Thermal Response Analysis for Economizer Tube Varying Tube Material and Clamping Arrangement Using FEA Software

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Abstract— An economizer is a used with boiler to retain the heat generated from boiler combustion and hence to improve the efficiency of the boiler. The flue gases which exits from boiler chamber are found very hot and are used to preheat boiler feed water. The economizer in present research paper is modelled in Creo-Parametric software and is imported to ANSYS software for the purpose of thermal analysis. Stress concentration in economizer tube is reported several times from the user industries. The problem is tried to solve by suggesting the clamping type improvement i.e use of half curved 'C' clamped economizer tubes to reduce stress concentration at clamping surface of tube. Also alternate material of economizer tube is tested i.e. tungsten alloy instead of steel tubes. The result of present paper compared von-mises stresses, total deformation of economizer tube, strain energy and elastic strain for all cases under consideration i.e. full clamp tube and 'C' clamp tube both with material steel and tungsten alloy respectively.

Key words: Economizer, FEA

I. LITERATURE REVIEW

Then density gradient and Mach contours of the simulation results are qualitatively compared to schlieren visualizations of Pophali Finally, PIP ("Peak Impact Pressure") distributions of the following flow scenarios are examined.

Vikil D. Malwe, Major components of power plants are subjected to high temperature heat transfer, Economizer is one of the important efficiency improvement component for boiler, and Thermal analysis is performed to identify possible failures in case of water tube boilers.

H. E. Emara-Shabaik, M.A.Habib, Al-Zharana, Computed riser tube heat transfer coefficient, the parameters are analysed for different loads. The prediction of generation of boiler and economizer tube temperature is analysed to improve performance and safety. Methodology is useful to avoid the tube failures as well as the overheating of the riser tubes which will be very helpful for operation engineers.

II. PROBLEM FORMULATION

The major problem reported is that the economizer tube is repetitively failing due to erosion effect. As the economizer tube is subjected to high temperature under operating condition, internal thermal impact and stresses are continuously affecting the life and performance of economizer tube. The tubes are to be changed every failure time. Same is causing high cost to organisations operating Boiler and economizer operations.

The dimensions of the economizer tube assembly are taken as:

Tube id = 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

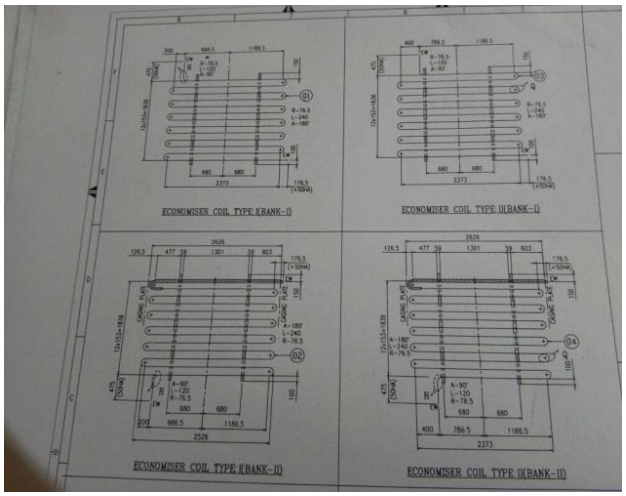

Fig. 1: Economizer drawing 1 taken for research problem

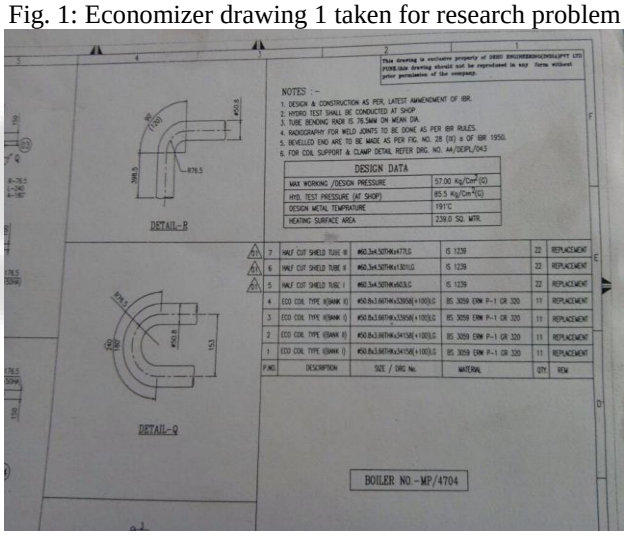

Fig. 2: Economizer drawing 2 taken for research problem

Fig. 3: Original Economizer tube front view

III. METHODOLOGY

- Economizer Problem Definition
- Modeling of Economizer using Creo Parametric Software

A. Model Import in ANSYS

1) Execution Parameters
- Analysis Type Selection
- Element Type

2) Material Properties
- Elastic Modulus (E)
- Poisson's ratio (υ)
- Density (ρ)

3) Model Geometry
- Meshing

4) Boundary Condition
- Applying Boundary Conditions

5) Thermal Analysis

B. Solution
- Job Submit and Run

C. Post-Processing
- Obtain Results
- Compare Results

IV. MODELLING AND ANSYS ANALYSIS OF ECONOMIZER TUBE

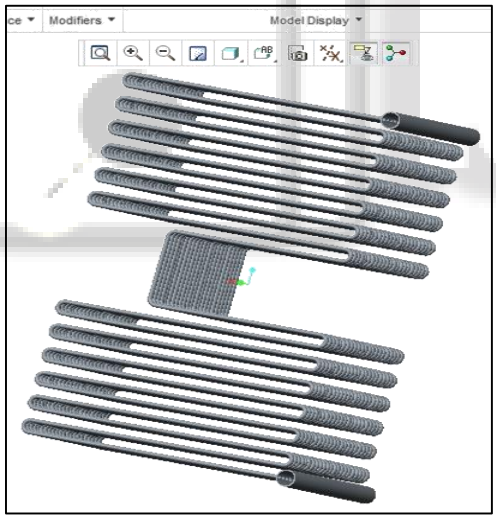

Fig. 4: Creo Model for economizer

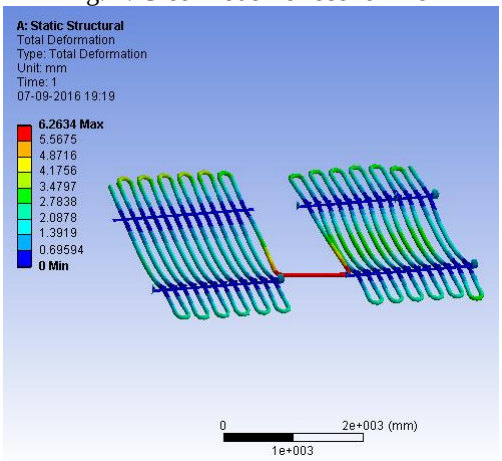

Fig. 5: Total Deflection for Titanium Tube

V. RESULT AND CONCLUSION

The problem of the economizer is suggested and tested by suggesting 'C' clamp economizer instead of full clamp economizer. The analysis after modelling 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:

	Clamp Type	Von-Mises Stress (N/mm^2)	Elastic Strain	Total Deformation (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

Table 1: Overall Result Summary Table

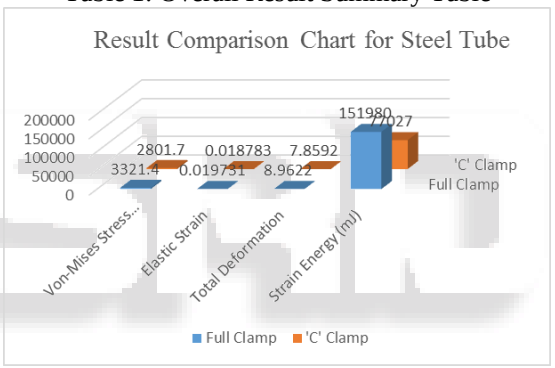

Fig. 6: 6Steel Tube Economizer Result Comparision for Both Full and 'C Clamp Tubes

Result Comparison Graph for Steel Tube Results Values. 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 exixting full clamp economizer

Steel Tube Economizer Result Comparision for Both Full and 'C Clamp Tubes

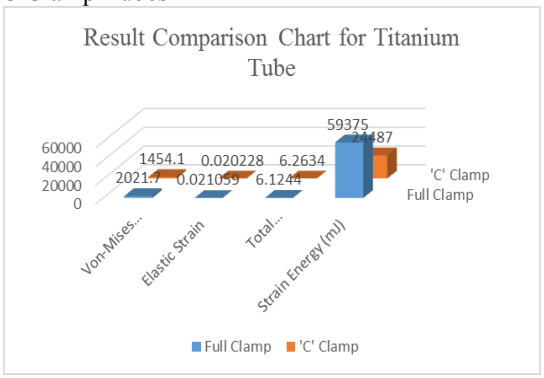

Fig. 7: Result Comparison Graph for Titanium Tube Results Values

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.

Overall Result Comparison for Steel and Titanium both Full and 'C' Clamp Tubes

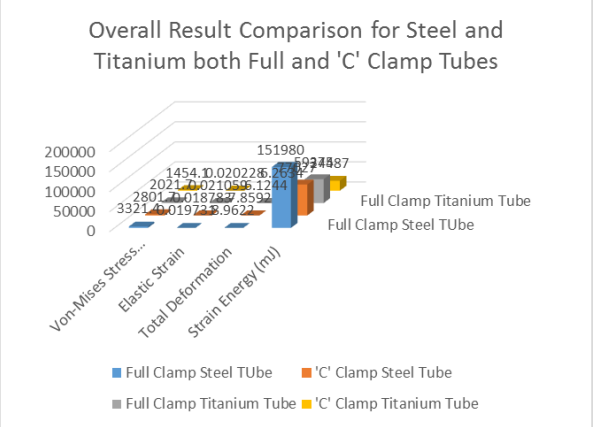

Fig. 8: Result Comparison Graph for Steel and Titanium Full Clamp and 'C' Clamp Tube Results Values

As the material shifted from steel to titanium alloy and the clamp shifted from full clamp to 'C' clamp type the values for Stresses, total deformation, elastic strain and strain energy decreases.

So it is banificaial to shift material from steel to titanium alloy, and clamp type from full clamp to 'C' clamp type.

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

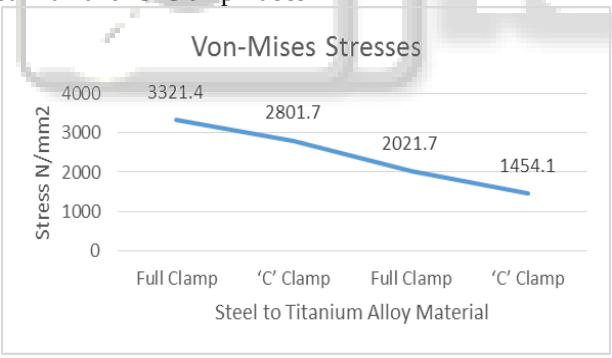

Fig. 9: Stress Comparison For all Cases

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.

VI. 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 addopted to impliment most effective results concluded from ANSYS thermal analysis for Economizer tube performance under thermal action.

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