Performance Analysis of Economizer Using Different Material of Tubes

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Abstract - *Economizer is used in thermal power plant with boiler and used to preheat the feed water. Economizer help in increases overall efficiency of power plant. Economizer consists of number of tube attached in parallel, instead of feeding the water in boiler drum, the water first feed in the economizer which increases the temperature. In general the water available is at surrounding temperature which is at approx. 25°C-30°C this water is feed in the economizer and the flue gases coming out from chimney is at approx. 55°C-60°C these hot gases passes from the economizer help in increase the temperature of water from surrounding temperature which is at approx. 25°C-30°C to 40°C-45°C, so sensible heat required to raise temperature up to boiling point is less and there for directly increases the efficiency of plant. But the material of economizer plays an important role as heat transfer from hot gases to water take place through conduction. In conduction if conductivity of material increases the heat transfer increases and if decreases the heat transfer decreases.*

Key Words: Economizer, Clamping, Tube Material, Stress Concentration.

1. INTRODUCTION

This Economizer is used in thermal power plant with boiler and used to preheat the feed water. Economizer increases the overall efficiency of power plant.[1] Economizer consists of number of tube attached in parallel, instead of feeding the water in boiler drum, the water first feed in the economizer which increases the temperature.[2] In general the water available is at surrounding temperature which is at approx 25°C-30°C this water is feed in the economizer and the flue gases coming out from chimney is at approx. 55°C-60°C these hot gases passes from the economizer help in increase the temperature of water from surrounding temperature which is at approx. 25°C-30°C to 40°C-45°C, so sensible heat required to raise temperature up to boiling point is less and therefor directly increases the efficiency of plant. But the material of economizer plays an important role as heat transfer from hot gases to water take place through conduction. In conduction if conductivity of material increases the heat transfer increases and if decreases the heat transfer decreases.[3]

2. ECONOMIZER

A feedwater economizer reduces steam boiler fuel requirements by transferring heat from the flue gas to incoming feedwater. Boiler flue gases are often rejected to the stack at temperatures more than 100°F to 150°F higher than the temperature of the generated steam. Generally, boiler efficiency can be increased by 1% for every 4ºC reduction in flue gas temperature. By recovering waste heat, an economizer can often reduce fuel requirements by 5% to 10% and pay for itself in less than 2 years.[4]

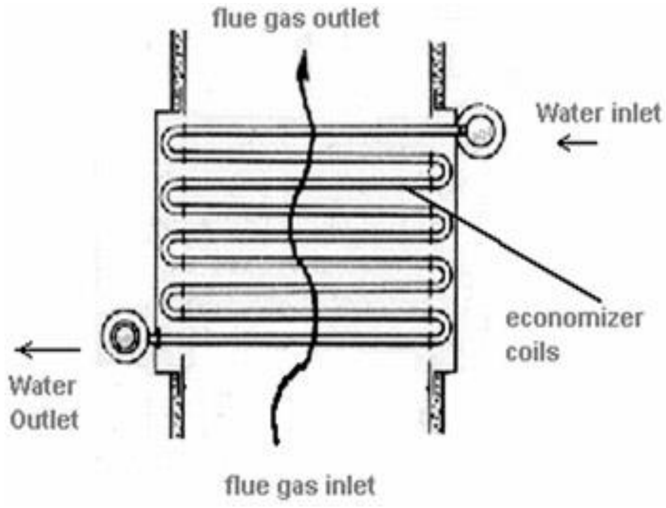

Fig. 1 : Economizer

3. DESIGN AND MODELING OF ECONOMIZER

In this work we do analysis on economizer, problem that generally occurred in the economizer is the deposition of scale in the tube which is generally referred as fouling or scale. [5] Scale decreases the heat transfer rate in the economizer which reduces the efficiency of power plant. Corrosion is also another major problem in the economizer tube as corrosion in the tube also decreases the heat transfer rate as the economizer tube is subjected to high temperature. Underoperating conditions internal thermal impact and stresses are continuously affecting the life and performance of economizer tube.[6] In this work, analysis on clamping design used in economizer i.e use of half curved 'C' clamped economizer tubes to reduce stress concentration at clamping surface of tube and done analysis.

economizer without taking the factor of scaling or fouling and do the calculation. In another case, inside layer in the economizer which act as fouling and again do the calculation and see the effect of fouling and see the reduction in efficiency of boiler. The tubes are to be changed every failure time. Same is causing high cost to organizations operating boiler and economizer operations. Modeling of economizer in Creo software and then imported to Ansys for further stress and heat transfer analysis. The dimensions of the economizer tube assembly are taken as.

Tube inner diameter	= 50.8 mm
Tube thickness	= 3.667 mm
Inlet/Outlet cylinder id	= 219.10 mm
Number of tubes	= 22
Economizer overall size	= 2873 x 4622 x 1906

4. METHODOLOGY

Design of economizer was made in Creo Parametric software with dimension stated as above. After designing, import the design in the Ansys software and define the various mechanical property like elastic modulus, density, poisson ratio after describing all mashing of design and after meshing, define the thermal boundary condition. After defining boundary conditions, analysis was done and obtained the result. After obtaining the result we change the geometry of economizer and put another inside layer of another material inside the economizer tube which behave like scale or corrosion in the tube and applying the same boundary condition and again obtain the result. After obtaining the result we compare both the result and made conclusion.

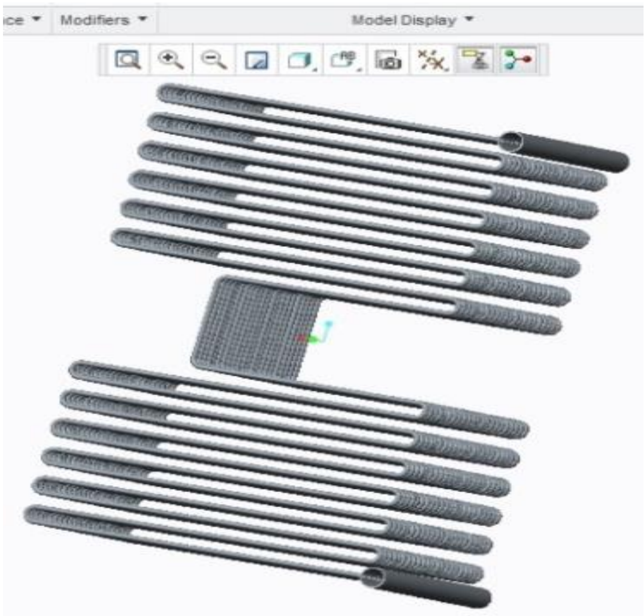

Fig. 2 : *Economizer model*

5. RESULT

The problem of the economizer is suggested and tested by suggesting 'C' clamp economizer instead of full clamp economizer. The analysis after modeling is performed for both existing full clamp economizer and proposed 'C' clamp economizer. The results for von-mises stress, elastic strain, total deflection and strain energy are summarized in following table.

Table 1 : Result of analysis of different material tubes

Particular	Clamp Type	Von-Mises Stress (N/mm²)	Elastic Strain	Total Defor-mation (mm)	Strain Energy (mJ)
Steel	Full Clamp	3321.4	0.019731	8.9622	151980
	'C' Clamp	2801.7	0.018783	7.8592	77027
Titanium Alloy	Full Clamp	3321.4	0.019731	8.9622	151980
	'C' Clamp	2801.7	0.018783	7.8592	77027

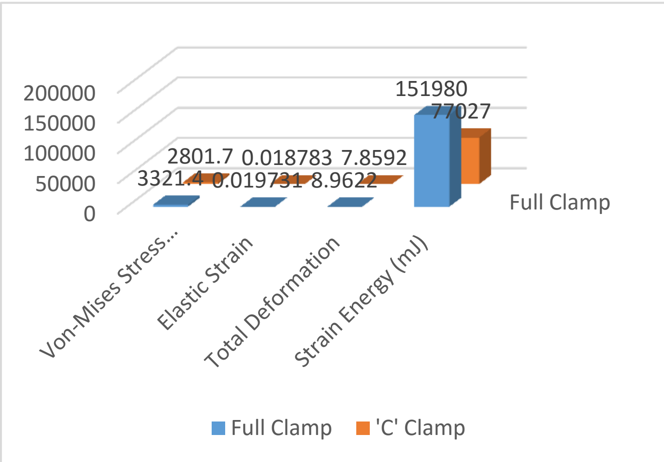

Fig. 3 : *Compression of result in full clamp & C clamp of steel*

It is observed from analysis performed for Steel tube, that the values for all the examined parameters for full clamp economizer are much greater than 'C' clamp economizer and hence the 'C' clamp proposed economizer will perform longer with respect to time and will have greater service life in comparison to existing full clamp economizer.
It is observed from analysis performed for Titanium Alloy tube, that the values for all the examined parameters for full clamp economizer are much greater than 'C' clamp

economizer and hence the 'C' clamp proposed economizer will perform longer with respect to time and will have greater service life in comparison to exixting full clamp economizer.

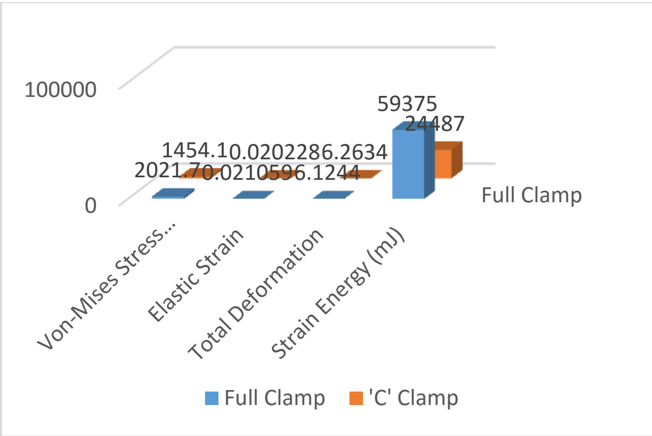

Fig. 4: Compression of result in full clamp & C clamp for titanium tube

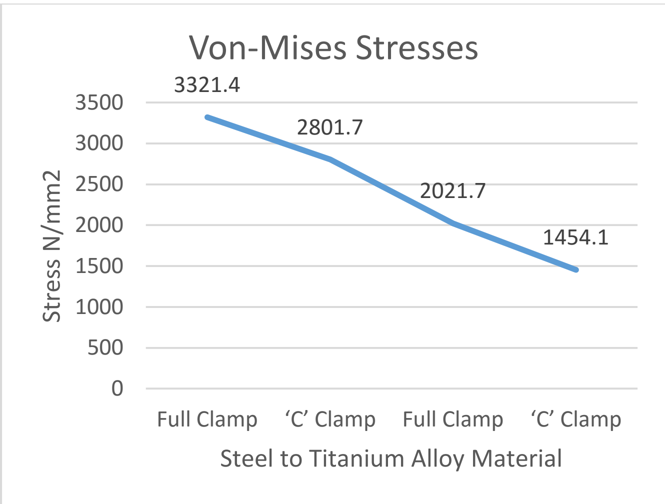

Fig. 5: Von-Mises Stress Result Comparison for Steel and Titanium both Full and 'C' Clamp Tubes

Stresses developed plays major role to tube thermal failure, as the graph shows that the value to resultant stresses decreases from, material steel to titanium alloy, and clamp type from full clamp to 'C' clamp type.

6. CONCLUSION

Two final options are available for change to improvement, the material only can be changed from steel to titanium, it will improve the tube performance. And the titanium alloy material with clamp type 'C' can be adopted to implement most effective results concluded from ANSYS thermal analysis for Economizer tube performance under thermal action.

REFERENCES

[1] J. Ganan, A. Al-Kassir, J.F. Gonzalez, J. Turegano, A.B. Miranda, Experimental study of fire tube boilers performance for public heating, Appl. Therm. Eng. 25 (2005) 1650–1656.
[2] M.D. Paepe, C.T. Joen, H. Huisseune, M.V. Belleghem, V.Kessen, Comparison of different testing methods for gas fired domestic boiler efficiency determination, Appl. Therm. Eng. 50(2013) 275–281.
[3] T. Lv, Z. Guo, Y. Gao, Power plant boiler waste heat recycling design research, in: Asia-Pacific Power and Energy EngineeringConference, Shanghai, 2012.
[4] H. Ghritlahre, T.J. Singh, Effect of excess air on 30 TPH AFBC boiler on dry flue gas losses and its efficiency, Int. J. Res. Advent Technol. 2 (2014) 19–23.
[5] V. Mallikarjuna, N. Jashuva, B.R.B. Reddy, Improving boiler efficiency by using air preheater, Int. J. Adv. Res. Eng. Appl.Sci. 3 (2014) 11–24.
[6] Ozaki N, Harayama K, Shinohara W, Hayashi S. Recovery Boiler Intelligent Control. Annual Review in Automatic Programming 1991; 16:139-143.