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Performance analysis of Economizer using Wrought Iron tubes

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Abstract **- The economizer is used to preheat the feed water used in the boiler. The economizer includes an extra quantity of tubes linked parallel to each other. On the internal aspect of the tubes, the feed water is passed and the flue gas popping out from the chimney is passed over at the surface of the tubes to increase the feed water temperature. To increase the heat transfer rate, the material of the tubes can be modified. We have changed the material of the tubes from carbon steel to wrought iron. The thermal conductivity of the wrought iron is excessive. Because of this, the heat transfer rate can also be increased and the temperatures of the water coming out from the economizer tubes get multiplied. Computational Fluid Dynamics (CFD) is one of the pleasant-suitable software for the analysis of flow styles which involve the dynamic parameters inside the drift. The CFD evaluation is used to measure the temperature rate of the water coming out from the tubes. The temperature changes analyzed by using CFD-Fluent Flow for wrought iron tubes with existing carbon steel tubes.**

Keywords **- Economizer, Tube Material, Conductivity, Analysis**

I. INTRODUCTION

In boilers, economizers are warmness exchangers that warmness the fluids. Economizer helps in raises the total effect of the thermal plant. Using of economizer can increase feed water temperature and reduces the temperature of flue fuel. The range of warmness transferred and the feed water temperature relies upon steam strain temperature of flue gases discharged from the boiler. Transferring warmness from flue fuel to water will minimize the flue fuel temperature. Economizer reduces working fee by means of making improvements to further energy from the flue fuel. The fine intent of the economizer design is to attain fundamental warmness switch. The CFD modelling is an effective gadget to be taught the fluid drift, to beef up the efficiency of the economizer through changing the fabric of the economizer tubes. By changing the economizer tube material from metal to wrought iron the heat transfer price raises, due to the fact that the wrought iron material had high thermal conductivity. CFD developed as a most important tool for modelling the economizer and it could also be used to quantify the fluid go with the flow within the tubes and the temperature distribution.

II. LITERATURE REVIEW

[1] A. Ashokkumar (2012) "Improvement of Boiler Efficiency in Thermal Power Plant". On this, a soot blower is mounted in the exit pathway of the flue gas vent to put off Soot and Ash fashioned inside the path of combustion procedure within the furnace. With the resource of eliminating the soot and ash at the go out course manner, the flue fuel temperature can be stepped forward. By way of growing the flue fuel temperature, the general overall performance of the boiler may be improved.

[2] A.D.Patil, P.R.Baviskar, M.J.Sable, S.B.Barve (2016) "Optimization of Economizer Design for the Enhancement of Heat transfer Coefficient". As per their perception, most extreme number of cause of disappointment in economizer unit is due to venting gas disintegration. The past disappointment points of interest uncover that disintegration is more in U-bend ranges of Economizer Unit since of increment in pipe gas speed close these twists. The show is illuminated utilizing customary CFD strategies with STAR-CCM+ program. The pipe gas temperature, weight and speed field of liquid stream inside an economizer tube utilizing the real boundary conditions have been analysed utilizing CFD apparatus.

[3] A.N. Aziz, P. Siregar, Y.Y. Nazaruddin, Y. Bindar (2012) "Improving the Performance of Temperature Model of Economizer using Bond Graph and Genetic Algorithm". The numerical demonstrate of economizer, based on physical laws is inferred utilizing bond chart methodology Overall warm exchange coefficient of the economizer is gotten by utilizing logarithmic temperature cruel contrast between vent gas and evaporator bolster water. An alteration of in general warm exchange coefficient in

the frame of the parameterized polynomial is too done by utilizing the offer assistance of hereditary calculation strategy. A step re-enactment of the demonstrate at most extreme, nonstop, and least kettle working condition illustrates, that model's execution has been improved.

[4] P. Krunal, S. Mudafale and Hemant, Farkade (2012) "CFD Analysis of Economizer in a Tangential Fired Boiler". As per their perception greatest number of cause of disappointment in economizer unit is due to pipe gas disintegration. The CFD approach is used for the creation of a three-dimensional show of the economizer coil. The past disappointment points of interest revels that disintegration is more in U-bend zones of Economizer Unit since of increment in vent gas speed close these twists. With harmony presumption connected for the depiction of the framework. The vent gas temperature, weight and speed field of liquid stream inside an economizer tube utilizing the real boundary conditions have been analysed utilizing CFD apparatus.

[5] Tsung-Feng Wu (2009) "Failure Analysis of Economizer Tube of Waste Heat". This paper is almost disappointment investigation of the spillage of the economizer tube of the squander warm evaporator in the thermal plant. The comes about appear that in spite of the fact that the fabric and mechanical properties of the tube, were the second rate to those of the unused one, most of them was still palatable to the model prerequisite it is clear that the break started in the external surface and proliferated toward the inward surface of the tube and the split was distinguished to be rectangular in shape.

III. ECONOMIZER

An economizer is a device which is used as a heat exchanger by preheating a fluid to slash energy consumption. A feed water economizer reduces steam boiler fuel requisites with the support of transferring warmth from flue fuel to incoming feed water. More often than not boiler efficiency will also be elevated via 1% for each 4^0C discount in flue gas temperature. Through bettering waste warmth, an economizer can commonly, slash fuel requisites. The recovered warmth is flip used to preheat the boiler feed water in an effort to ultimately be transformed into heated steam. Accordingly, the economizer in the thermal power vegetation is used to economics the method of electrical energy new release.

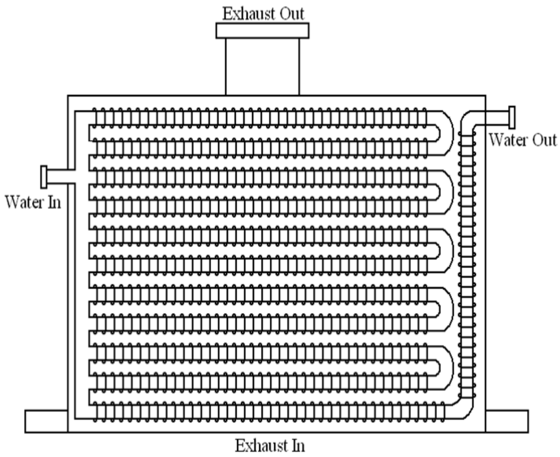

Fig.1 Economizer

IV. DESIGN OF ECONOMIZER

On this work we do evaluation on economizer to fortify the efficiency of the boiler in the thermal plant via changing the material of the tube. By altering the material of the economizer tube the warmness switch expense is excessive as compared to the older one. The fabric used in thermal power plant is steel. In steel the thermal conductivity is much less so the warmth transfer rate js also lowered. Because of increase the warmth switch cost of the economizer, the tube material is converted to wrought iron. The thermal conductivity and the melting point of the wrought iron are excessive, so the warmth transfer cost raises and it could competent to resist excessive temperature.

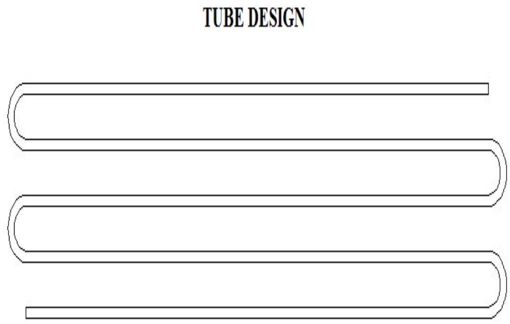

Fig.2 2D Model of Tube

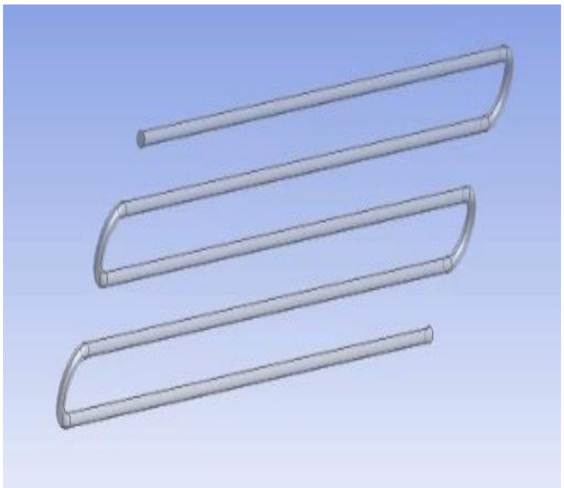

Fig.3 3D Model of Tube

Tube diameter	= 120 mm
Length of the tube	= 9000 mm
Number of tubes	= 78
Area of the tubes	= 3.482 mm^2

V. PHYSICAL PROPERTIES

Table 1.Physical Properties of Wrought Iron

S.No	Physical Properties	Metric
1	Density	7.7g/cm^3
2	Melting point	1540^{0}C
3	Thermal conductivity	59 W/mK

Table 2.Physical Properties of Carbon Steel

S.No	Physical Properties	Metric
1	Density	7.8 g/cm^3
2	Melting Point	1370^{0}C
3	Thermal Conductivity	36 W/mK

VI. METHODOLOGY

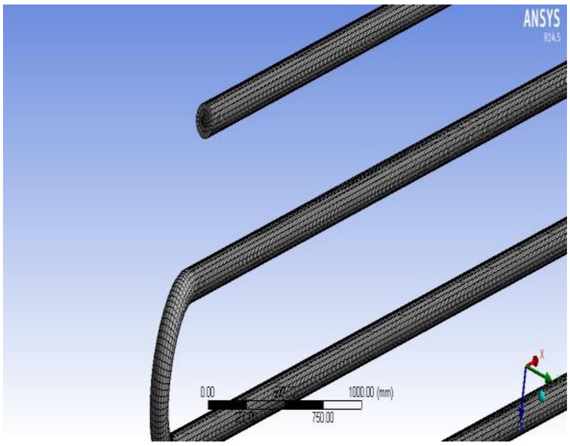

Fig.4 Meshing

Design of economizer was once made within the stable Works software with dimension mentioned as above. After designing import the design within the Ansys CFD device for measure the temperature alterations in the tube by giving the inlet temperature of the water and flue fuel of the economizer. And also the physical homes of the economizer are also defined in the CFD instrument for analyzing. After the analysis was executed and the result can be taken out. We evaluate both the outcome and made the conclusion.

VII. CFD MODELING OF ECONOMIZER

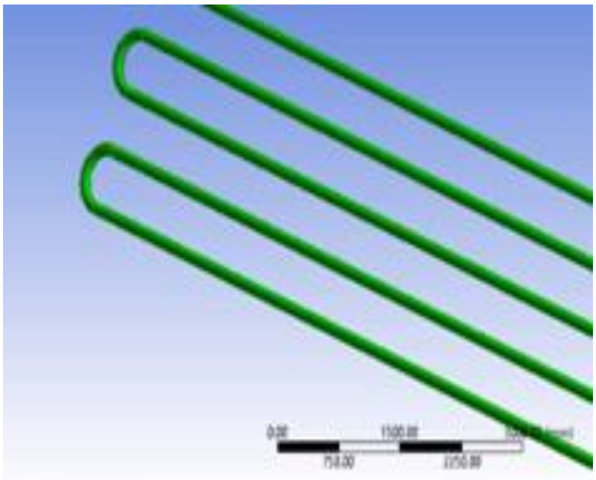

Fig.5 CFD Model

Computational Fluid Dynamics CFD is one of the best-suited software for the analysis of flow patterns which involve the dynamic parameters in the flow. It is very stable robust and accurate in providing the required outputs. Generally, experiments on moving fluid particles are not feasible. Dynamics study of moving particles involves many complex calculations and large variables. But their analysis can be easily carried with the help of CFD.

All the physical properties of the fluid and of the solid are considered as constant. The flow of the water enter should be at a uniform velocity. The given parameters are required for the CFD analysis of the economizer tubes.

Table 3.Input Parameters for CFD Modelling

S.No	Input parameters	Value	Unit
1	Inlet temperature of feed water	245	^{0}C
2	Inlet temperature of flue gas	455	^{0}C
3	Feed water outlet temperature	360	^{0}C
4	Mass flow rate of feed water inlet	600	Tons/hr
5	Mass flow rate of flue gas inlet	1.907	Kg/Sec

VIII. BOUNDARY CONDITION

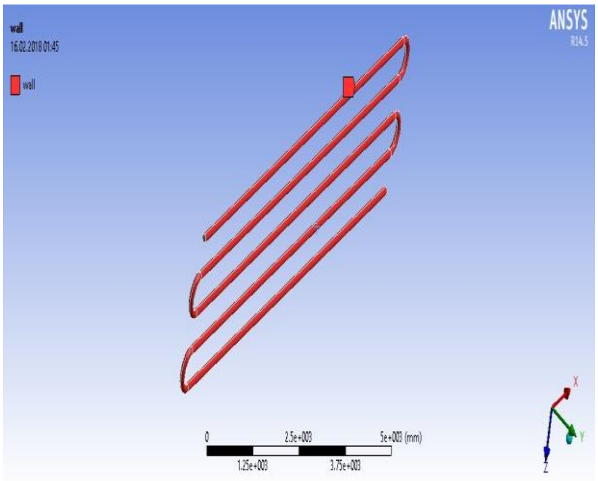

Fig.6 Boundary Condition

On discrediting the geometry, the specific boundary conditions should be assigned to the surface of the elements, which decides the behaviour of the element to the solver. The following working and boundary conditions are to evaluate the performance of the right-angled and circular tube pipes. In the fluent solver, the following boundary and solver conditions are used:

Model: Solve under energy equation with viscosity k-epsilon equation with standard wall function, with the possibility of viscous heating.

Material: Wrought iron for the pipe wall.

IX. TEMPERATURE DISTRIBUTION OF ECONOMIZER IN CARBON STEEL TUBES

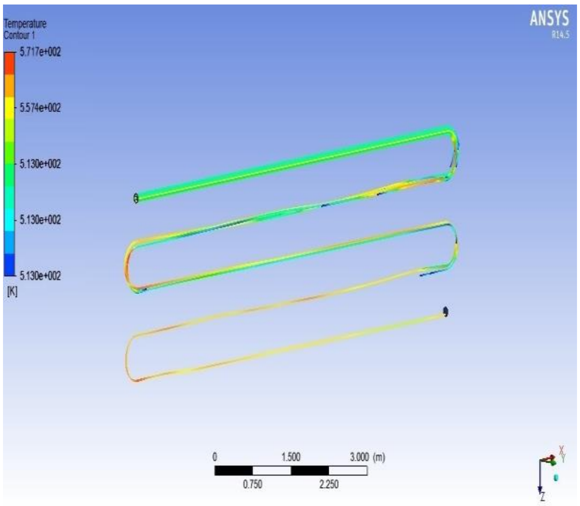

Fig.7 Temperature Distribution in carbon steel tubes

The above figure shows the temperature distribution of carbon steel tubes. But the carbon steel materials have less thermal conductivity. So to improve the thermal conductivity of the tubes the material of the tubes should be changed. Due to this the efficiency of the economizer should be improved.

X. TEMPERATURE DISTRIBUTION OF ECONOMIZER IN WROUGHT IRON TUBES

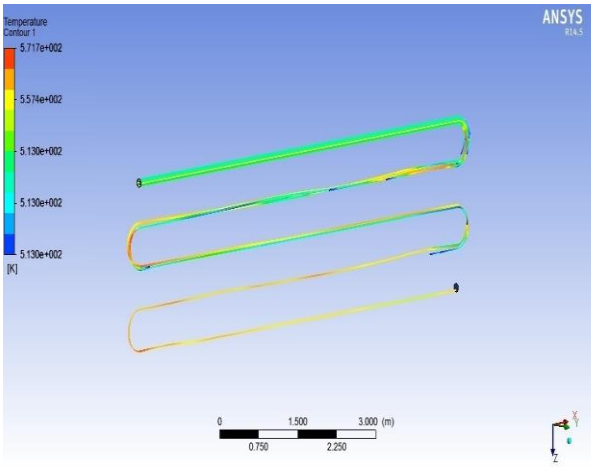

Fig.8 Temperature Distribution in wrought iron tubes

The above figure shows the temperature distribution of the feed water. The temperature plot displays that the hot flue gases losses its heats and move downwards and the heat is gained by the feed water. Inside the tube, the temperature of the feed water gets increases along its whole length by picking up the heat from the hot flue gases moving towards downward.

Due to this, the outlet temperature of the feed water in the economizer gets higher.

XI. PRESSURE DISTRIBUTION OF ECONOMIZER IN WROUGHT IRON TUBES

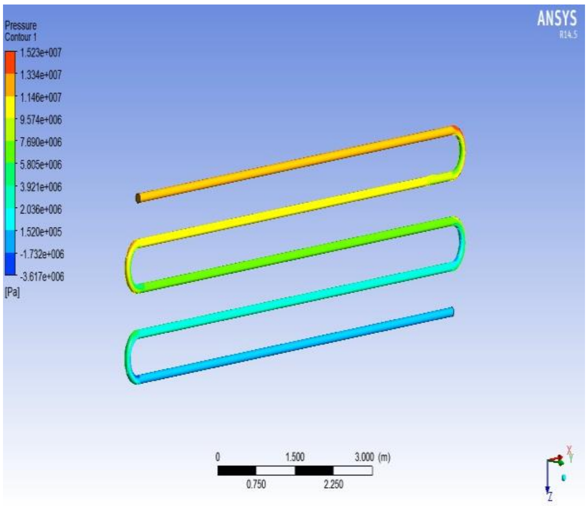

Fig.9 Pressure Distribution in wrought iron tubes

The excessive pressure zone has been observed on the higher aspect of economizer coil, which may be because of gigantic change within the momentum of feed water. The stress of feed water in the tubes is bigger at the inlet and reduces because it strikes in the direction of the outlet. The high-pressure gradient along the tube length is due to friction between feed water and the tube wall.

XII. VELOCITY DISTRIBUTION OF ECONOMIZER IN WROUGHT IRON TUBES

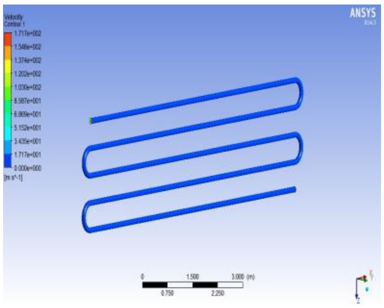

Fig.10 Velocity Distribution in wrought iron tubes

The above figure shows the velocity distribution of the feed water. The velocity plot displays that the water flows through the tubes of the economizer from an inlet to outlet is constant. Because the length and diameter of the tubes cannot be changed and no other nozzles are used in between the tubes. So the velocity flow of the feed water becomes constant. Due to this, there are no velocity changes in the water tubes.

Table 4.Result Analysis of different Tube Material

Material	Temperature			
	Feed water inlet	Feed water outlet	Flue gas inlet	Flue gas outlet
Steel	245^0C	287^0C	425^0C	320^0C
Wrought Iron	245^0C	295^0C	425^0C	280^0C

XIII. ITERATION

New release manner the act of repeating a procedure with the intention of coming near a desired goal. That's exact with the aid of the researcher on what number of zeros he needs to look after a dot (ex: 0.0000) depending upon desired accuracy.

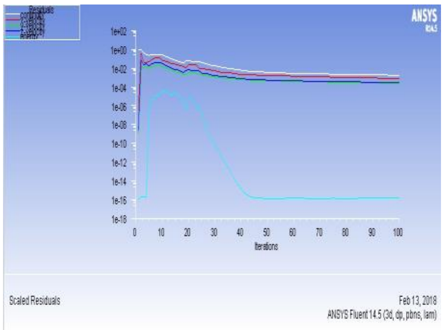

Fig.11 Iterations Criteria

CFD application are furnished a stopping criteria that's both through a default condition of stopping the calculation after a quantity of iteration or by the consumer specifying the stopping criteria at a detailed conditions.

XIV. RESULT

The problem of the economizer is identified and the answer of quandary is recommended by altering the wrought iron tubes as an alternative to using carbon steel tubes. Due to this, the temperature of the water popping out from the economizer is increased. The results of the temperature, pressure, velocity flow of the water inside the economizer are analysed. It is found from the analysis of wrought iron tube, that the outlet temperatures of feed water are higher than the present metal tubes, because the melting point of the wrought iron is high, also having high corrosion resistance than the carbon steel material. As a result of this, the heat transfer rate of the economizer tubes can also be increased and the efficiency of the boiler can also be elevated to 0.5%.

XV. CONCLUSION

The temperature of the feed water coming out from the economizer can be increases by changing the material of the economizer tube. The most effective results concluded from ANSYS thermal analysis for economizer tube performance under thermal action. From the obtained results, the efficiency of the economizer can be improved by changing the material from steel to wrought iron.

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