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A STUDY ON OPTIMIZATION OF LOW PRESSUREFEED WATER HEATER FOR THERMAL POWER PLANT

Kiran .V.S[1], Manjunath.H.N[2], Madhusudhan[3]

[1]Student, IV semester M.Tech (thermal power Engineering), [2]Asst, professor, [3]Professor,
Mechanical Engineering Department, Nitte Meenasksi Institute of technology,
Affiliated to VTU Belagavi, Karnataka, Bangalore (India)

ABSTRACT

A feed water heater is a component of the power plant which is used to preheat the water and to deliver to a steam generating boiler. In steam power plant, the low pressure (LP) feed water heater are used known as Shell and Tube Heat exchanger which are the basic types of heat exchangerthere are about three low pressure (LP) feed water heaters are used LP1, LP2, LP3,Aim of the projectwork is to eliminate the LP3 feed water heater so that to eliminate LP3 feed water, the parameter like temperature, mass flow rate, pressure are known & the condition of steam and water of work to be known. Since both the water and steam having the same heat flux the water heat flux has been considered on steam side for the given boundary condition. The water flow from LP1 at tube side inlet which flows to LP2 to LP3 the tube side an outlet further fluid flows in to deaerator. If LP3 eliminated the outlet temperature of LP3 has to be achieved at LP2 outlet temperature of fluid further flows in to deaerator and optimization of LP2 has been carried out by computational fluid dynamics CFD. The project work is carried by adapting passive method and the results are shown by using ANSYS CFX,

Keywords: CFD, feed water heater, passive method, Shell and tube heat exchanger etc.

I. INTRODUTION

A feed water heater is a component of the power plant which used to preheat the water and to deliver to the steam generating boiler called as steam power plant. In the steam power plant the low pressure (LP) feed water heater are used known as (Shell and Tube Heat exchanger) are the basic types of heat exchanger where the water is the fluid which flow in to a bundle of tubes enclosed by a shell. The outer fluid (steam) is forced through a shell side that flows over outside surface of tubes. (2011)[1] An un-baffled shell-and-tube heat exchanger design with respect to heat transfer coefficient and pressure drop is investigated by numerically modeling. The flow and temperature fields inside the shell and tubes are resolved using a commercial CFD package considering the plane symmetry2012 [2] the objective of the project is design of shell and tube heat exchanger with helical baffle and study the flow and temperature field inside the shell using ANSYS software tools. The heat exchanger contains 7 tubes and 600 mm length shell diameter 90 mm. The helix angle of helical baffle will be varied from 00 to 200. In simulation will show how the pressure vary in shell due to different helix angle and flow rate.2014 [3] the main objective of this paper is to verify the heat exchanger designed with the use of the Kern's method, by the use of Commercial computational fluid dynamics (CFD) software. In the present study, CFD simulation is used to study the temperature and velocity profiles through the tubes and the shell. 2015 [4]using the above Kern method with different fluid combinations such as sulphur-dioxide on the tube side steam on shell side and carbon-dioxide side on tube side and steam on shell side, Parameters such as heat transfer coefficient, friction coefficient, length, area and pressure drop are determined. C code is written to evaluate the above parameters. Graphs are drawn to depict the behavior for different fluid combinations. The results are tabulated2015 [5]Calculating the heat transfer capacity of the heat exchanger by mathematical modeling equations. The flow and temperature fields inside the shell and tube are resolved using a commercial FLUENT package. Heat exchanger consists of two fluids (water) of different starting temperatures flow through the heat exchanger. Here, we are varied tubes with different materials copper and brass. Finally analysis has been done by varying the tube materials and hence it is observed that copper material gives the better heat transfer rates than the brass materialtransfer is a common problem in heat exchanger.

1.1. Physical Model

The shell and tube heat Exchanger has been created in the CATIAV5 and the dimensions are provided as per the KPCL power plant Bellary 500MW, the tubes are the important components in this project a single tube has been considered for the analysis

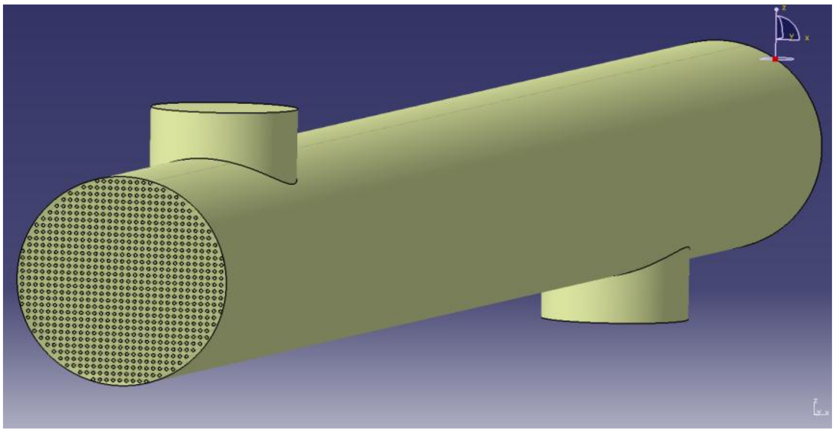

Fig. 1 CATIA 3D model of shell and tube heat exchanger

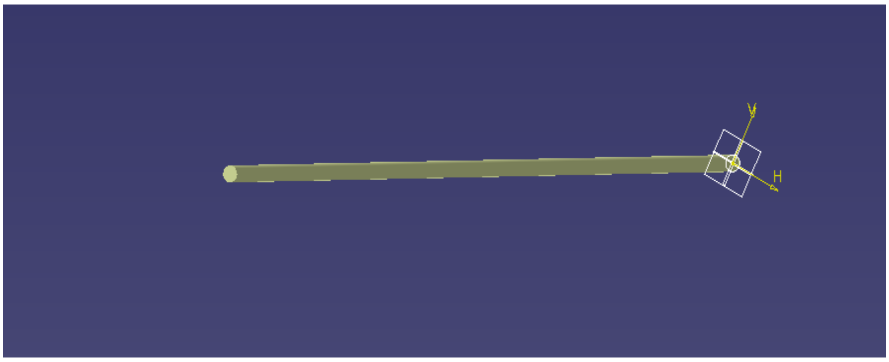

Fig. 2 CATIA 3D view of single tube

the meshing is carried out at ICEM CFD and analysis are shown as results by ANSYS ,CFX, the outlet temperature at tube side at LP2 is 379.5 K counter are valid and shown in results.After the validation for the purpose of passive method the model is to be redesigned at CATIAV5 for better rate of heat transfer and enhancement is carried out at LP2 and the results are shown in CFX

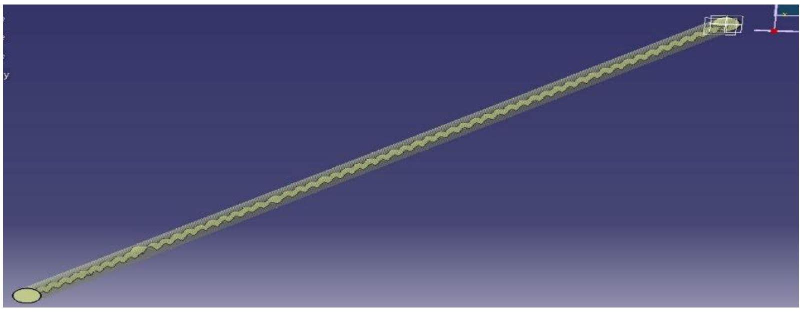

Fig. 3 CATIA 3D model single tube with strip

1. Figure shows physical model of tube which has length 11934mm and diameter 19mm

water is flowing at tube side and there about 916 u tubes inside the shell as shown in figure 1 the water fluid is flowing inside the tube at mass flow rate at 341.11kg/sec and the pressure remains constant 32.21atmospheric

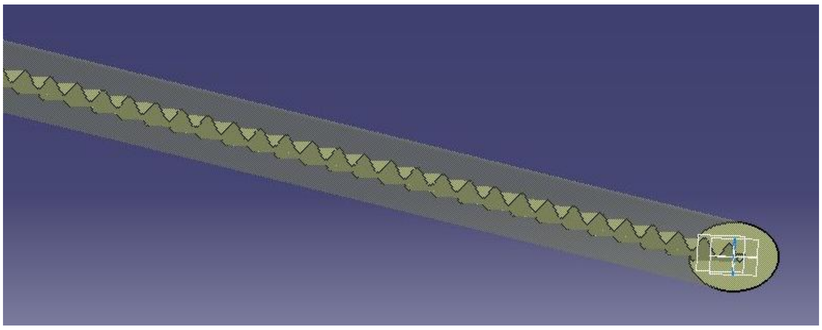

Fig. 4 close view 3D model single tube with strip

Steam at LP2 inlet flowing at 426K and outlet flowing at 345K the heat at water and steam from both side are same hence the heat flux at water side has been calculate and given as boundary condition for CFD analysis The catia model in saved in IGES and imported to ICEM CFD

Fig.5 mesh model of single tube

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After complitiion of cadd model it is saved in IGES, and exported to meshing tool to ICEM CFD, the meshing is carried out by considereing a single tube & elements are tetra, about 9lakh of elements are created, and the parts are assigned the blue colour is the inlet part and the green is wall and the red is outlet of the tube and the strip inside the tube is red colour.

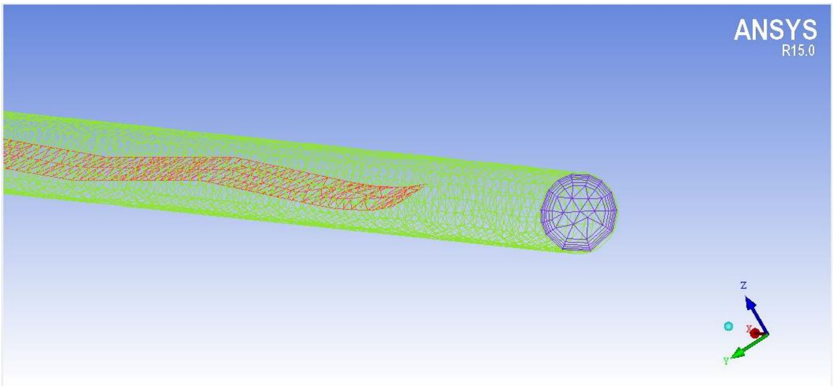

Fig.6 mesh model of single tube inlet with strip

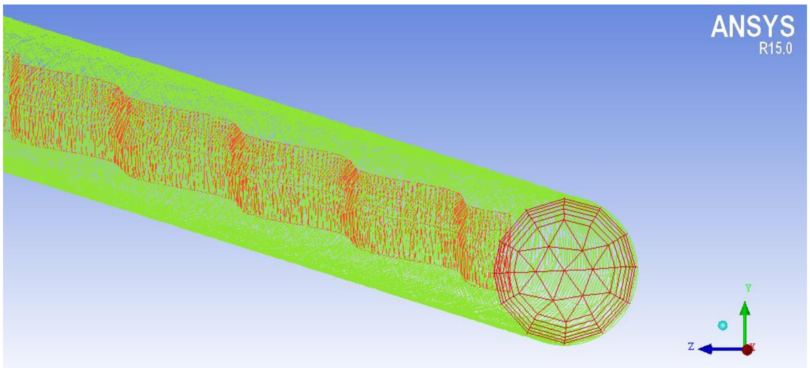

Fig.7 mesh model of single tube outlet with strip

II GOVERNING EQUATIONS

For the analysis the Standard K-epsilon model is used to calculate the turbulent flow field at tube side

1.2.1 Continuity Equation

$+ \quad = \quad + \quad = 0$ (1)

1.2.2 Conservation of Momentum equation for an incompressible fluid:

$\rho \quad = \rho g x - \quad + \quad u$ (2)

1.2.3 Energy Equation:

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$U \quad + v \quad + w \quad = \quad (\quad + \quad)$ (3)

1.2.4 Rate of heat transfer

$Q = M\, C_P \Delta t = 341.11\times4.18\times38.2 = 54894.83$ watt (4)

1.2.5 Area of tube LP2

$A=\pi\, D\, L= 3.1415\times .019 \times11.93$ (5)

A=.71257

1.2.6 Heat flux

1.2.6 Heat flux at LP2, q (6)

q = Q/A= 54894.8323/ .71268 = 77025.851 w/

TABLE 1 BOUNDARY CONDITIONS

sl.no.	LP heater	water kg/sec	$C_p$of water KJ/kg k	water temperature k		Q= $C_p\Delta t$ watt
				Inlet temp T_{C1}	outlet temp T_{C2}	
1	1	341	4.18	321	341	28516.8
2	2	341	4.18	341.4	379.5	54894.81
3	3	341	4.18	379.9	399.5	27946.460

III RESULTS AND DISCUSSION

The results shows the counters of outlet temperature at tube side and the pressure distribution and also the outlet temperature at tube side with strip shows more temperature and pressure drop can also be studied by graph. After the optimization the outlet of LP2 temperature at tube side is 404 k by this it concludes that LP3 can be eliminated since the outlet temperature of LP3 has been achieved at LP2.the case1 results shows the validation of the project. The case 2 shows the enhancement of the project.

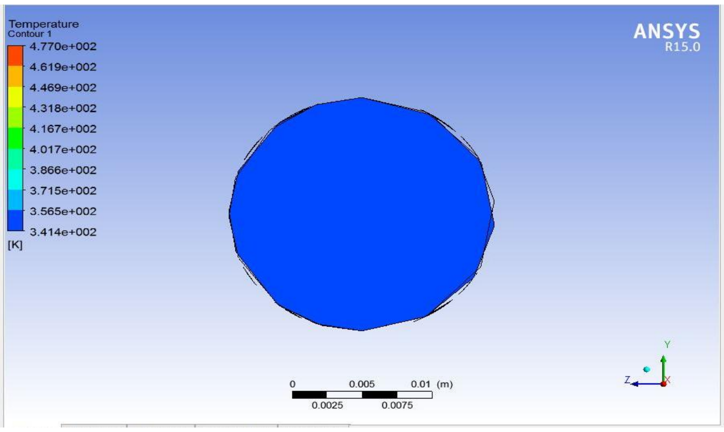

Fig.8 case 1 inlet temperature at tube side

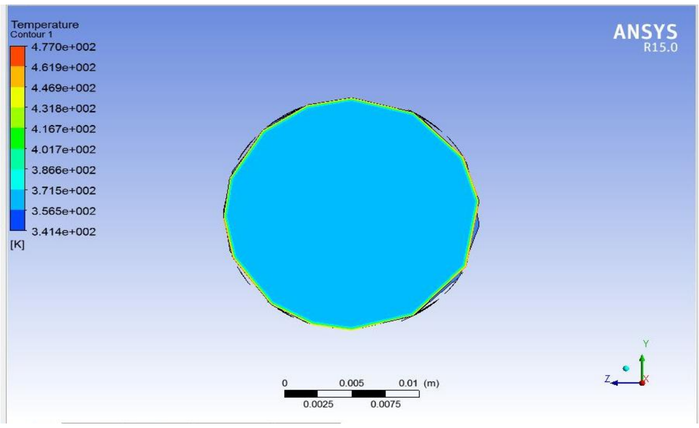

Fig.9 case 1 outlet temperature at tube side

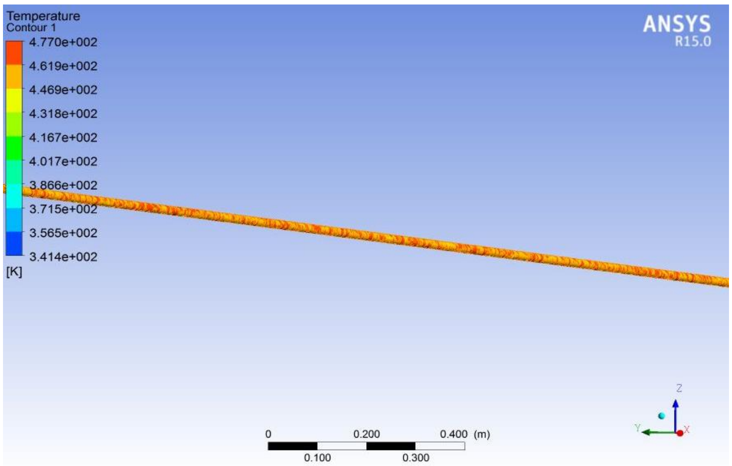

Fig.10case 1 wall temperature at tube side

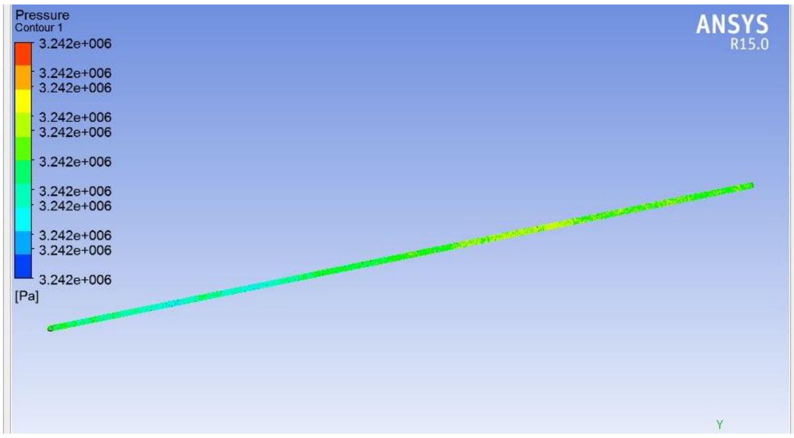

Fig.11case 1 pressure at tube side

For the case 2 passive method is adapted due that the more temperature is observed at outlet tube side of the heat exchanger but the pressure is found to be droped below figure shows reults

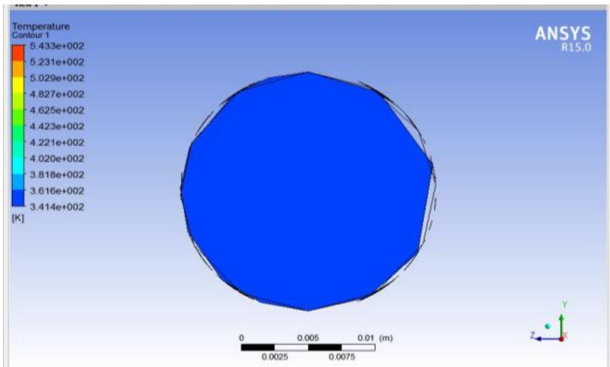

Fig.12case 2 inlet temperature at tube side with strip

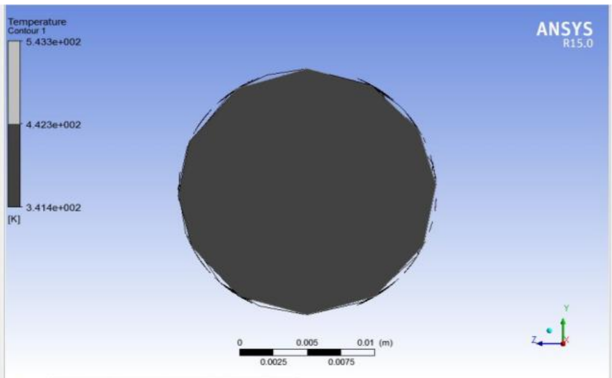

Fig.13case 2 outlet temperature at tube side withstrip

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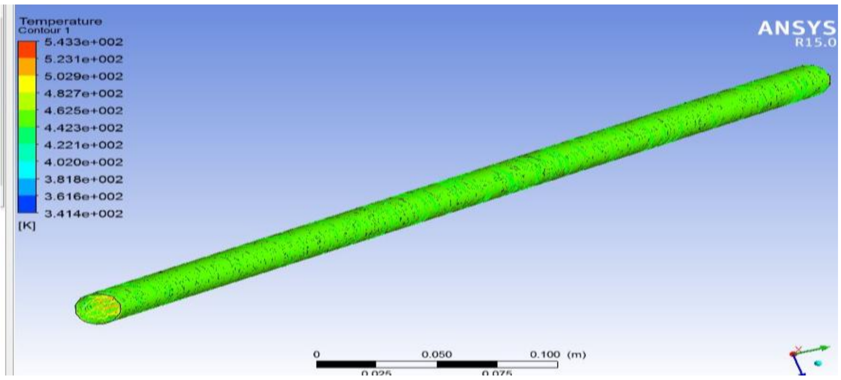


Fig.14case 2 wall temperature at tube side

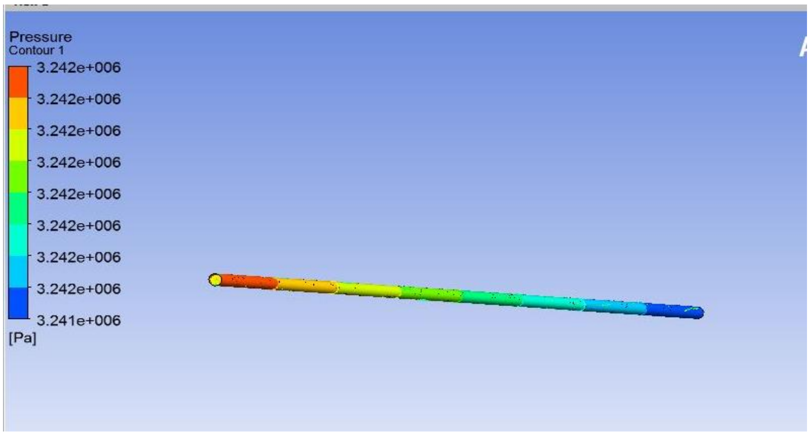
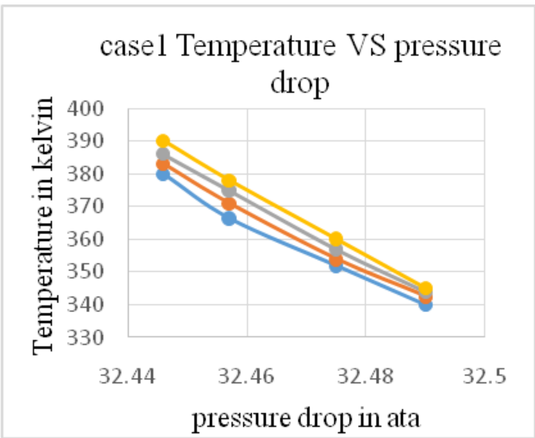
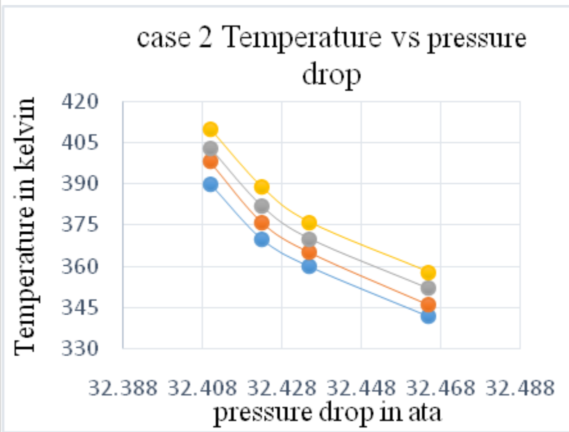


Fig.15case 2 pressure at tube side

The graph shows the temperature distribution versus pressure drop for cases 2 (b) by adapting passive method the temperature has been improved but the pressure drop is found to be .001ata



(a)



(b)

IV.CONCLUSION

There are three LP (low pressure) feed water heater (shell and tube heat exchangers) are used in thermal power plant. i.e. LP1, LP2, LP3 after studying the cases the LP2 has to be optimized and LP3 has to be eliminated. To eradicate the LP3 feed water heater the, LP2 must be optimized. The data and parameters are collected from Bellary thermal power plant 500MW. Analysis has been carried out by CFD (computational fluid dynamics) for the validation, data are analyzed in commercial software ANSYS CFX and then for optimization has been done by adapting passive method and results are shows that heat transfer rate has been improved.

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