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Design and Fracture Analysis of Husk Feed Boiler

M. Pradeep Kumar , R. Pavan Satya Sai , Mr. G. Pardhiv

[1](B.Tech Student, Department of Mechanical Engineering, Srinivasa Institute of Engineering & Technology, Cheyyeru, Amalapuram, A.P, India)

[2](B.Tech Student, Department of Mechanical Engineering, Srinivasa Institute of Engineering & Technology, Cheyyeru, Amalapuram, A.P, India)

[3](M.Tech scholar, Department of Mechanical Engineering, Srinivasa Institute of Engineering & Technology, Cheyyeru, Amalapuram, A.P, India)

ABSTRACT

Boilers are closed vessel used for heating and steam generation, these are operated at high temperatures and pressures, safety is a major issue in boilers, these are subjected to corrosions and ware, boilers are porn to cracks and occurrences of a crack or existence of crack may lead to complete failure of malfunctioning of boiler

In present wok a boiler is modelled using existing blue prints in catia and is tested using ansys work bench. Different cases with varying location of crack are studied and compared for better understanding of effect caused by cracks, boiler mountings, internal and external tubing is neglected in this model for easy of work

INTRODUCTION

The function of the boiler is to convert water into superheated steam, which is then delivered to turbine to generate electricity (Bamrotwar & Deshpande 2014). Pulverized coal is the common fuel used in boiler along with preheated air. The boiler consists of different critical components like economizer, water wall, super heater and reheated tubes. Thermal power plant boiler is one of the critical equipment for the power generation industries. In the present situation of power generation, pulverized coal fired power stations are the backbones of industrial development in the country, thus necessitating their maximum availability in terms of plant load factor (PLF). At the same time reliability and safety aspect is also to be considered. The major percentage of the forced shutdown of the power stations is from boiler side. So it is necessary to predict the probable root cause/ causes of the forced outages and also the remedial action to prevent the recurrence of similar failure in future. A drum type utility Boiler for thermal power generation typically consists of different pressure parts tubes like water wall, economizer, super heater and reheated (Bhowmick 2011). Different damage mechanism like creep, fatigue, erosion and corrosion are responsible of the different pressure parts tube failure. Successful, reliable operation of steam generation equipment requires the application of the best available methods to prevent scale and corrosion. When equipment failures do occur, it is important that the cause of the problem be correctly identified so that proper corrective steps can be taken to prevent a recurrence. An incorrect diagnosis of a failure can lead to improper corrective measures; thus, problems continue.

FAILURES DUE TO OVERHEATING

Figure 3 overheating

Figure 4 Thick lip

Failure of boiler tubes is common in industries where fossil fuel is used. There are several factors that cause this type of failure. The use of high sodium, sulphur and ash containing fuel, high working temperature and pressure exceeding the design limit and lack of periodic maintenance are the major factors that affect the performance of materials employed for boilers. The hostile environment is the source of corrosion and stress which leads to the failure of boiler tube. The failure of boiler tubes appears in the form of bending, bulging, cracking, wearing or rupture and these hampers the performance of boilers or makes it obsolete in applications.

LITERATURE REVIEW

The steam boiler is an energy conversion equipment or device which transforms chemical energy of fuel such as coal, oil, gas or nuclear energy into steam which in turn is used for mechanical energy. Boilers are also commonly used in industry to generate a utility steam used for various purposes like heating or drying chemical compounds in a reactor. The primary function of boiler is to maintain the steam energy in balance with the load demand while maintaining the internal variables such as pressure, level in a desired range [1].

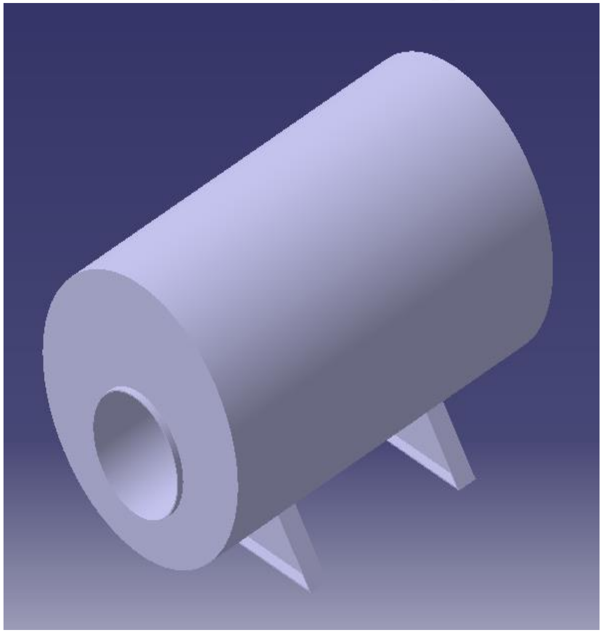
Steam pressure is one of the most important parameters for power plants efficiency. High steam pressure and temperature are the necessary conditions for achieving high (designed) efficiency of the power plant. However, both parameters are limited with the constraints of the drum and evaporator materials. Especially, boiler drum is protected with safety valves, taking out excess of the steam on high pressure. Activating this kind of protection makes large disturbance to the drum level control and leading to the plant fallout and loss of several thousand. At the other side, stable and smooth steam pressure is a necessary condition for high quality steam temperature and turbine control. Accordingly, steam pressure control is to provide low pressure variations enabling in that way pressure to be close to the safety limit, and not to exceed it [2].

A number of mathematical models have been developed to describe the dynamics of steam boiler pressure. The goal of this paper is to design a prototype of boiler kit using PLC based PID controller which uses IMC technique for tuning the parameters of the PID. Besides this, work includes the modeling of the process and simulation has been done with the appropriate transfer function using feed forward feedback control strategy. Further practical responses and theoretical response has been compared. Also open loop validation has been done to validate the prototype model.

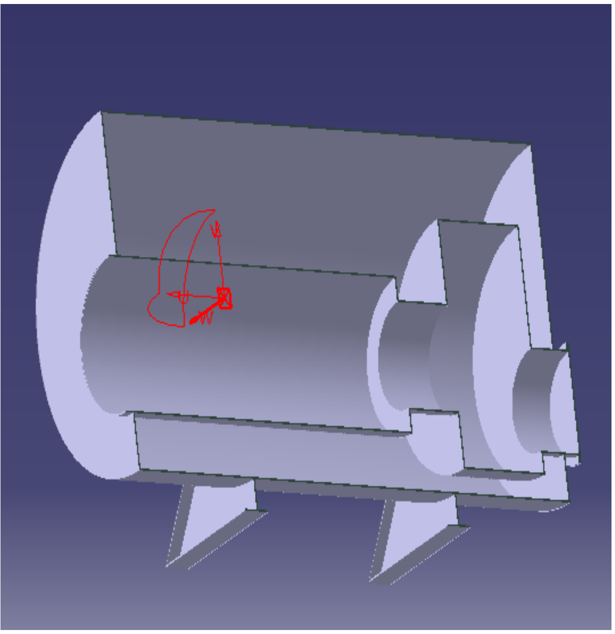
MODELING

There are various types of drawings required in the different fields of engineering and science. In earlier days, various drawing instruments like drafting machine, T-square, scale etc., are used to prepare drawings easily and accurately. But to obtain better ease in modifying the design and making calculations, the process of preparing a drawing is made in the computer using certain software's. This use of computer systems is termed as computer aided design. It replaces manual drawing with an automated process.

CATIA which stands for Computer Aided Three Dimensional Interactive Application is CAD software owned and developed by Dassault Systems and marketed worldwide by IBM. It is the world's leading CAD/CAM software for design and manufacturing. CATIA supports multiple stages of product development through conceptualization, design, engineering and manufacturing. CATIA has a unique ability of modelling a product in the context of its real life behaviour. This design software became successful because of its technology which facilitates its customers to innovate a new robust, parametric, feature based model consistently. CATIA provides easy to use solution tailored to the needs of small medium sized enterprises as well as large industrial corporations in all industries, consumer goods, fabrications and assembly, electrical and electronics goods, automotive, aerospace, shipbuilding and plant design. It is user friendly. Solid and surface modelling can be done easily.



View of boiler design



Cut section view of boiler

ANSYS

4.2 -1000 mm from central plane

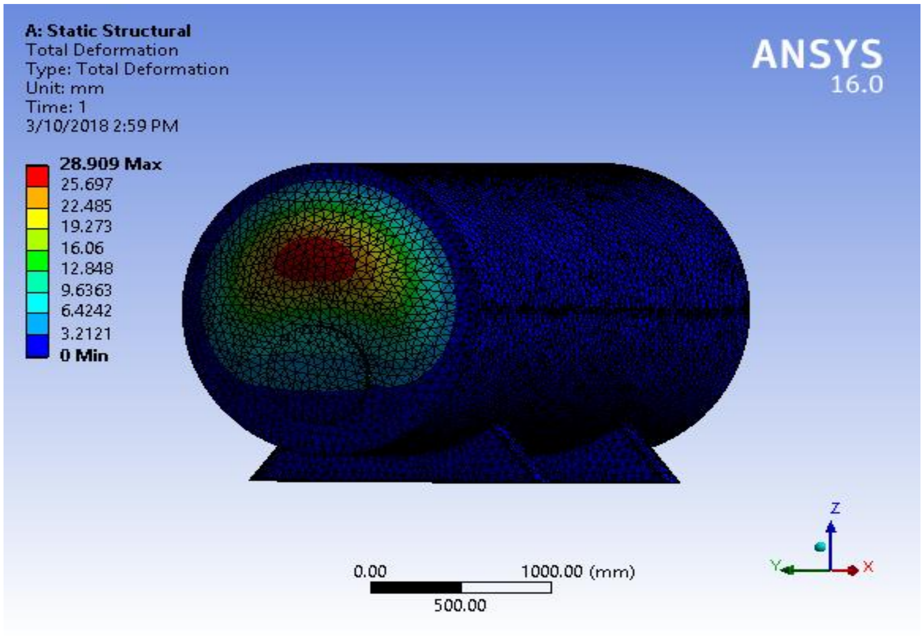


Fig: 4.2.1 picture showing total deformation at -1000mm from central plane

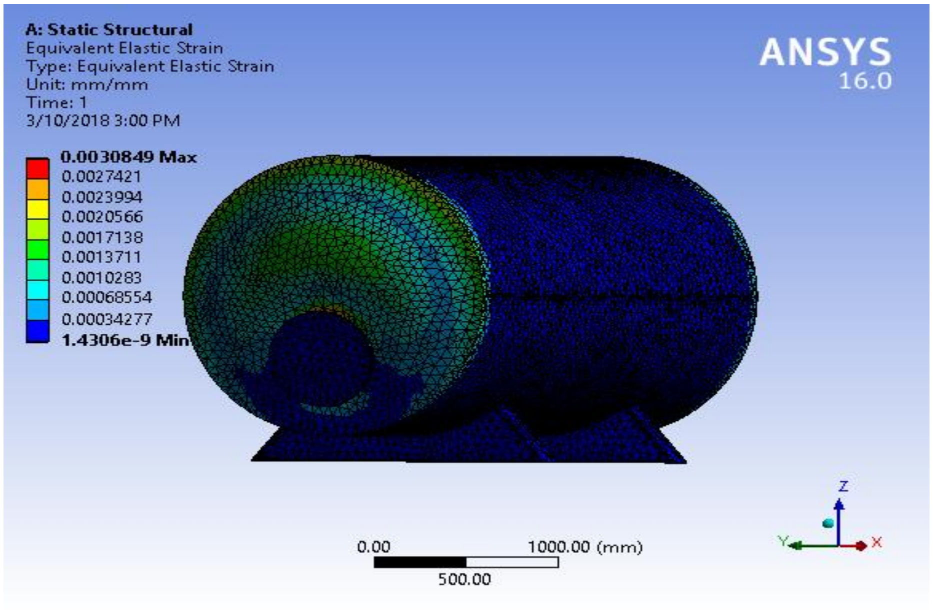


Fig: 4.2.2 picture showing equivalent strain at -1000mm from central plane

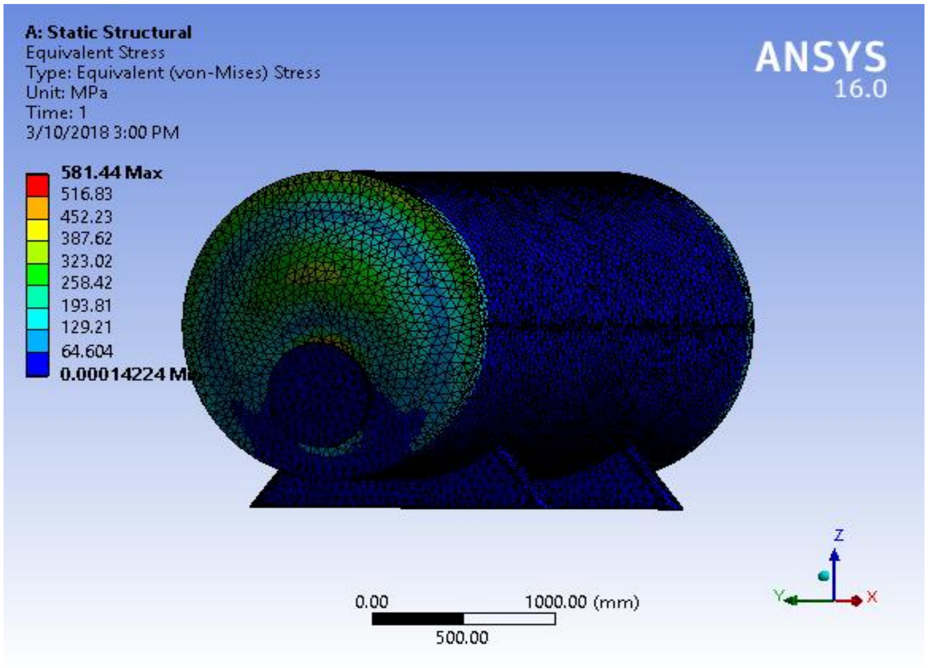


Fig: 4.2.3 picture showing equivalent stress at -1000mm from central plane

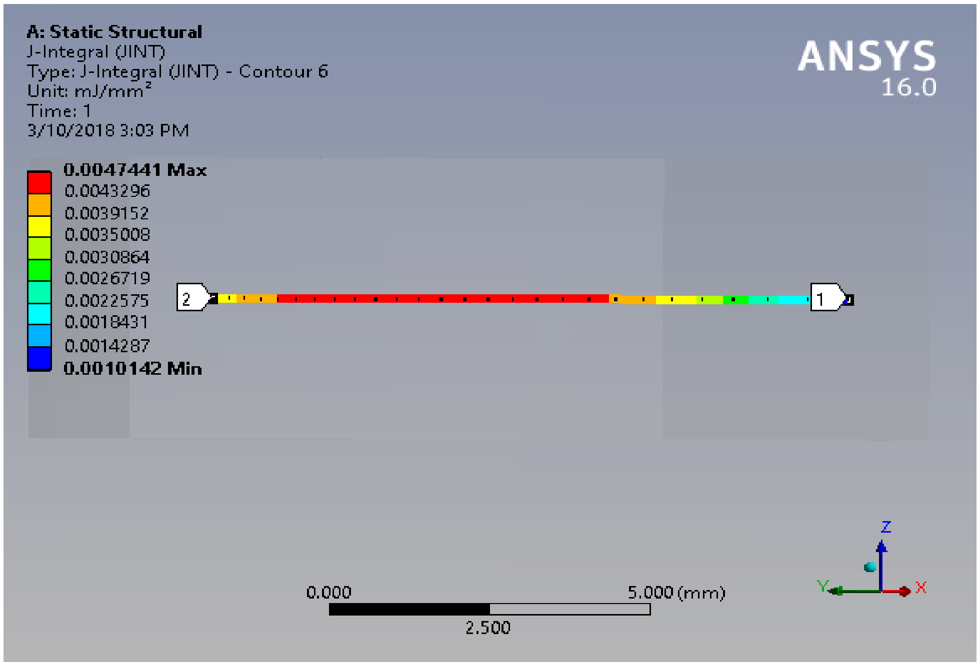


Fig: 4.2.4 picture showing j-integral at -1000mm from central plane

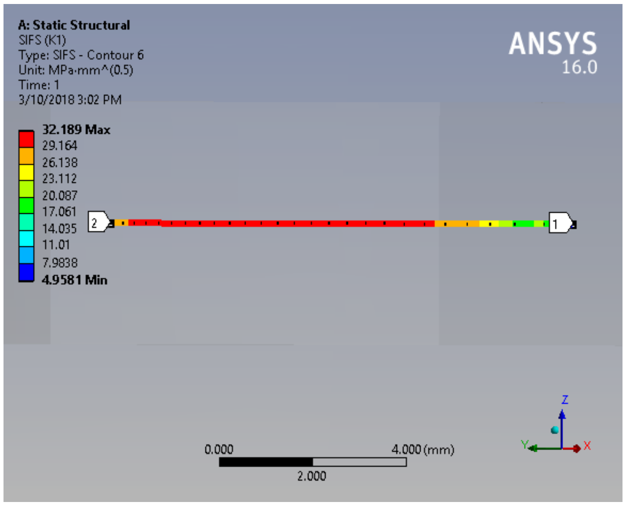


Fig: 4.2.5 picture showing stress intensity factor mode 1 at -1000mm from central plane

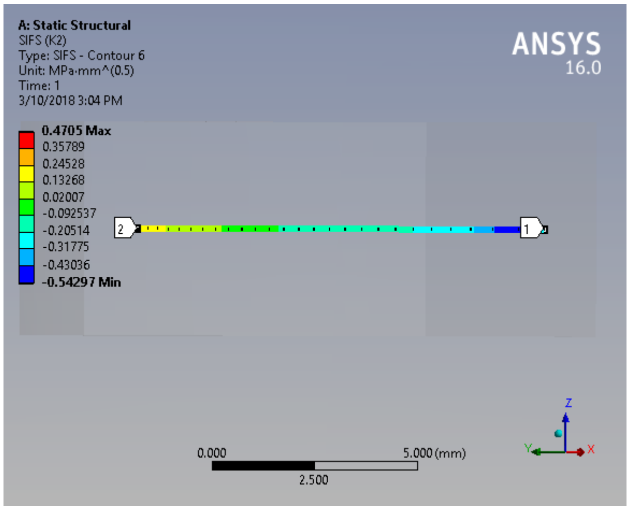


Fig: 4.2.6 picture showing stress intensity factor mode 2 at -1000mm from central plane

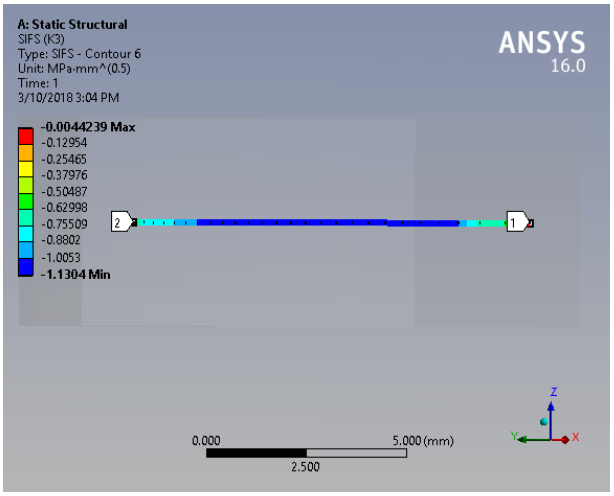


Fig: 4.2.7 picture showing stress intensity factor mode 3 at -1000mm from central plane

REPORT

1 Table showing boiler crack values at various positions from central plane

	total deformation (mm)		equivalent elastic strain(mm/mm)		equivalent stress (Mpa)		J-Integral (mj/mm2)	
.	min	max	min	max	min	max	min	max
-1000 mm from central plane	0	28.9	1.43E-09	0.003085	0.000142	581.4	0.001014	0.004744
-500 mm from central plane	0	28.9	1.43E-09	0.003085	0.000142	581.44	0.001121	0.005371
on central plane	0	28.9	1.43E-09	0.003085	0.000142	581.44	0.001125	0.005334
500 mm from central plane	0	28.9	1.41E-09	0.003085	0.000142	581.44	0.001103	0.005214
1000 mm from central plane	0	28.9	1.43E-09	0.003085	0.001422	581.44	0.00103	0.004983

GRAPH

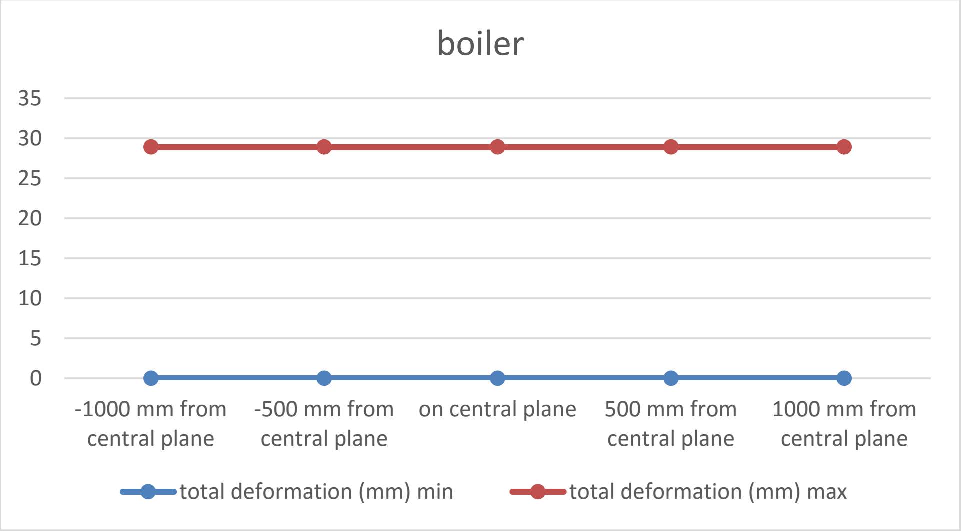


Fig: 5.1 Graph representing total deformation at various positions from central plane

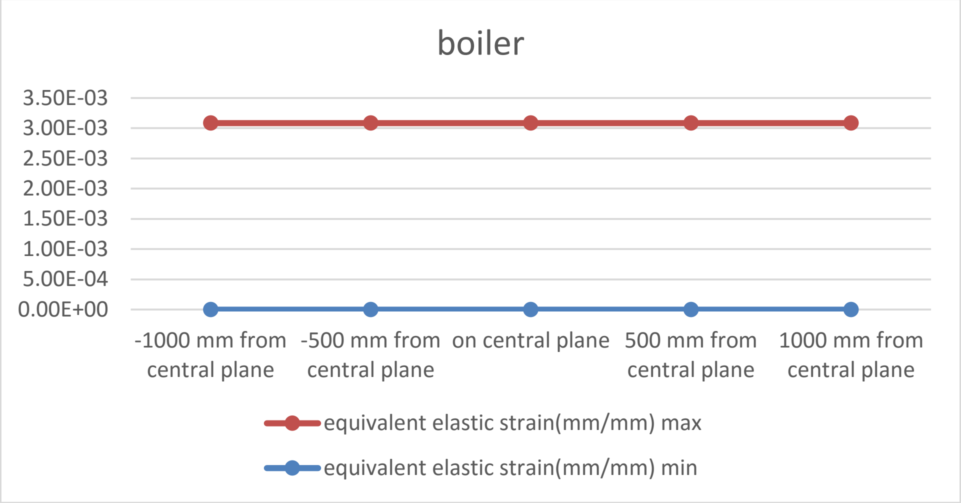


Fig: 5.2 Graph representing equivalent strain at various positions from central plane

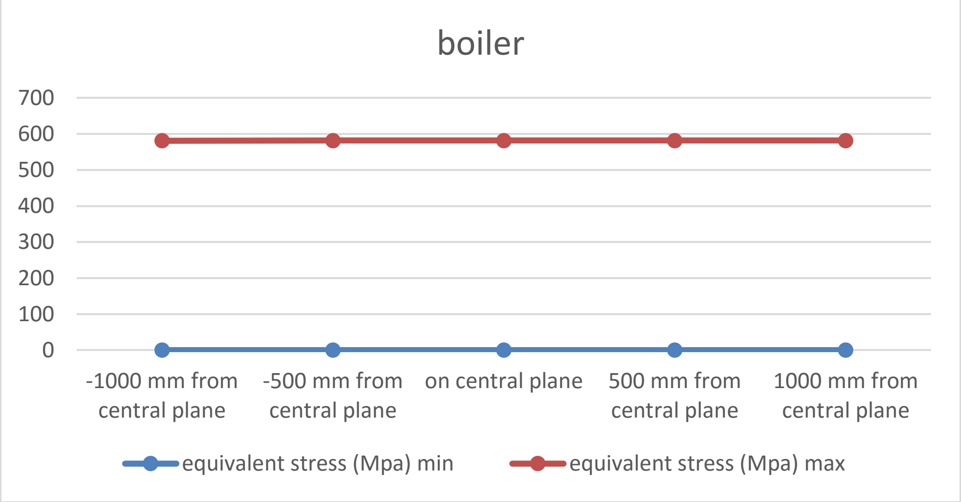


Fig: 5.3 Graph representing equivalent stress at various positions from central plane

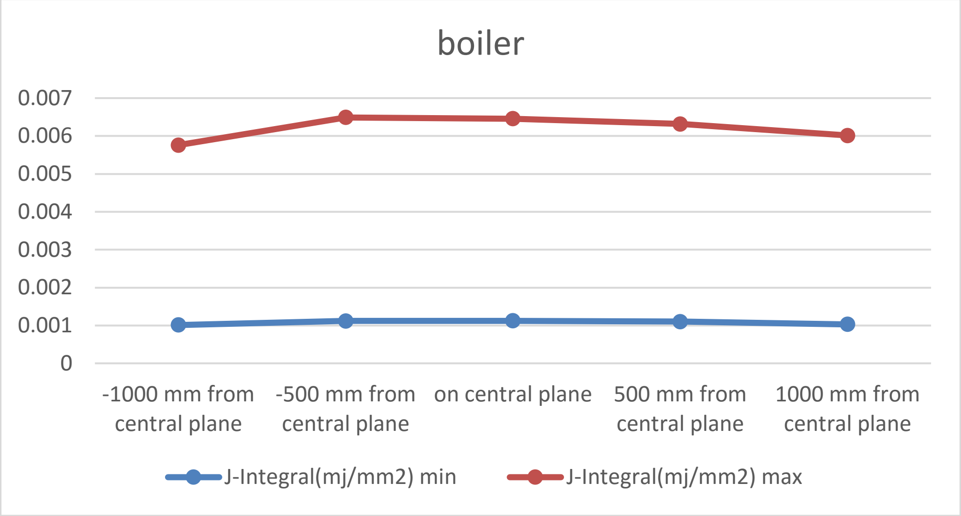


Fig: 5.4 Graph representing energy release rate at various positions from central plane

2 Table showing boiler crack values of stress intensity factor at various positions from central plane

	Stress intensity factor		
boiler	mode 1	mode 2	mode 3
-1000 mm from central plane	32.189	0.4705	-0.00442
-500 mm from central plane	34.255	0.49445	-0.00474
on central plane	34.135	0.5837	-0.00768
500 mm from central plane	33.751	0.53567	-0.00745
1000 mm from central plane	32.992	0.51389	-0.00437

CONCLUSIONS

In this thesis variations in stress intensity factor is observed when the position of crack is changed gradually on the lateral wall of the boiled , for cylindrical vessels with orthogonally symmetric geometry the stress intensity factor in opening mode gradually increases as the crack location reaches it centre plane and decreases when it is located away from the centre plane. But in this case the geometry is nor a orthogonally symmetric due to internal chambers etc.

The following observation are made from the study

1. Peak stress intensity factor shifts away from the central plane depending on the inclusions in the geometry.
2. Stress intensity factor in second two modes (tearing and shearing) doesn’t follow any pattern as possibility for their occurrence is very little.
3. Overall deformations , stress, and strains does not change with location of the crack

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