave cooler utilized in BSP. Sensible knowledge have taken from experimental setup supported a similar known stave cooler. From the experimental setup we have a tendency to live the particular heat load in subjective stave cooler. once a similar heat load calculated from experimental setup is place in analytical model in ANSYS then temperature distinction (dT) Matched to be as within the actual setup.

3.1 Numerical Analysis

In this work a Three-dimensional numerical study has been undertaken to review the consequences of water, outlet and wall temperature of casting hole in stave cooler. Heat flux has given to the one facet of stave, that having one couple wall up between stave body and fluid body. This couple wall is formed by build interface between solid wall and fluid wall. Mass rate of fluid has given to the water.

The steps for simulation and analysis are:

1. After importing the .mesh file

2. The first step is the material selection. The material is selected for the stave body i.e. cast iron, copper.

3. The materials selected for Fluid ie water or nitrogen

4. Then it has been given assumptions and boundary conditions to the stave cooler for the

5. Thermal calculations

6. Then it has been checked boundary condition of interface wall if couple wall come than it is correct.

7. Then it has given for iteration.

3.2 Assumption

1. Steady state conductive heat transfer process

2. Three Dimensional

3.3Boundary conditions of stave cooler for thermal calculation

• Wall of stave cooler assumed to be insulated except hot wall.

• Heat flux has given on the hot wall of stave cooler.

• Heat flux varied according to the position of Blast Furnace.

• Cooling fluid entered at constant temperature i.e 300K.

• Mass flow rate has given to the inlet.

IV. RESULTS AND DISCUSSION

Results deals with the experimental graph and analytical graph and contour plots of temperature created for the stave cooler. Actual heat flux calculated with the assistance of experiment, then heat flux is place within the 3Dmodel of stave subsequently it absolutely was found that temperature distinction of numerical model stave cooler matched to the much stave cooler of BSP furnace. this analysis has been done exploitation 2 gas and water. In experiment we've given same mass rate of flow of water likewise as gas then it absolutely was found heat extracted by water cooling fluid was bigger than gas. once we passed a fourfold mass rate of flow of gas quite water mass rate of flow then it absolutely was found that the warmth extraction of water fluid and gas is same. the worth obtained by much, that is precisely identical as within the numerical model. This analysis have drained exploitation totally different sort of material like as cooper, and forged iron then it found that copper is best then alternative material thanks to high thermal physical phenomenon. the graph and contour plots of temperature shown in below .

V. CONCLUSIONS

The overall conclusions of the current work. In modeling and projected analysis methodology of the cooling stave, the most part is that the tool by that simulation is to be done. So, bench computer code is employed for the modeling and ANSYS is employed for analysis. The results are going to be achieved supported some parameters, assumptions, and boundary conditions. These all values has taken from Bokhara steel plant (BSP). Thus, the most aim of this study is to verified the numerical model with experimental model of stave cooler and analyze the behavior of stave cooler at completely different hundreds temperature from 573k to 1723 k through heat transfer analysis by finite part technique computer code. S. during this study, 3 differing types of materials like forged iron and copper and is taken into account for the stave cooler material of the furnace our work. thus from the analysis it's been conclude that.

[1].Numerical knowledge is verified with Experimental knowledge.

[2].Nitrogen are often a best various cooling medium of the furnace stave. because the quantitative relation of heat of N and water square measure within the vary of 1:4, mass flow of N is hyperbolic fourfold than water so as to maintained constant heat transfer rate within the stave cooler.

[3].The copper stave is best than different stave. In copper stave most temperature on the new face is less than

different stave, as a result of copper material has higher thermal physical phenomenon instead of forged iron, thatis mostly employed in stave cooler.

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