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OUTLINE AND INVESTIGATION FROM CLAIMING CRYOTREATMENT CHAMBER UTILIZING MSC NASTRAN PATRAN

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ABSTRACT

Cryogenic treatment is the process of deep freezing materials at cryogenic temperatures (below -150°C). It has been proven to increase the strength and durability of the material being treated, relieve stress, create a more uniform material, and micro-smooth surface.This dissertation work covers the Design and Analysis of Cryotreatment Chamber which is used for cryo treatment process.

The prime objective of the project is to design and analyse the cryo treatment chamberThe system can be operated for various operating conditions of time and temperature and their effect on the changes in properties can be studied and optimized. The study of system will be done to design the unit in the simplest form. 3D modelling of the component will be developed according to the specifications and functional requirements. The design of cryotreatment system is carried out using AUTOCAD software. Finally structural analysis for cryotreatment chamber is done using NASTRAN & PATRAN software and the results are compared.

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1 INTRODUCTIONS TO CRYOGENICS

1.1 DEFINITION OF CRYOGENICS

Cryogenics is a branch of physics (or engineering) that studies the production of very low temperatures (below –150°C, –238°F or 123K) and thebehavior of materials at those temperatures.

1.2 CRYOGENIC TREATMENT

Cryogenic treatment is the process of deep freezing materials at cryogenic temperatures (below -150°C). It has been proven to increase the strength and durability of the material being treated, relieve stress, create a more uniform material, and micro-smooth surface.

1.3APPLICATION OF CRYOGENICS

The process has a wide range of applications from industrial tooling to improvement of musical signal transmission. Some of the benefits of cryogenic treatment include longer part life, less failure due to cracking, improved thermal properties.

2 INTRODUCTION TO CRYOTREATMENT CHAMBER

2.1 CRYOTREATMENT CHAMBER

The cryotreatmentunit incorporates a novel concept of cooling the samples indirectly by producing forced convection heat transfer closed loops of cold nitrogen gas. This indirect cooling technique eliminates the direct contact of liquid nitrogen droplets with the samples so that the cold spots on the test samples are avoided. The portable unit has the capability to hold large number of samples at one time. It is possible to cryotreat the samples for various operating conditions of temperature and time.The system can be operated for various operating conditions of time and temperature and their effect on the changes in properties can be studied and optimized.

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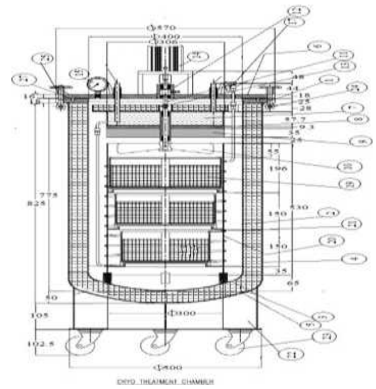

Fig 1: Front View of Cryotreatment Chamber

2.3 METHODOLOGY

The Methodology involves

- Component study
- Data collection for design inputs
- Design concepts
- Design calculation
- Detail drawing
- CAD model preparation for component
- Analysis of the component.

3 ANALYSIS OF CRYOTREATMENT CHAMBER& RESULTS

3.1 INTRODUCTION

The prime objective of FEA was to predict the stress analysis of cryotreatment chamber on the basis of the boundary conditions imposed

Model Description

A two dimensional drawing of the cryotreatment chamber is shown in the figure below. The structure is cylindrical in shape. There are two layers of cylindrical skin. Only cryotreatment structural members are shown in the figure. The functional components of the chamber are not load bearing structural members, therefore they are not considered for the analysis.

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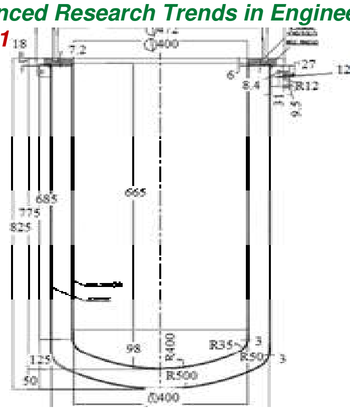

Fig.2: 2D Model of Cryotreatment Chamber

3.2 FINITE ELEMENT MODEL OF CRYOTREATMENT CHAMBER

It is well known that stress analysis with application of FEM provides the most approximate results. For the stressanalysis MSC/NASTRAN software was used.

In this project, two-dimensional finite element modeling techniques have been adopted for structural analysis of the cryotreatment chamber. The FE analysis is conducted using the commercial package MSC/PATRAN for post processing and MSC/NASTRAN as solver. [4] discussed about Intelligent Sensor Network for Vehicle Maintenance System. Modern automobiles are no longer mere mechanical devices; they are pervasively monitored through various sensor networks & using integrated circuits and microprocessor based design and control techniques while this transformation has driven major advancements in efficiency and safety. In the existing system the stress was given on the safety of the vehicle, modification in the physical structure of the vehicle but the proposed system introduces essential concept in the field of automobile industry. It is an interfacing of the advanced technologies like Embedded Systems and the Automobile world. This “Intelligent Sensor Network for Vehicle Maintenance System” is best suitable for vehicle security as well as for vehicle’s maintenance. Further it also supports advanced feature of GSM module interfacing. Through this concept in case of any emergency or accident the system will automatically sense and records the different parameters like LPG gas level, Engine Temperature, present speed and etc. so that at the time of investigation this parameters may play important role to find out the possible reasons of the accident. Further, in case of accident & in case of stealing of vehicle GSM module will send SMS to the Police, insurance company as well as to the family members.

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Given input to geometry creation

- Geometric dimensions Diameter of outer chamber=500mm
- Length of outer chamber=757mmDiameter of inner chamber=400mm
- Length of inner chamber=685mm

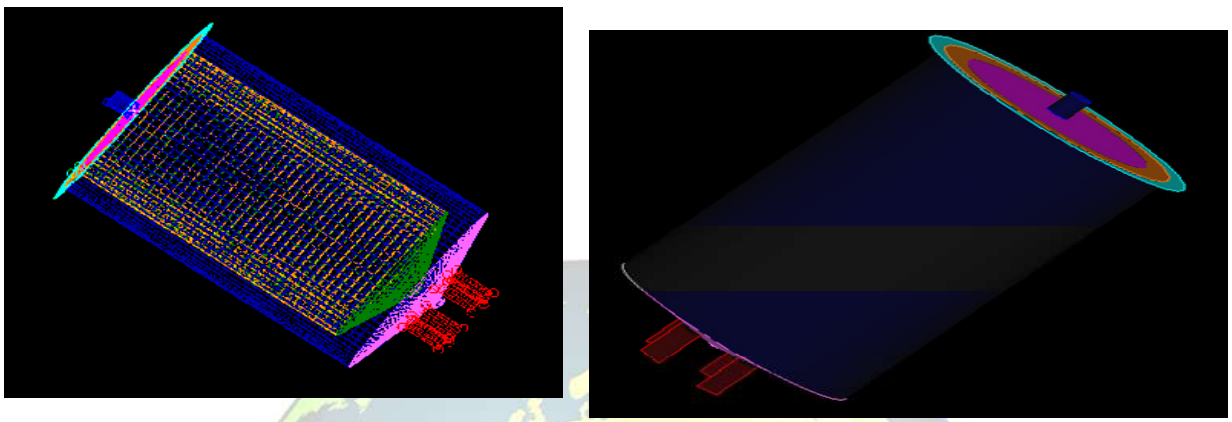

Fig 3: shows the geometric model of cryotreatment chamber showing wireframe and smooth shaded view of model

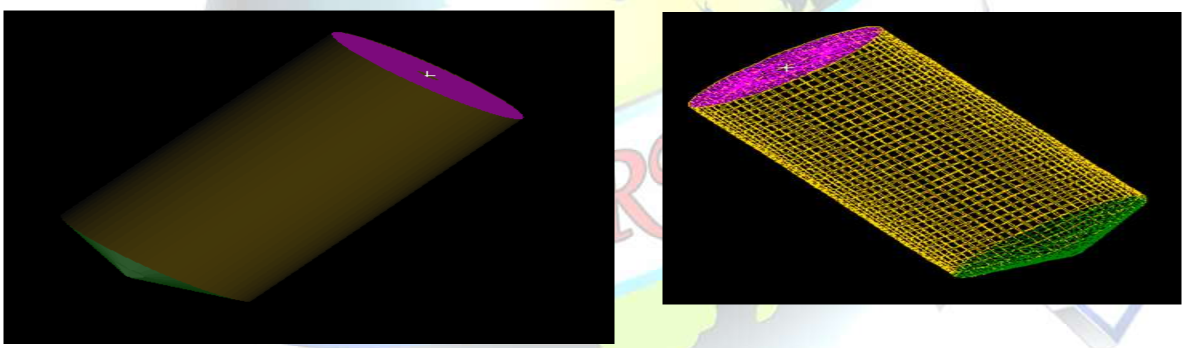

Fig 4: Meshed view of the inner model

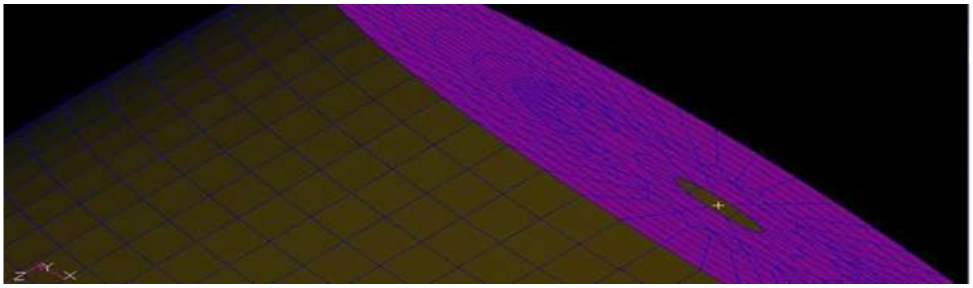

Fig 5: Meshing appearance showing the connectivity on the inner shell

The above figures from 3 to 5 shows the different views of the finite element model of the chamber. QUAD4 and TRIA3 type of elements are used in the preparation of the two dimensional model of the cryotreatment chamber. Finer mesh is required only at critical regions of the structural members and other locations can be meshed with larger size elements.

3.4 LOADS CASES AND BOUNDARY CONDITIONS

In the present project work pressure is applied inside inner cylinder which is in the direction of normal and ends of the four stands are constrained in both translational and rotational degrees of freedom. Design internal pressure=0.0407Kg/mm^2

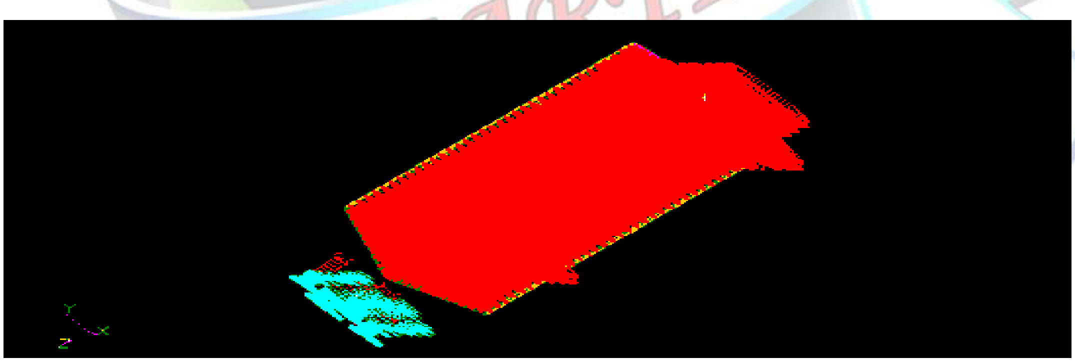

Figure 6: Shows loads and Boundary conditions applied to cryotreatment chamber

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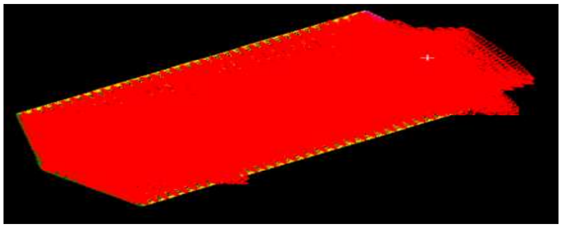
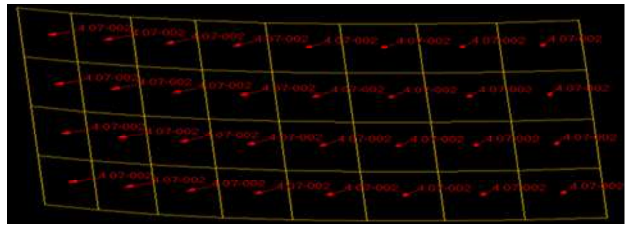


Figure7: The pressure applied to innershell



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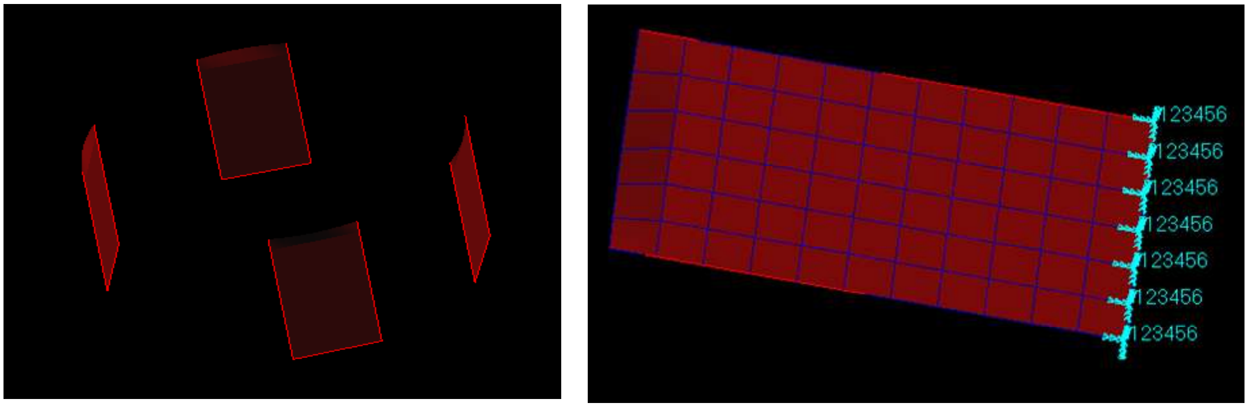

Figure 8: The boundary conditions applied to the stand at the bottom end

Analysis results & Observations

- The output results are obtained and discussed as shown figures.
- The static stresses for von mises stress tensor, the maximum stress location at thickness Z1 and the static displacementvariation as shown figure.
- The maximum and minimum von mises stressat thickness Z1 andZ2 is 16.4 kg/mm^2, 0.0869kg/mm^2 and 10.9kg/mm^2,0.15kg/mm^2 respectively.
- The maximum static displacement from figure is 0.356mm.

Fig 10: At thickness Z1 shows the static stress for von mises stress tensor and maximum stress location

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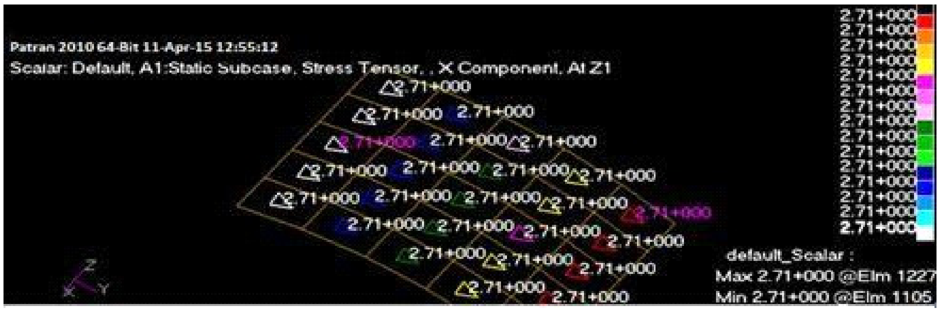

Fig 11: At thickness Z1 shows the static stress for von mises stress tensor and maximum stress location

The figure shows the output of stress results from the finite element analysis. From these figures one can observe that the stresses are correlating exactly with the theoretically expected values.

CONCLUSIONS

The following concluding remarks are made based on the design calculations and analysis carried out on cryotreatment chamber unit.

- A maximum internal pressure of 4 bar ($4*10^5 N/m^2$) is used in the design of the chamber
- Classical design approaches are followed in arriving at the wall thickness of the inner and outer cylinder of the cylinder.
- Internal pressurization which was considered for the design calculation was used in the analysis.
- The maximum stress was observed at the end of the cylinder near the connecting location between cylinder and the cover plate.
- The stress distribution on the cylinder wall was found to be uniform
- The maximum von mises stress at thickness Z1 and Z2 are found to be 16.4 kg/mm^2, and 10.9kg/mm^2 respectively.
- The maximum stress magnitude obtained from the analysis is less than the ultimate tensile strength of the SS304 material.
- From the analysis and calculations it was found that there is a good correlation between theoretical calculations and the analytical results

Acknowledgement

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