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# Designing and Analysis of Liquid Nitrogen (LN<sub>2</sub>) Cryogenic Storage Vessels

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**ABSTRACT:** Cold transformers are a type of pressure vessel designed for the storage of liquid oxygen and nitrogen or argon under the required pressure conditions. The materials used for these materials are discussed and analyzed. The design process follows industry standards. Cryogenic storage containers are pressure containers used to store cryogenic liquid with a small amount of heat leaking from the vessel from the outside to the inside it is possible. The challenge of designing to use such items can be lost desirable structures at such a low temperature. The process of designing a cold nitrogen converter has become necessary the data has been tested and modified to create a cryogenic storage for complete storage container. Here the greatest care is taken to design a final container that satisfies both mechanical and thermal design. The results will be compared to the current one industrial ship Design statistics and results are shown. After the cryogenic liquid is immersed in the liquid and diluted to the desired level; should then store and transported. Cryogenic fluid storage-vessel and transmission line design has developed rapidly due to the increasing use of cryogenic liquids in many areas of engineering and science. The development of the Dewar ship represents such improvements to cryogenic water storage vessels can be placed in the "crossing" section vessel design. the concept of the Dewar design project is a two-wall container with the space between the two vessels full of insulation and extraction from it space. A detailed design of cryogenic-fluid storage vessels is included in that standards such as the American Society of mechanical engineers (ASME) boiler and pressure vessel code, section VIII (1983), and the British Standards Institution levels 1500 or 1515. Most users require ships to be built, made, and tested according to a code size larger than 250 dm<sup>3</sup> that is, 66 litre in the U.S., due to the proven design of the safety code.

**KEYWORDS:** Cryogenic Storage Vessels, CATIA, ANSYS, FEA

## I. INTRODUCTION

cryogenics: Cryogenics is the science of low temperature. Cryogenics refers to everything temperature below 150 ° Development of systems and components that produce, store, or use low-cost temperatures. The word "cryogenic" is derived from the Greek word kruos, meaning snow, once genos, the origin of nature. Producing low temperatures. storage tank

The final tank is a container, usually a liquid reservoir, sometimes compressed gas. Cryogenics is the science of low temperature. Cryogenics refers to everything 150 ° C or 123K. Cryogenic engineering involves design as well development of systems and components that produce, store, or use low-cost. The word "cryogenic" is derived from the Greek word kruos, meaning snow, once genos, the origin of nature. In fact, cryogenics is the technology and art behind it producing low temperatures.

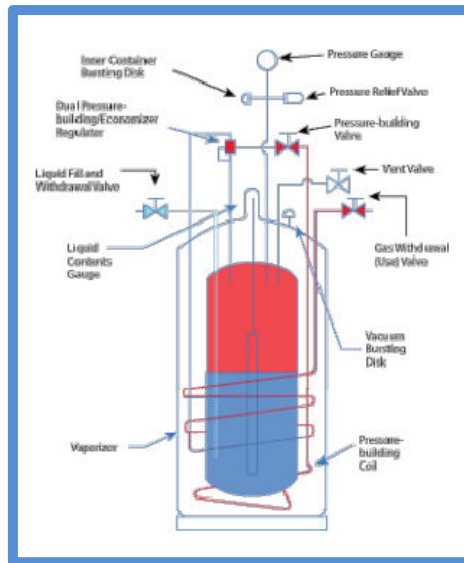


Fig 1. Part representation of Storage tank

Cryogenic vessels are designed for the storage and transport of liquefied gases temperatures. Producing such cryogenic tanks requires specialized technology as well complex synthetic methods. Universal has developed the necessary technology and has been producing these cryogenic machines as cryogenic vessels from the end seven years. The process that takes place in any pressure vessel or cylinder is a cycle of air separation process. The process is as follows

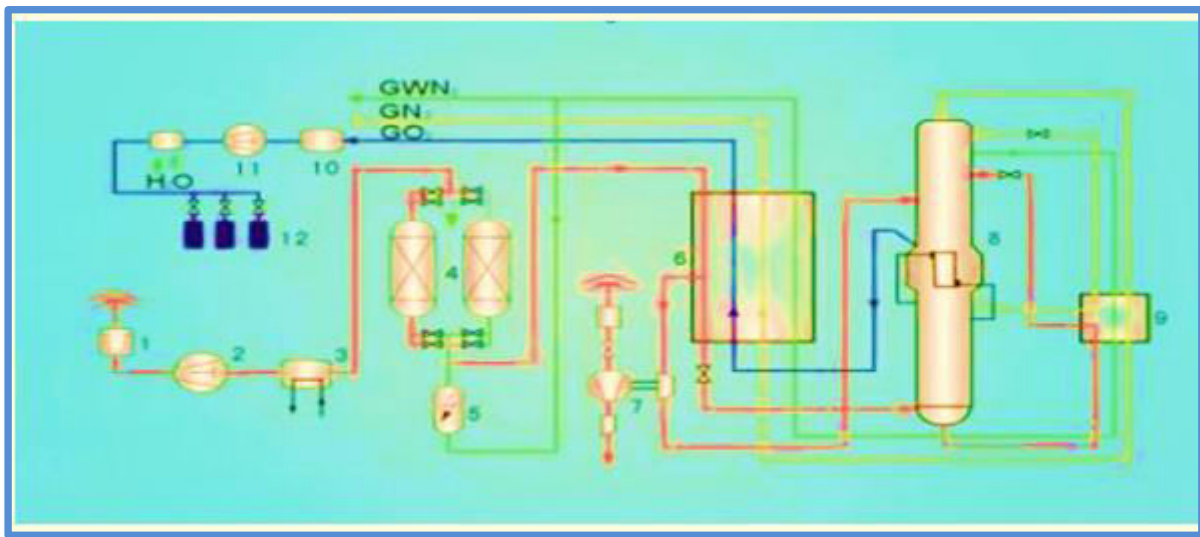


Fig 2 Shows the air separation Process

## II. MATERIAL AND MANUFACTURING PROCESSES

Material selection of specified components plays a major role. Austenitic stainless steel is suitable for cryogenic applications as it is stay firm and cover even at  $-269^{\circ}\text{C}$ . 9% nickel metal 9 percent of nickel steels are commonly referred to as ferrite steels, however and include austenitic ferrite and magnetite. Austenitic has supernatural power and resistance to breakage due to its presence. At  $200^{\circ}\text{C}$ , the ductility decreases with the temperature drop is slow, with chirpy v notch values of more than 25 Ft pounds (346 or 4.4 kg / cm<sup>2</sup>). It is often used in cryogenic storage and transfer equipment liquefied gases such as nitrogen, methane, and ethylene due to their guaranteed safety and low costs.



Extensive research on liquid nitrogen tanks has shown that quenching and heating, too like post-weld treatment, it does not help. ASME code specified that shipping is not required heat, heat treatment comes and includes 2 inches thick (up to about 50mm). Aluminum alloys like 5083 (Mg 0.445 percent, Mn 0.6 percent, and Cr 0.15 percent), 6003 (Mn 1.26 percent, and Cu 0.12 percent), and brazed aluminum temperature exchangers used for the production of cryogenic storage vessels, columns for air separation plants, as well as aluminum brazed for heat exchangers. Even temperatures of liquid helium, - 269 ° C, no ductile flexible. Because the durability properties of aluminum are well understood, it was not considered it is necessary to enter a minimum value in ASME or ASTM rules. The measure of the harvest is a honeycomb, tear resistance is high, and the severity of significant stress is high. Fatigue it increases as the temperature drops. Copper alloys such as alpha brass and phosphorous-di-oxide, copper was present simple materials for building cryogenic machines. Even today copper tubes are used trays in small air separation plants. Copper has low production capacity in annealed condition. Copper alloys have a lower production capacity compared to steel and are not affected temperature changes.

Material	Young's Modulus Ksi	Density lbmass/in <sup>3</sup>	Poisson's Ratio	Ultimate tensile strength psi	Shear Modulus Ksi
Al 5083	10007.6	0.0960986	0.33	55839.5	3762.26
Nickel copper Alloy 400	26005.3	0.319004	0.35	80931.1	9887.93
Stainless Steel 301AH	27410.21	0.289	0.265	79800	27410.21
Glass Epoxy	9427.45	0.0695	0.26	10500	3770.98
Ti-6Al-4v	16244.22	0.308165	0.34	78000	5946.54
Copper Alloy	1785.41	0.322254	0.355	48800	6526.69

Table 1: shows the material properties

### III. MODELLING AND ANALYSIS PROCEDURE

Autodesk Inventor is a 3D computer-assisted design application machine design, simulation, visualization, and documentation developed by Autodesk Developer combines 2D and 3D data into one place to create visual representation of the final product that allows users to check its shape, proportions, and work before it is done. [2] Autodesk Inventor has a strong parametric, precise editing, and free-form modelling tools, as well as multidisciplinary CAD translation and standardization skills DWG™ Drawings™. The founder uses Shape Manager, Autodesk's proprietary geometric modelling engine. Autodesk Inventor competes directly with Solid Works, Solid Edge, andCreo. Autodesk® Inventor® software provides engineers and designers a professional level3D mechanical design solution, simulation, visualization, and text. Autodesk. The developer combines powerful modelling tools and translation capabilities for multiple CADs at once standard DWG™ industry drawings™. To help you reduce costs of development, enter the market quickly, and make good products.

There are 14 new free tools that offer an alternative model for you to explore again create free-form models using straightforward deception. Users can start with free form shape (Box, Sphere, Cylinder, Torus, or Quad ball) best represents the desired geometry. Free editing tools can be used to change and adjust shapes. Direct editing tool gives users the ability to edit parts quickly. Users can adjust the size, shape, and / or location of model features by directly manipulating geometry. Use Direct Planning when you want to: Quickly modify a complex model that you did not create in the first place 2. Modify the imported basic components.3. Simply adjust your preferences while avoiding unintended changes due to complexity relationships Check out some of the design options right awayIn both parts and components, a new feature is introduced in the parameter box. Insteadfor deleting by performing unused parameters, users can use Unused Purge to delete it from party selection. This will help to reduce the size of the model file. Sketches, Meetings, and Drawings have a number of additional features and enhancements. Product system requirements for Autodesk® Inventor 2015.Make sure you install the appropriate version of the Autodesk Inventor



software your app. Inventor offers different 32-bit and 64-bit performance plugins programs. Note that the 64-bit version of Inventor cannot be installed on a 32-bit system and so on the contrary.

**Design Specifications of Inner Shell:**

Thickness of shell (as per ASME SEC VIII DIV 1)

$$T = \frac{P R_i}{S E - 0.4 P} + C.A + T.A$$

Where P = design pressure = 11.332 kg/cm<sup>2</sup>

S = allowable stress = 1406.14 kg/cm<sup>2</sup>

R<sub>i</sub> = radius of inner shell = 1350 mm

E = joint efficiency = 1

C.A = corrosion allowance = 0

T.A = thinning allowance = 0

Hence thickness T = 10.93 mm ≈ 12 mm

Adopted thickness = 12 mm

**Design Specifications of Outer Shell:**

Outside diameter of cylindrical shell D<sub>o</sub> = 3074 mm

Provided thickness t = 12 mm

Corrosion allowance C.A = 3 mm

Length between stiffener rings L<sub>s</sub> = 3740 mm

L/D<sub>o</sub> = 1.218

D<sub>o</sub>/t = 256.16

From ASME SEC VIII DIV 1

From graph factor A = 0.00025

From graph factor B = 3400

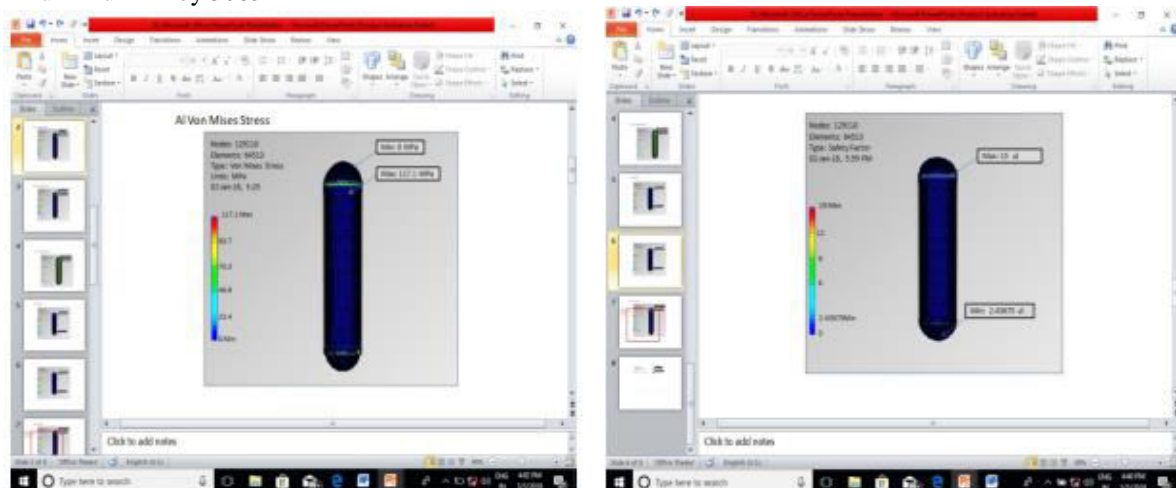
$$Pressure P_a = \frac{4B}{3(D_o/t)} \frac{4B}{3(D_o/t)}$$

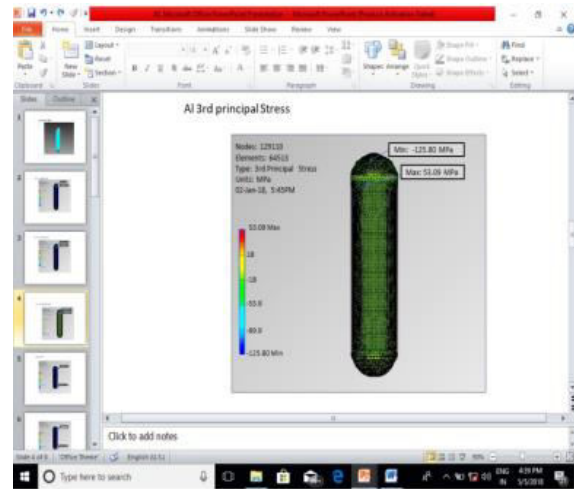
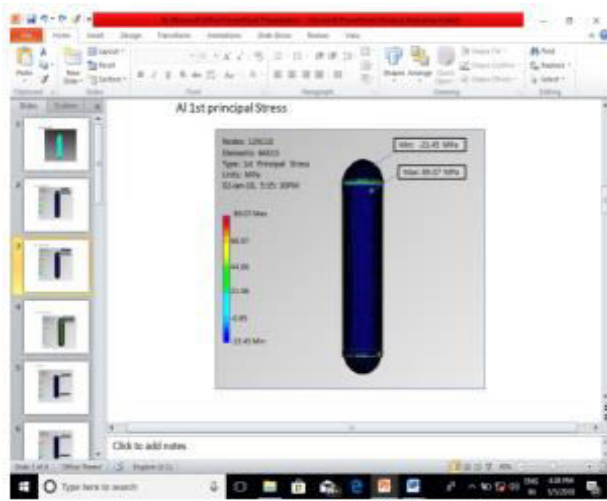
P<sub>a</sub> = 17.69 psi

External pressure P = 15 psi

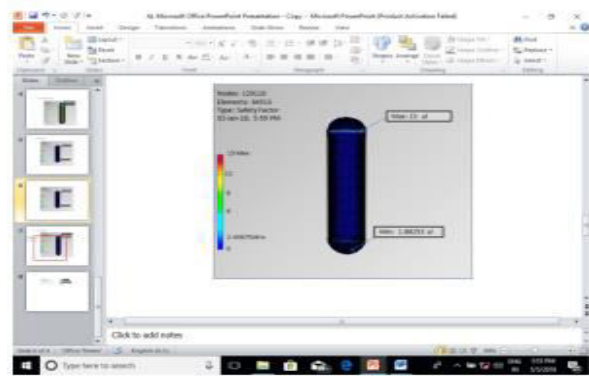
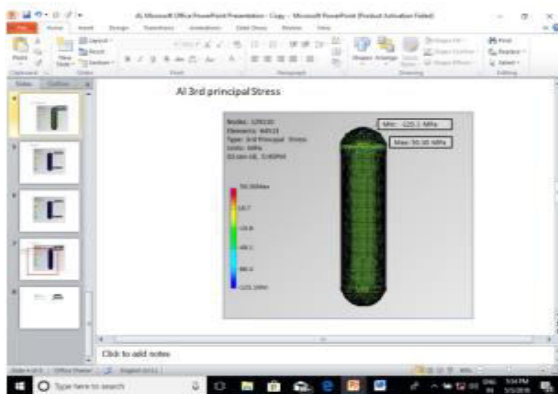
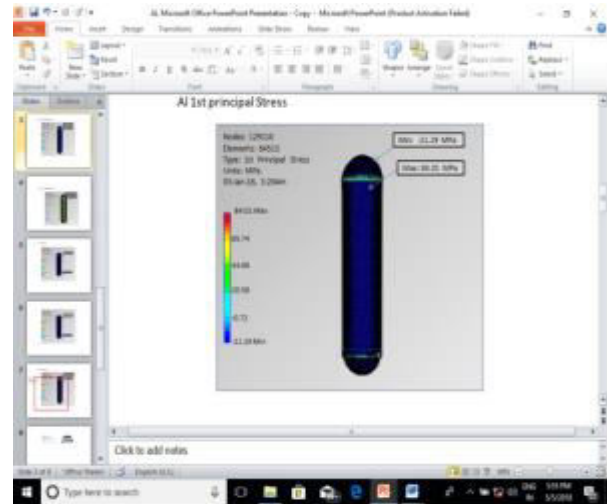
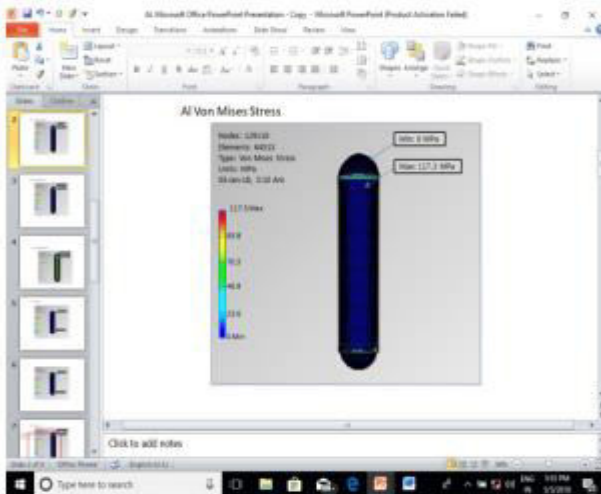
**IV. RESULTS AND EXPLANATION**

With Aluminium Alloy 5083



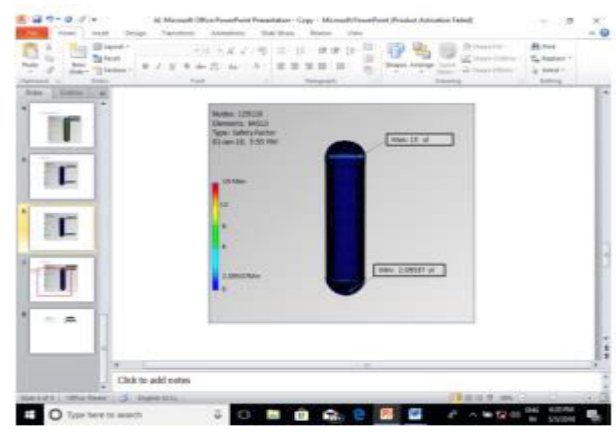
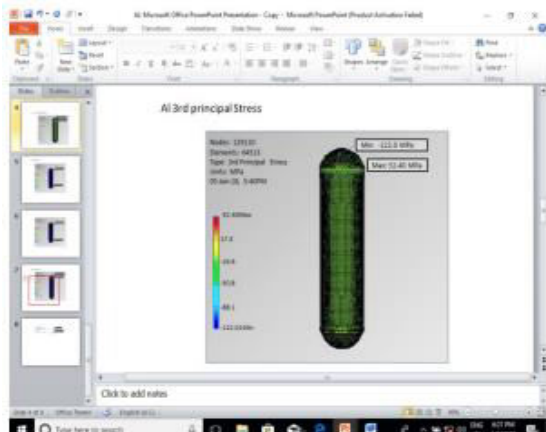
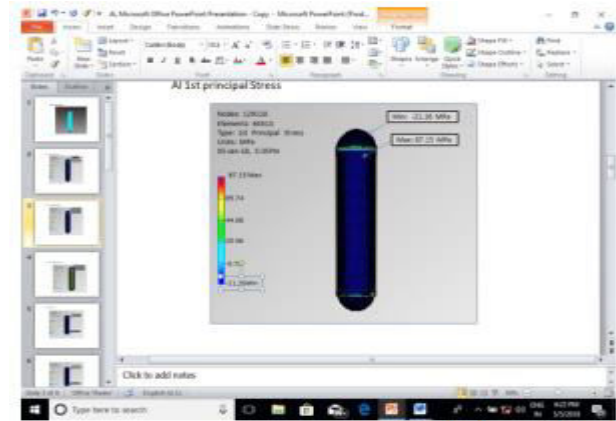
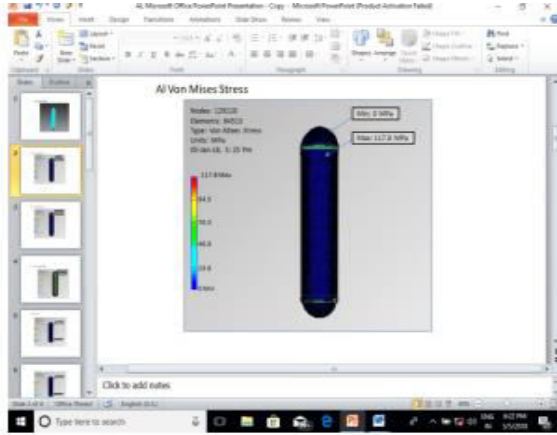


With Nickel Copper Alloy 400

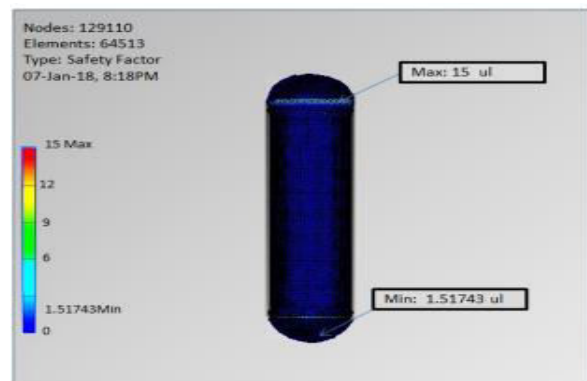
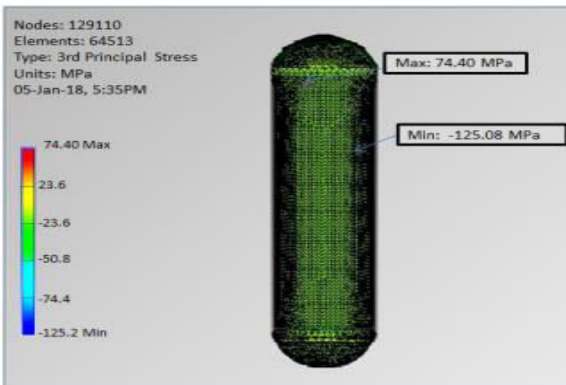
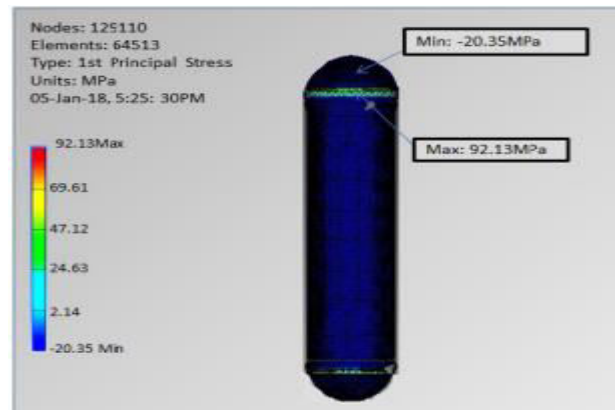




With Stainless Steel 301 AH

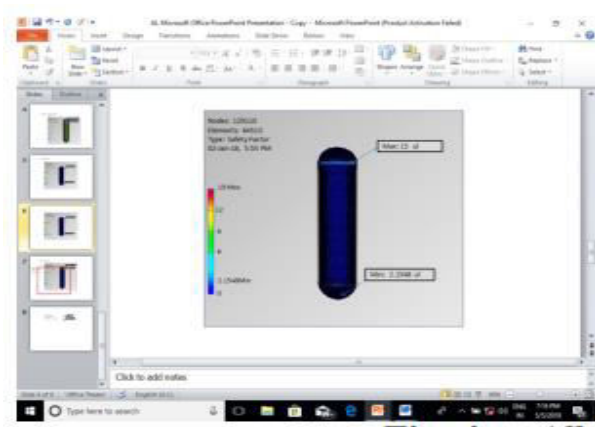
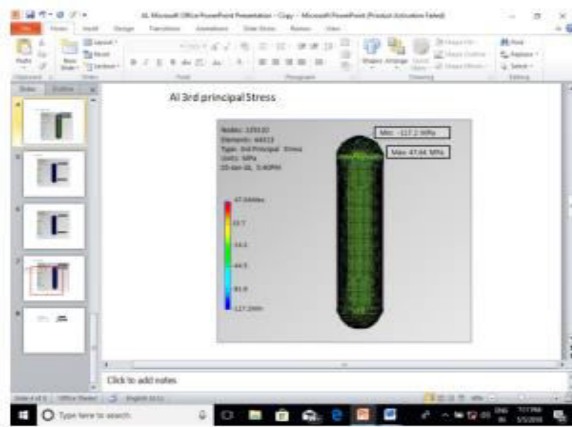
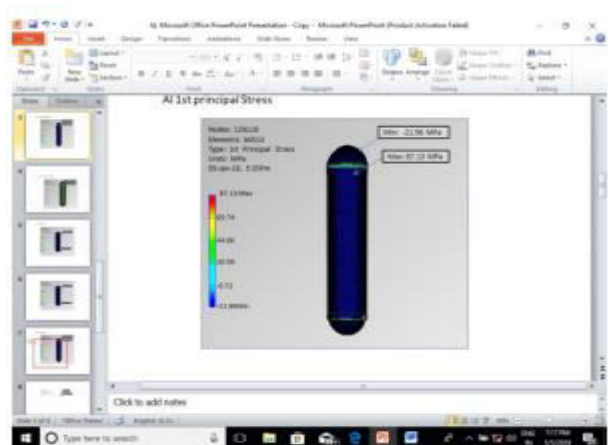
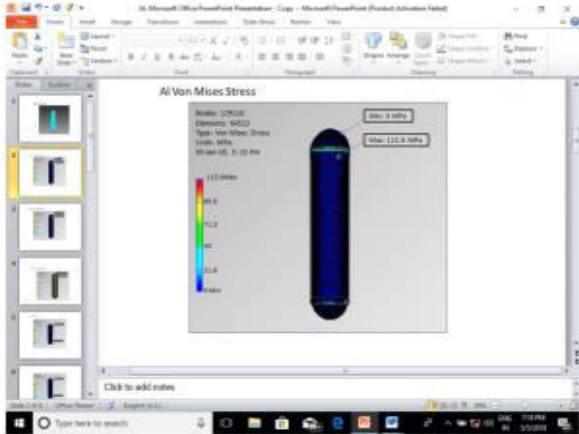


With Glass Epoxy

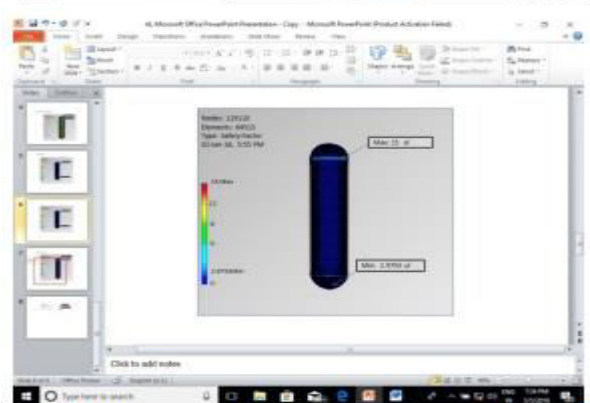
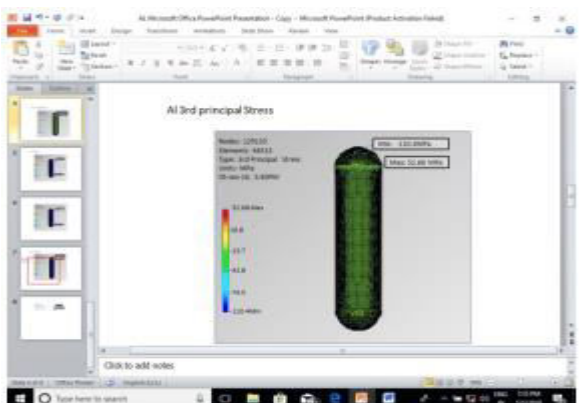
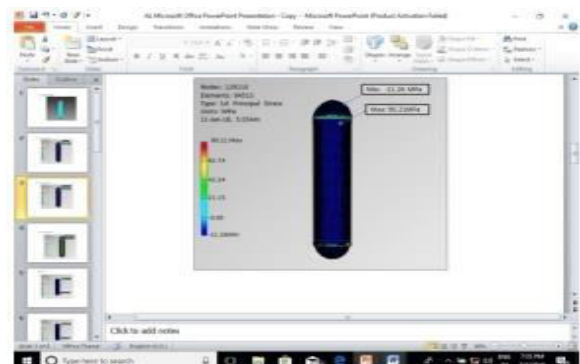
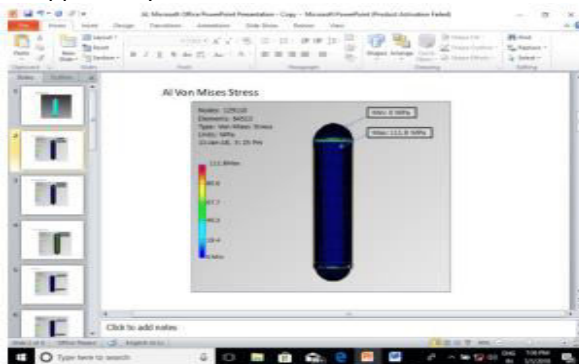




With Ti-6Al-4V

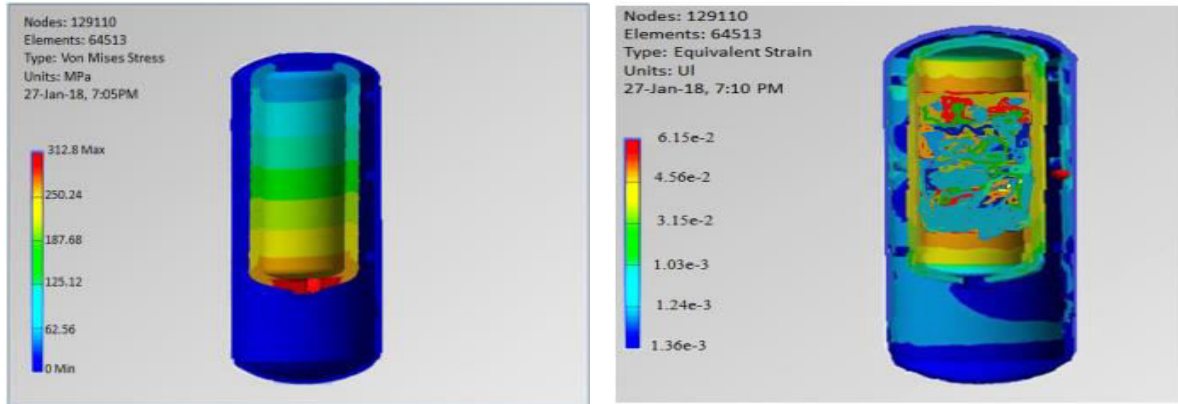


With Copper Alloy





### Cryogenic Vessel of Inner and Outer Vessel with Glass Epoxy



### V. CONCLUSION

The Small safe size configuration and specifications for various components of cryogenic vessel converter calculated. Slightly higher sizes accepted. This has been the case done to ensure that standard values are selected. Only those parts have it. The minimum and maximum allowable pressures are accepted and some are once again done due to its high durability. The pressure vessels involved have the same width so these are not ongoing withdrawal depression. Members do not have the right pressure. Actually the design is safe and ready to use. It is mainly used to integrate the design process of parts as well. is widely used in industry to facilitate the calculation and size of parts can be obtained from any design pressure with in no time.

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