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Design and Analysis of Hydrogen Storage Tank with Different Materials by Using Ansys

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ABSTRACT

Pressure vessels are used for large commercial and industrial applications such as softening, filtration and storage. It is expected that high-pressure hydrogen storage vessels will be widely used in hydrogen-fuelled vehicles. Liquid hydrogen is seen as an outstanding candidate for the fuel of high altitude, long-endurance unmanned aircraft.

The design of lightweight and super insulated storage tanks for cryogenic liquid hydrogen is since long identified as crucial to enable the adoption of the liquid hydrogen. Progressive failure properties, the burst pressure and fatigue life should be taken into account in the design of composite pressure vessels. In this project, the model and analysis of hydrogen storage vessels along with complete analysis. The structure of the tank was analyzed by the finite element numerical simulation method. The analysis will be carried out with different materials like titanium, aluminum alloy and some coated like the zirconium and carbon fiber. Hydrogen fuel tanks have been carried out for above mentioned combination and results have been analyzed and discussed extensively. The Static Structural analysis and steady state thermal analysis was performed by means of Ansys LS-DYNA Student 2022 R1.

Keywords: storage tank, design, composite materials, ansys.

Introduction

The intemperate use of fossil fuels has led to gradually increasing drastic environmental pollution and energy crisis. Numerous research works have recently been carried out on lookingfor renewable resources as a replacement for conventional fossil fuels.

The current near-term technology for onboard automotive hydrogen storage is 35 and 70 MPa nominal working-pressure compressed gas vessels. The main advantage of employing a compressed hydrogen storage system is the ability to rapidly refuel the vehicles in approximately 3–5 min Hydrogen has been recognized as the superior option for the future energy industry because of the characteristics of unlimited supply, zero-emission of greenhouse gases, and high energy efficiency. Hydrogen storage has become one of the predominant technical barriers limiting the widespread use of hydrogen energy. Safe, high-efficiency and economical hydrogen storage technique is a key to ensure a favorable run of hydrogen fuel cell vehicles. Among many hydrogen storage patterns including high-pressure gaseous storage, cryogenic liquid storage and chemical hydrogen storage, high-pressure gaseous storage has become the most popular technique. The basic requirements for the design of storage vessels are safety, reliability and economy.

However, the composite pressure vessels may work under the high-pressure and high- temperature environment. Conventional metallic pressure vessels cannot longer be competent for the rigorous need for high strength and stiffness weight ratios. Therefore, the composite filament wound technology was introduced to improve the performance of the storage vessels. Generally, the composite materials are used for fabrication of pressure vessels by placing them in different orientations for different layers and in a common orientation within a layer. These layers are stacked in such a way to achieve high stiffness and strength. The design of the composite vessel as a fundamental research work relates the physical and mechanical properties of materials to the geometric specifications.

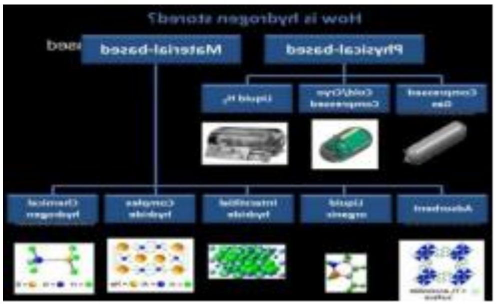


Fig:1.1 - How Hydrogen stored.

Literature Review

- Senthil kumar, Bibin Chidambaranathan, Ramachandran Manickam et.al-(1): Among many hydrogen storage patterns including high-pressure gaseous storage, cryogenic liquid storage and chemical hydrogen storage, high-pressure gaseous storage has become the most popular technique. The basic requirements for the design of storage vessels are safety, reliability and economy. However, the composite pressure vessels may work under the high-pressure and high-temperature environment.

- Pawan N Naik, Dr. M K Venkatesh, Dr. R Keshavamurthy. et.al-(2): Three-dimensional modelling and analysis of a hydrogen gas container with different combination of materials have been successfully carried out. Static structural analysis and fatigue life estimation of hydrogen fuel tank using aluminium, Aluminum + Epoxy, and Aluminium + carbon fibre have been successfully carried out using finite element tool.

- Juan pedro berro ramirez, damien halm, jean-claude grandidier, stéphane villalonga, fabien nony et.al-(3): A FE model of a type IV wound composite pressure vessel has been developed. In order to simulate properly the burst test, a continuum damage model dedicated to wound composites has been used. The results obtained are fairly good: the difference between the simulated burst pressure and the actual one is 7.74%. In this structure, fiber breakage is the most important damage mode, as it leads to tank burst. Even if this mode drives the burst process, the use of a complex damage model is justified by the existence and prediction of other phenomena related to matrix cracking or delamination

- Rahul Krishna, Elby Titus, Maryam Salimian, Olena Okhay, Sivakumar Rajendran, Ananth Rajkumar, J. M. G. Sousa, A. L. C. Ferreira, João Campos Gil and Jose Gracio. et.al-(4): The hydrogen revolution following the industrial age has just started. Hydrogen production, storage and conversion have reached a technological level although plenty of improvements and new discoveries are still possible. The hydrogen storage is often considered as the bottleneck of the renewable energy economy based on the synthetic fuel hydrogen. Different hydrogen storage methods and materials have been described already and need to be study more.
- Karen Law, and Jayanti Sinha Nuclear Engineering Division, Argonne National Laboratory, Argonne, Illinois et.al-(5): The performance and cost of compressed hydrogen storage tank systems has been assessed and compared to the U.S. Department of Energy (DOE) 2010, 2015, and ultimate targets for automotive applications. The on-board performance and high- volume manufacturing cost were determined for compressed hydrogen tanks with design pressures of 350 bar (~5000 psi) and 700 bar (~10,000 psi) capable of storing 5.6 kg of usable hydrogen.

- Shitanshu Sapre, Kapil Pareek, Mayank Vyas et.al-(6): The ply based modeling approach was used to develop the FE model of the composite structure. The FE analysis was conducted to investigate the mechanical and thermal behavior of each layer under severe loading conditions. The paper presents a comprehensive analysis of composite tank including stress, strain, deformation and failure pressure of the tank.

- Dong Ho Nguyen, Ji Hoon Kim, Thi To Nguyen Vo, Namkeun Kim, Ho SeonAhna et.al- (7): Portable hydrogen tank using absorption material is considered as an alternative to Type IV compressed tank. Light-weight, high-capacity and cost-effective hydrogen storage tank is presented for automobile applications. Three-layer thermal insulation effectively maintains cryogenic temperature for long time. FEM equivalent conduction model with surface-to-surface radiation is used for heat ingress estimation. Estimation procedure for futuristic capacity of hydrogen storage system is established.

- Christopher Winnefeld, Thomas Kadyk ID, Boris Bensmann, Ulrike Krewer idand Richard Hanke-Rauschenbach et.al-(8): Although the integration of hydrogen tanks into common aircraft appears to be challenging or even inappropriate, future aircraft will be designed to accommodate new storage technologies. For this reason, further investigations covering the whole propulsion system are highly suggested under consideration of new design approaches.
- Patrick Adam and Jacob Leach man et.al-(9): The design and fabrication of a light-weight, reconfigurable liquid hydrogen fuel tank for use on small (<25 kg) Unmanned Aerial Vehicles (UAV) has been completed. The use of Iso grid flanges allows for complete disassembly of the tank system for Technology Readiness Level (TRL) advancement of storage and fueling components. The total tank weight is 6.3 kg with an estimated parasitic heat load of 1.15 W during cruise.

- Al-Nawas B., Bragger U., Meijer H.J., Naert I., Persson R., Perucchi A., Quirynen M., Raghoebar G.M., Reichert T.E., Romeo E., et.al-(10): This study confirms that TiZr small- diameter bone level implants provide at least the same outcomes after 12 months as Ti Grade IV bone level implants. The improved mechanical properties of TiZr implants may extend implant therapy to more challenging clinical situations.

Designing of Hydrogen Storage Tank

The outer wall is responsible for supplying a certain amount of strength to the tank. When the container is filled with hydrogen, it increases the pressure. Above acertain value, hydrogen goes through the filter wall into the dynamic wall region. Here it comes to a reaction with the wall material to form a compound which takes place at high pressures. The compound will be solid or adopt the solid phase under high pressure. The main property of this compound is to increase the volumetric density and create additional support to the outer wall in encountering the high pressure inside. Hence pressures can be achieved which are higher than of those the outer wall alone couldallow.

If a reduction in the pressure occurs during discharging the tank, some part of hydrogen can flow back through the filter wall and therefore supply hydrogen wheneverit is needed. In this sense it can also be stated that the tank adjusts its own strength and lower factor of safeties than the standards may be applied as well. Furthermore, this wall is going to reduce the total tank weight since it will be made of lightweight materials. At last but not at least, the dynamic wall is expected to reduce the permeation rate of hydrogen through the walls to the outside, so the leakages can be significantly reduced. Another advantage of this is that hydrogen embrittlement at the outer wall is prevented, since the wall will not stay under long exposure to hydrogen. This will also allow being more flexible with material choices for the outer wall, because it does not have to deal with hydrogen permeation.

Dynamic wall can be considered to be the key feature of the design whichseparates it from other pressure vessels. The main advantage of this feature is that hydrogen will be absorbed in this region with high volumetric densities, thus allowing bigreduction in the total system volume.

Hydrogenation generates volumetric expansions. These volumetric expansions and shrinkages are observed to be between 15 and 25 % for hydrides, which will result in a decrease in the gaseous hydrogen volume inside the tank.

Volumetric expansions are accompanied also by heat changes in the system upon hydrogen interactions in the dynamic wall region. As a similar technique, hydride storage suffers from high temperatures resulting from exothermic reactions of hydride creation. Assuming similar exothermic reactions, the excess heat has to be transmitted to outside or absorbed within the system.

PARAMETERS CONSIDERING FOR DESIGN

Circumferential or Hoop Stress: This is the stress which is set up in resisting the bursting effect of the applied internal pressure and can be most conveniently treated by considering the equilibrium of the cylinder. The hoop stress is the force exerted circumferentially (perpendicular both to the axis and to the radius of the object) in both directions on every particle in the cylinder wall. The effect of this may split the pipe into two halves. The failure of the pipe in two halves in fact is possible across any plane, which contains diameter and axis of the pipe. Elements resisting this type of failure would be subjected to stress and direction of this stress is along the circumference.

Longitudinal Stress: Consider a cylinder that could have closed ends and contain a fluid under a gauge pressure. Then the walls of the cylinder will have a longitudinal stress as well as a circumferential stress. Considering that the pipe ends are closed and pipe is subjected to an internal pressure ‘P’ the pipe may fail. Elements resisting this type of failure would be subjected to stress and direction of this stress is parallel to the longitudinal direction of the pipe.

Radial stress: Radial stress can also be a factor in thick-walled pipe. It is stress in directions coplanar with, but perpendicular to, the symmetry axis. The radial stress is equal and opposite tothe gauge pressure on the inside surface, and zero on the outside surface.

Design Specifications:

Total Length = 8270mm Internal diameter = 2300mmThickness = 39mm
Pressure = 35, 50,75 (MPa) Internal Temperature = -250℃External Temperature = 27℃

SYSTEMATICAL DESIGN PROCESSSTEP 1:

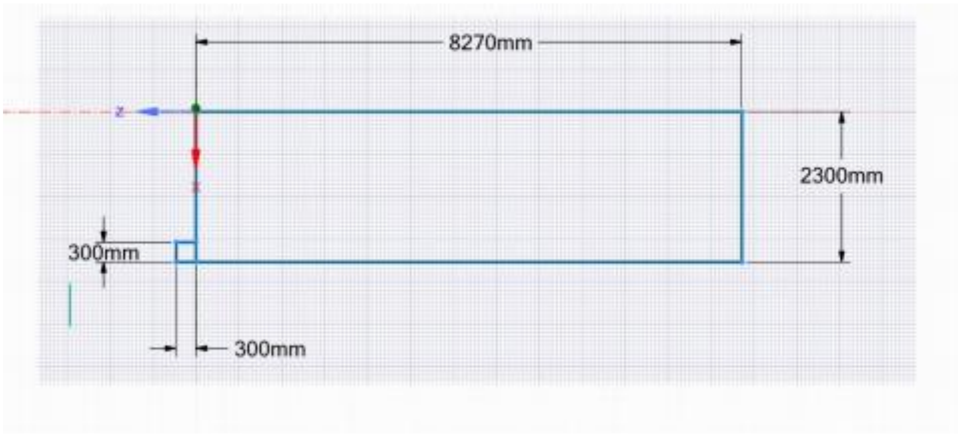


Fig 3.2.1: Line diagram of cylinder

Fig 3.2.2:Line diagram with offset

STEP 2:

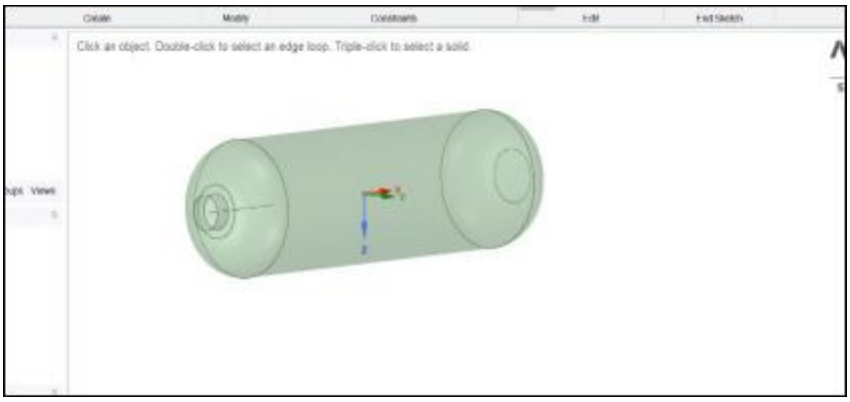


Fig 3.2.3: Design of cylinder in geometry

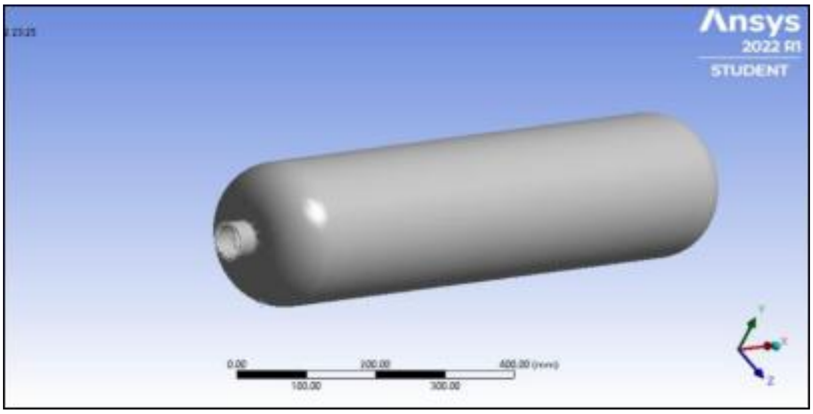


Fig 3.2.4: Diagram of cylinder in model

Analysis of Hydrogen Storage Tank

ANSYS is a general-purpose, finite-element modeling package for numerically solving a wide variety of mechanical problems. These problems include static/dynamic, structural analysis, heat transfer, and fluid problems, as well as acoustic and electromagnetic problems. With its widely adopted simulation platform, ANSYS enables every member of the product development team to participate in digital exploration. The result is more innovative products, faster time to market and lower development costs.

SELECTION OF MATERIAL

On the basis design specifications for the hydrogen tank the hoop stresses and longitudinal stress are carried out that the hydrogen tank material must have the tensile strength of 210Mpa. However the material which possess these characteristics those materials have taken into the consideration for the hydrogen tank. Titanium + zirconium and Aluminium + carbon fiber these are the materials which shows tensile property for the hydrogen tank.

STRUCTURAL ANALYSIS FOR TITANIUM ZIRCONIUM AT 35MPa

DEFORMATION

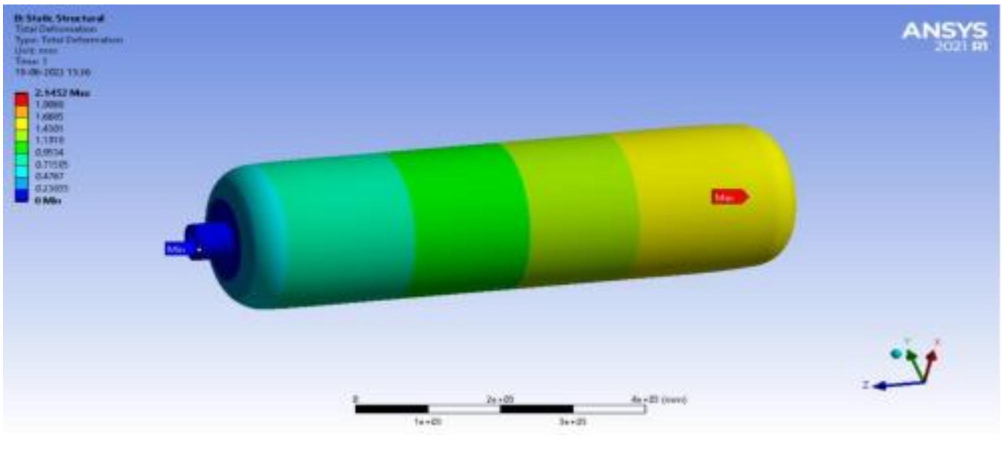


Fig:4.3.1: Structural analysis deformation result for 35Mpa for titanium zirconium.

- Deformation for titanium zirconium at 35Mpa is observed 2.1452 mm as maximumvalue and minimum value is 0.

STRESS

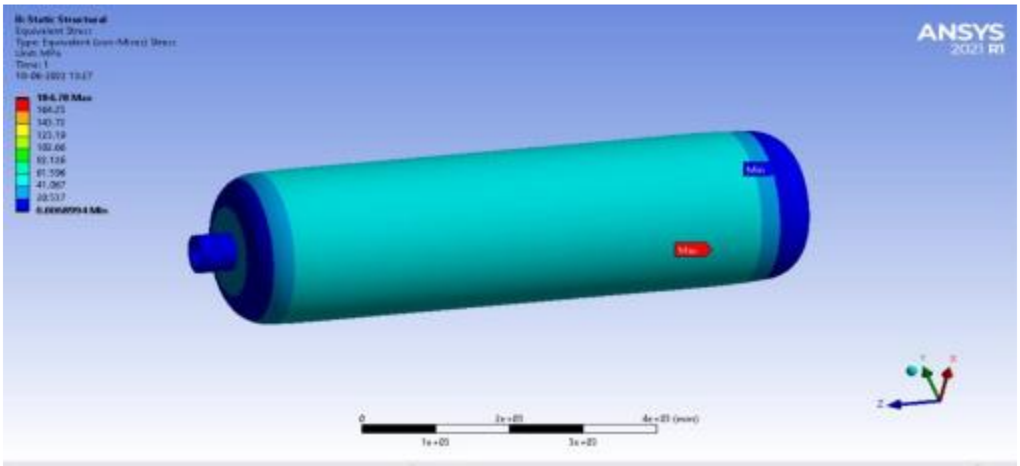


Fig:4.3.2: Structural analysis stress result for 35Mpa for titanium zirconium.

- Stress for titanium zirconium at 35Mpa is observed 184.78Mpa as maximum value andminimum value is 0.00689Mpa.

STRAIN

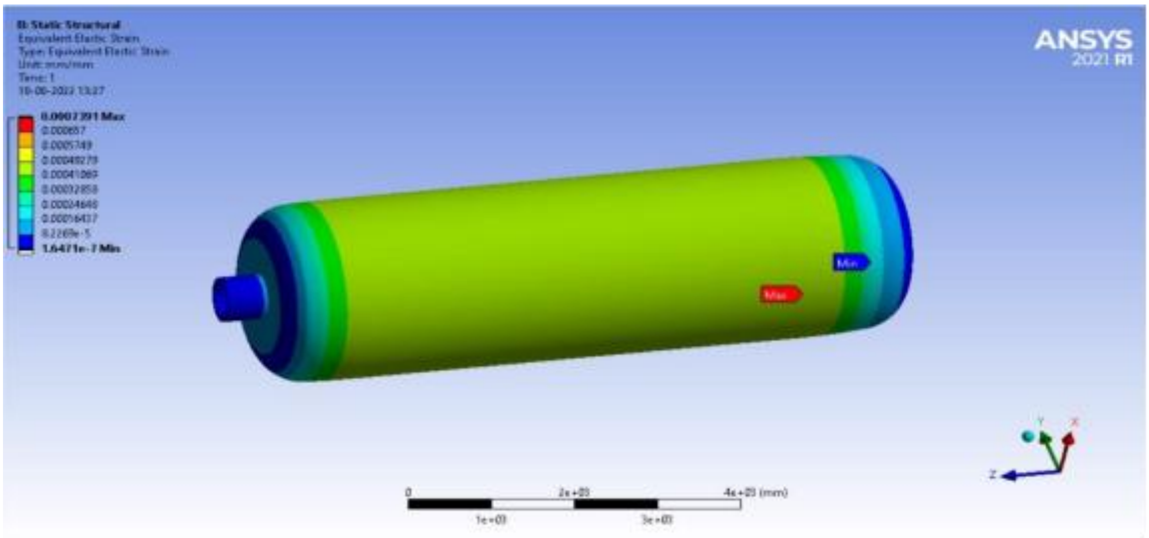


Fig:4.3.3: Structural analysis Strain result for 35Mpa for titanium zirconium.

- Strain for titanium zirconium at 35Mpa is observed 0.00073 as maximum value andminimum value is 0.

FACTOR OF SAFETY

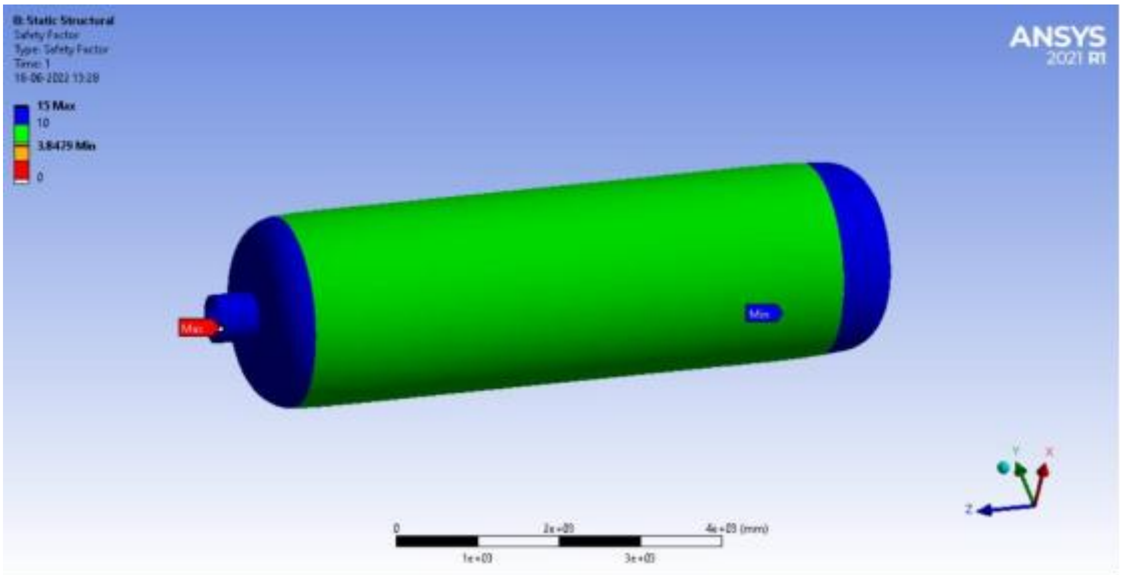


Fig:4.3.4: Structural analysis factor of safety result for 35Mpa for titanium zirconium.

- Factor of safety for titanium zirconium at 35Mpa is observed 15 as maximum value andminimum value is 3.8479.

SHEAR STRES

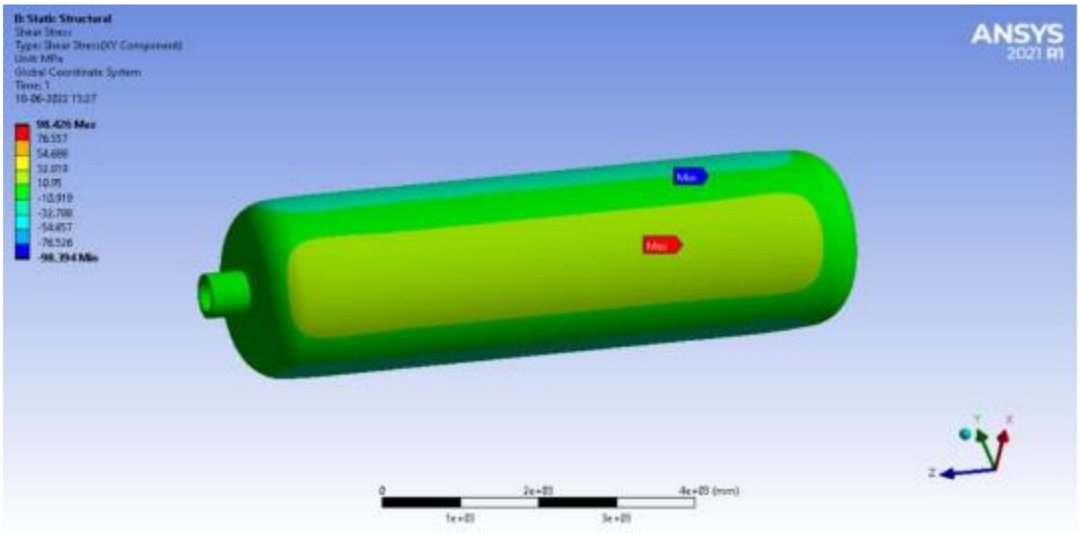


Fig:4.3.5: Structural analysis shear stress result for 35Mpa for titanium zirconium.

- Shear stress for titanium zirconium at 35Mpa is observed 98.486 Mpa as maximumvalue.

STRUCTURAL ANALYSIS RESULTS FOR TITANIUM ZIRCONIUMAT 50 MPa.

DEFORMATION

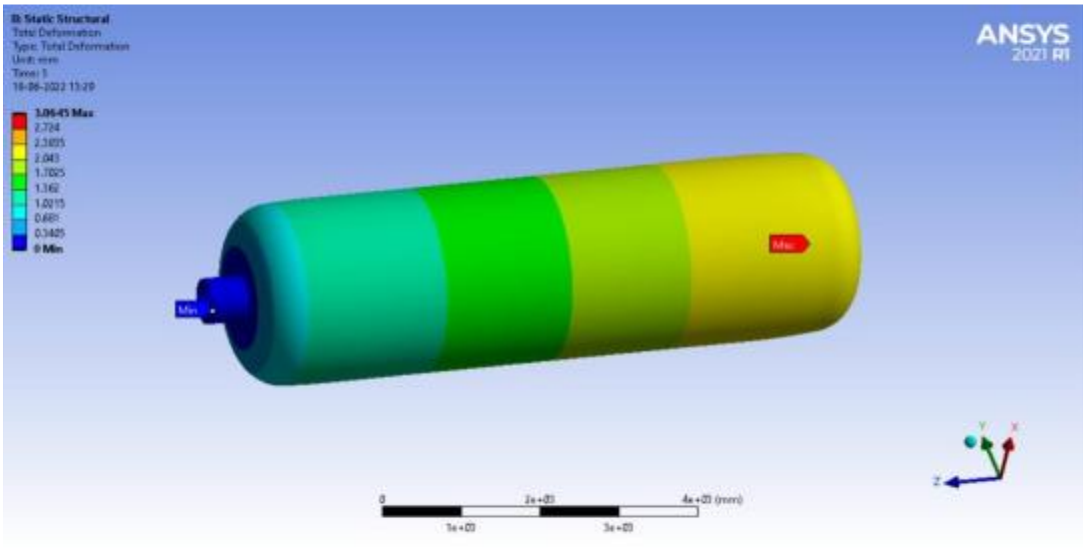


Fig:4.4.1: Structural analysis deformation result for 50Mpa for titanium zirconium.

- Deformation for titanium zirconium at 50Mpa is observed 3.0645 mm as maximumvalue and minimum value is 0.

STRESS

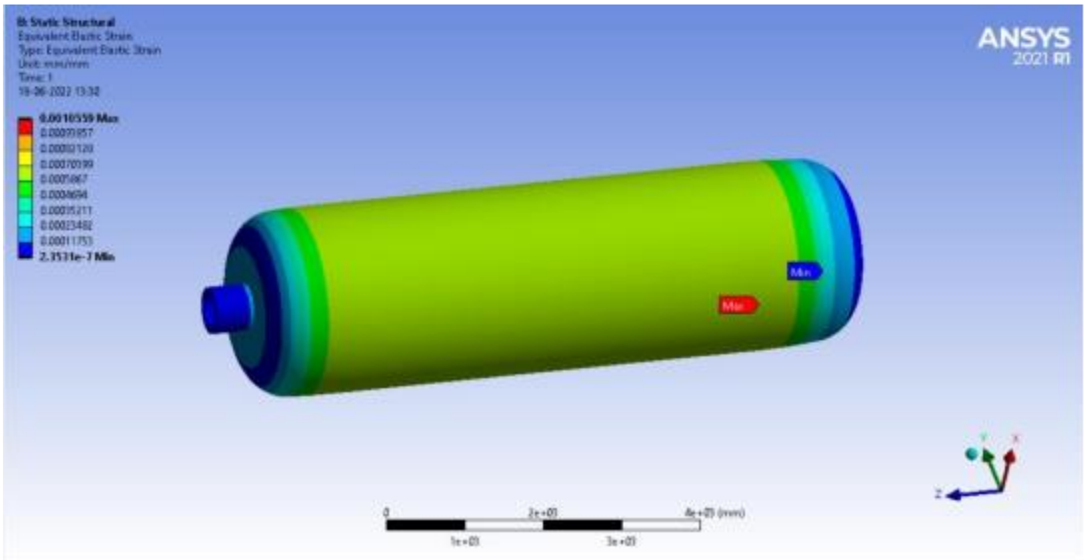


Fig:4.4.2: Structural analysis stress result for 50Mpa for titanium zirconium.

- Stress for titanium zirconium at 50Mpa is observed 254.82Mpa as maximum value andminimum value is 0.00780Mpa.

STRAIN

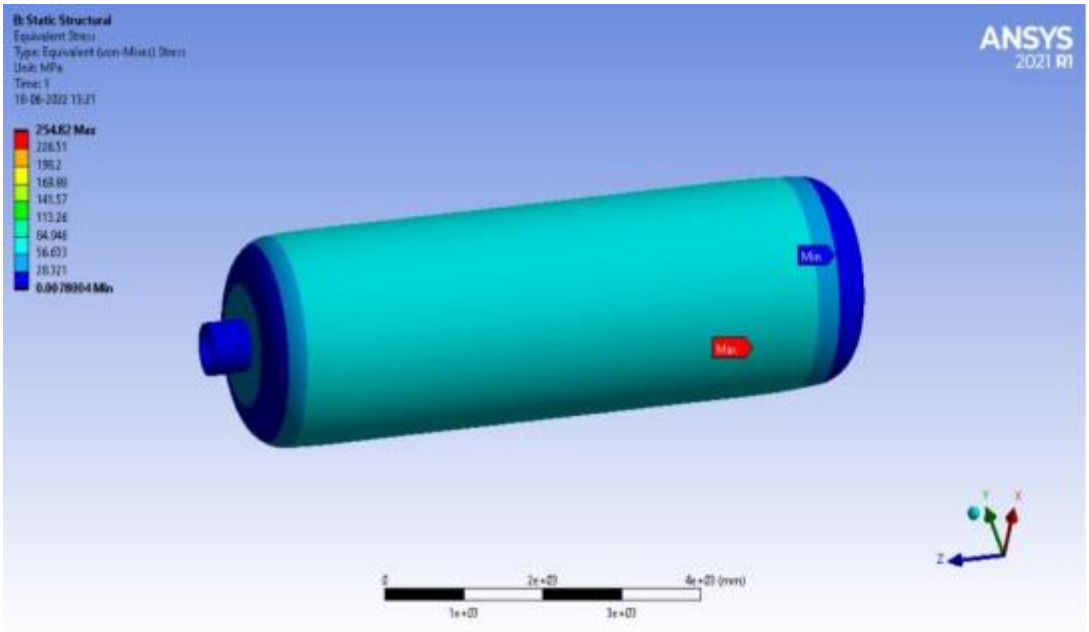


Fig:4.4.3: Structural analysis Strain result for 50Mpa for titanium zirconium.

- Strain for titanium zirconium at 50Mpa is observed as 0.0010559 maximum value andminimum value is 0.

SHEAR STRESS

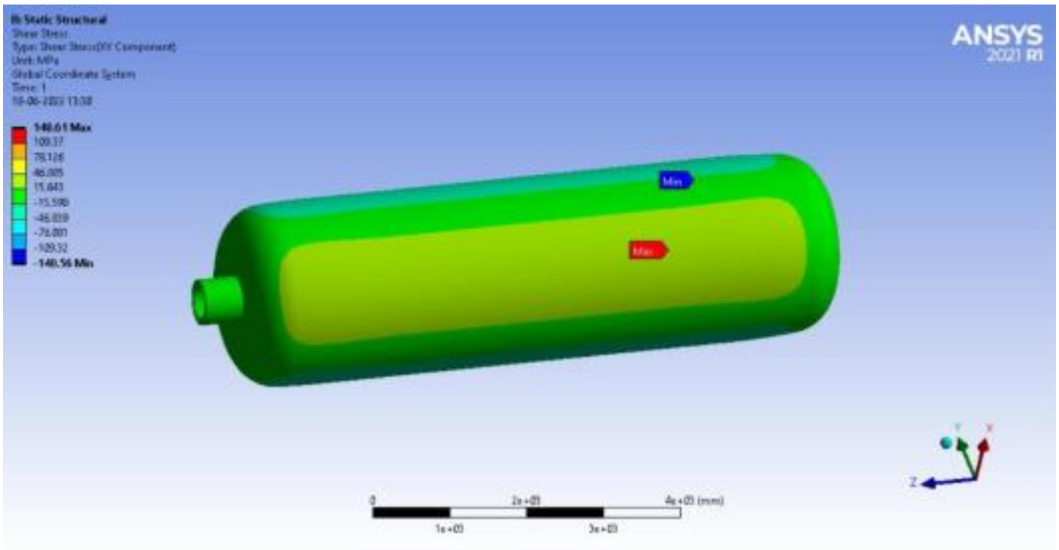


Fig:4.4.4: Structural analysis shear stress result for 50Mpa for titanium zirconium.

- Shear Stress for titanium zirconium at 50Mpa is observed as 140.65 Mpa maximumvalue.

FACTOR OF SAFETY

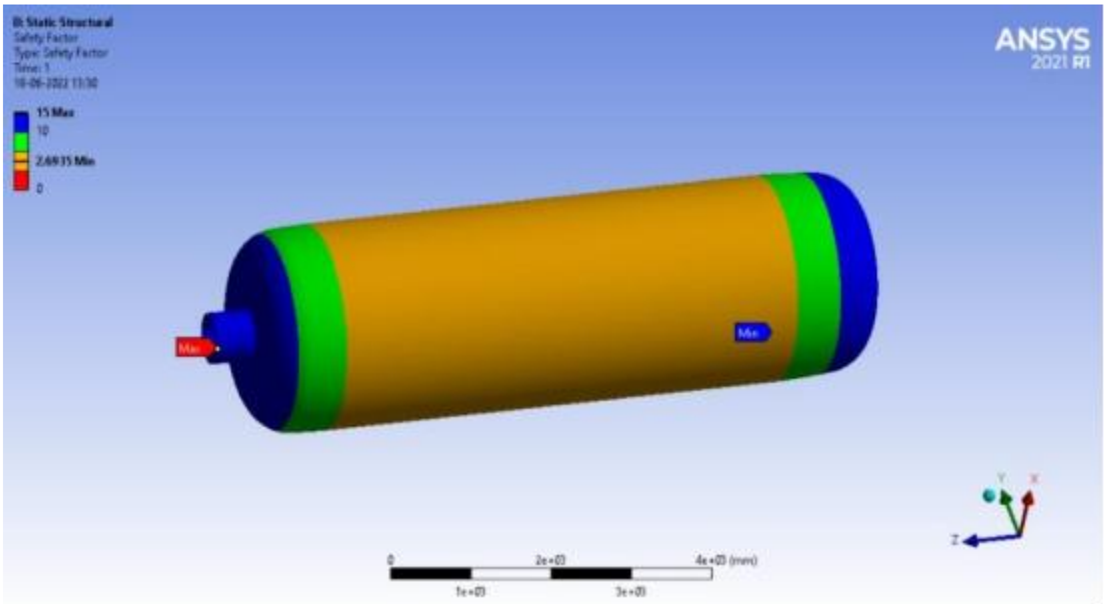


Fig:4.4.5: Structural analysis factor of safety result for 50Mpa for titanium zirconium.

- Factor of safety for titanium zirconium at 50Mpa is observed 15 as maximum value andminimum value is 2.6935.

STRUCTURAL ANALYSIS RESULTS FOR TITANIUM ZIRCONIUMAT 75 MPa.

DEFORMATION

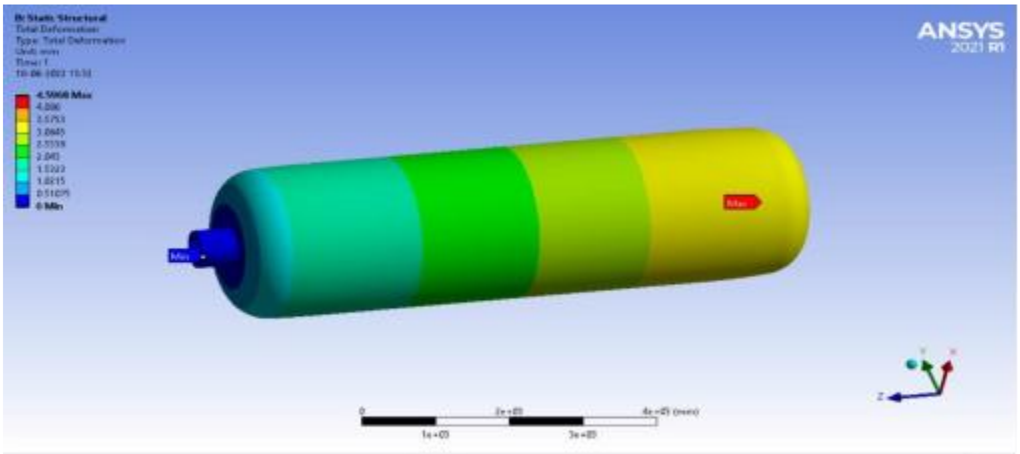
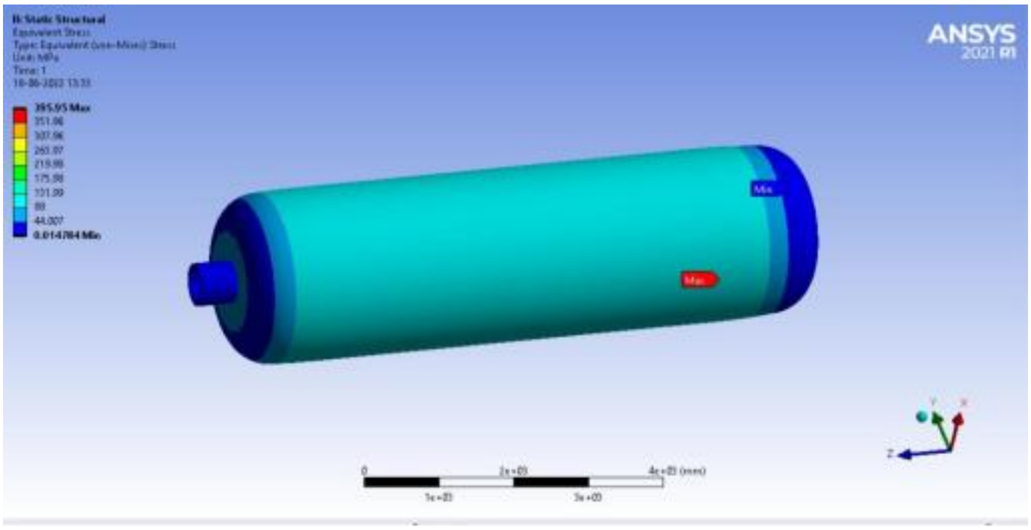


Fig:4.5.1: Structural analysis deformation result for 75Mpa for titanium zirconium

- Deformation for titanium zirconium at 75Mpa is observed 4.5968 as maximum valueand minimum value is 0.



STRESS

Fig:4.5.2: Structural analysis stress result for 75mpa for titanium zirconium

- Stress for titanium zirconium at 75Mpa is observed 263.97 MPa as maximum value andminimum value is 0.0147 MPa.

SHEAR STRESS

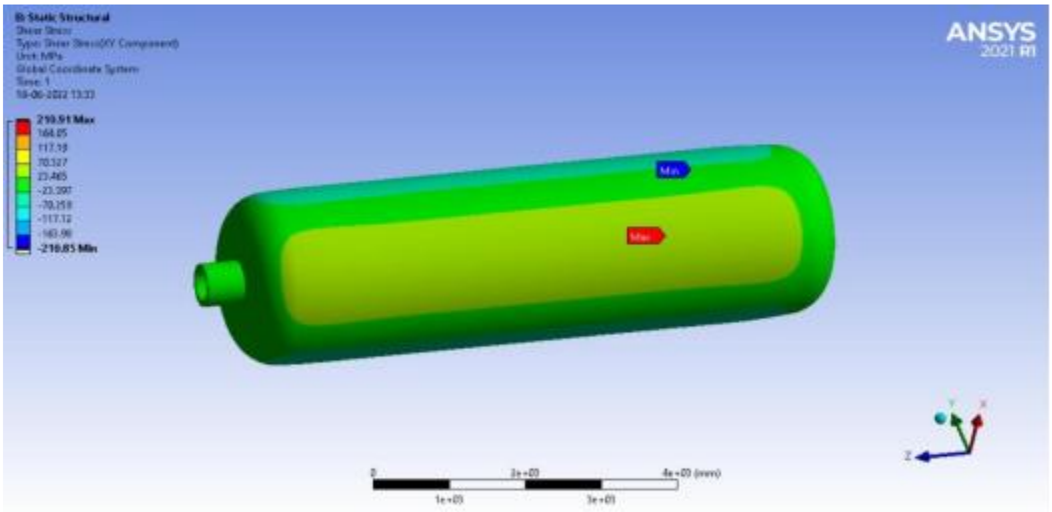


Fig:4.5.3: Structural analysis shear stress result for 75Mpa for titanium zirconium.

- Shear stress for titanium zirconium at 75Mpa is observed 210.91 MPa as maximumvalue.

STRAIN

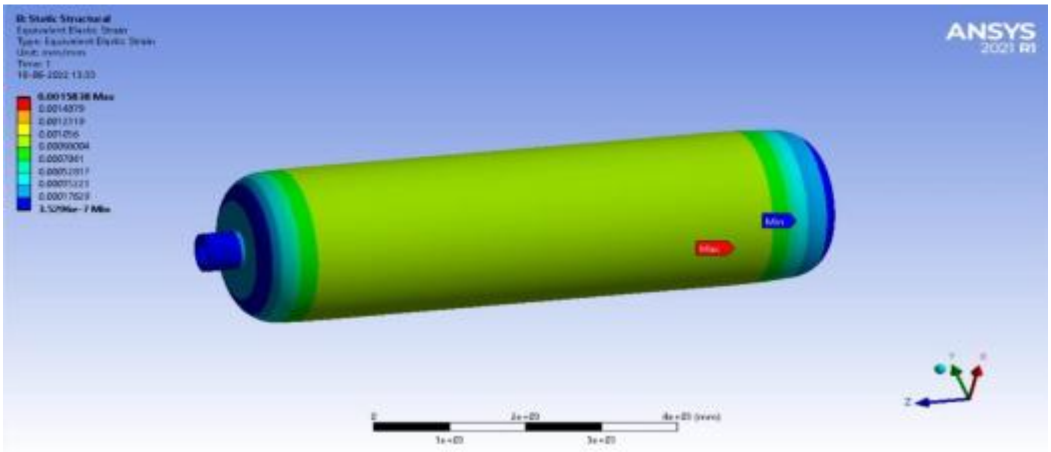
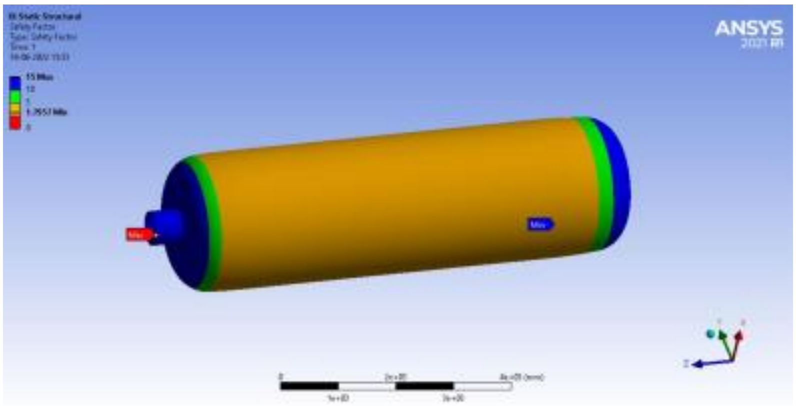


Fig:4.5.4: Structural analysis strain result for 75mpa for titanium zirconium.

- Strain for titanium zirconium at 75Mpa is observed 0.0015838 as maximum value andminimum value is 0.

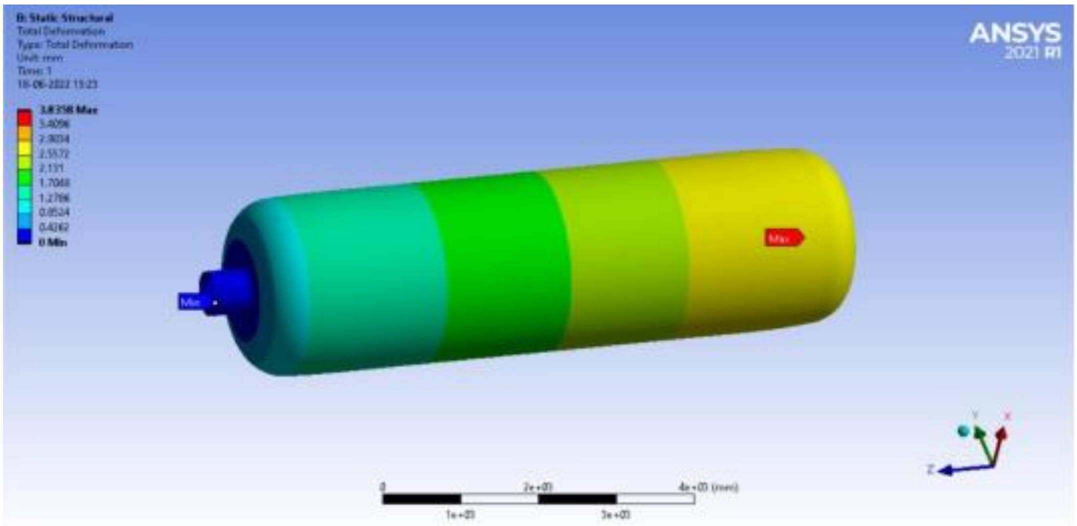
FACTOR OF SAFETY

Fig:4.5.5: Structural analysis factor of safety result for 75mpa for titanium zirconium.



- Factor of safety for titanium zirconium at 75Mpa is observed 1.7957 as maximum valueand minimum value is 0.

STRUCTURAL ANALYSIS RESULTS FOR ALUMINIUM CARBONANALYSIS AT 35 MPa



DEFORMATION

Fig:4.6.1: Structural analysis deformation result for 35Mpa for aluminium carbon fiber.

- Deformation for aluminium carbon fiber at 35Mpa is observed 3.8358 mm as maximumvalue and minimum value is 0.

STRESS

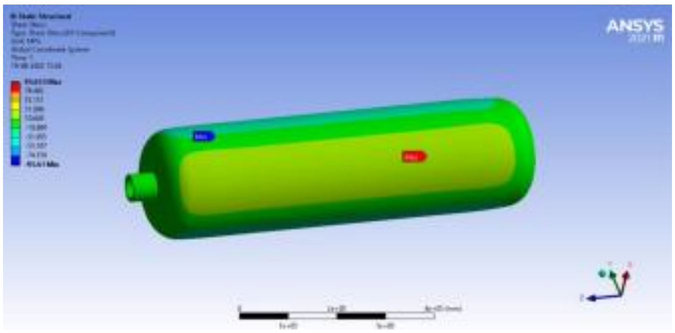


Fig:4.6.2: Structural analysis stress result for 35Mpa for aluminium carbon fiber.

- Stress for aluminium carbon fiber at 35Mpa is observed 178.38 MPa as maximumvalue.

SHEAR STRESS

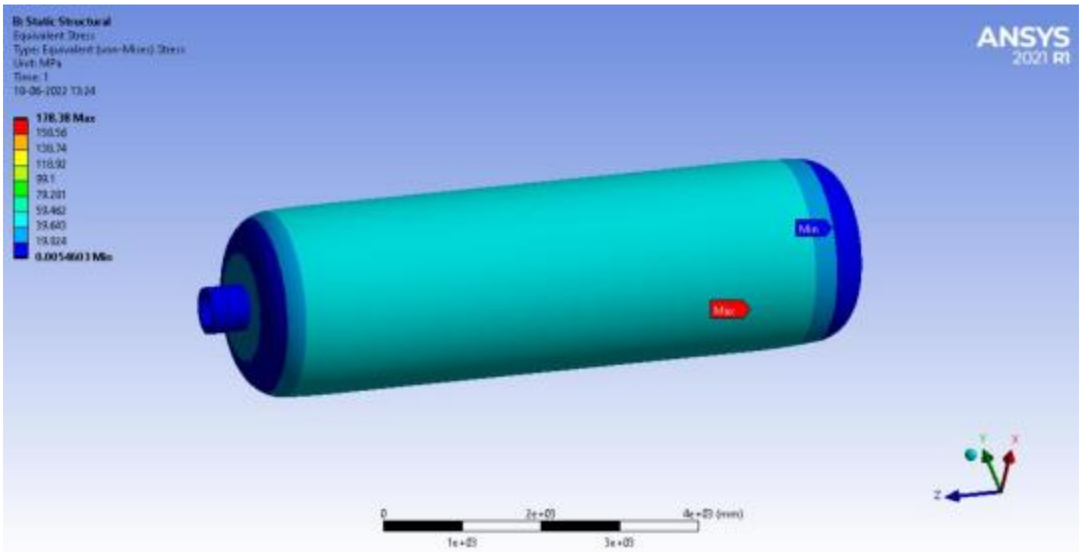
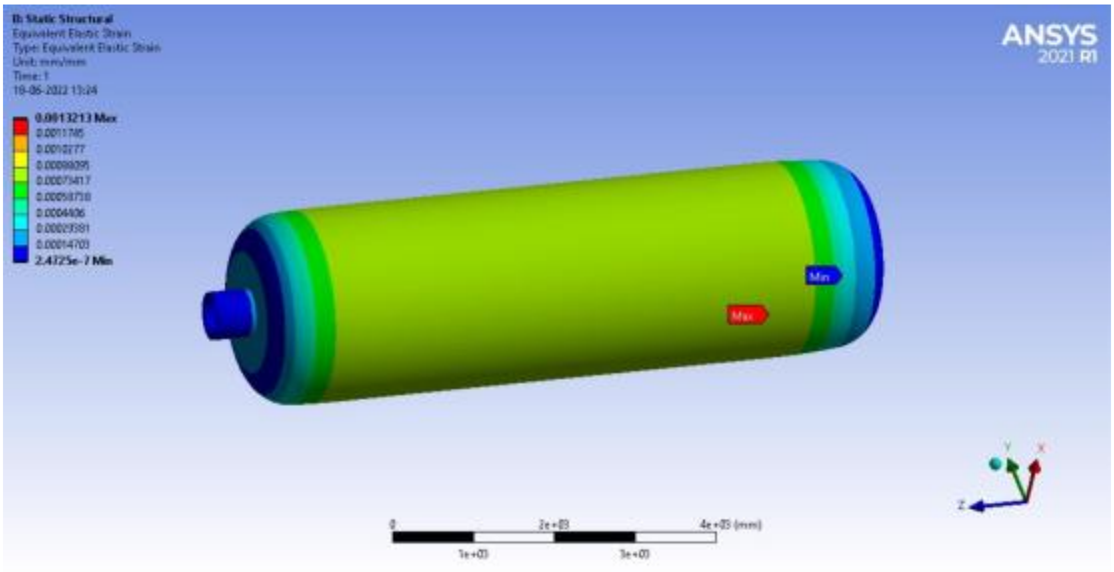


Fig:4.6.3: Structural analysis shear stress result for 35Mpa for aluminium carbon fiber.

- Stress for aluminium carbon fiber at 35Mpa is observed 178.38 MPa as maximumvalue.



STRAIN

Fig:4.6.4: Structural analysis strain result for 35Mpa for aluminium carbon fiber.

- Strain for aluminium carbon fiber at 35Mpa is observed 0.0013213 as maximum valueand minimum value is 0.

FACTOR OF SAFETY

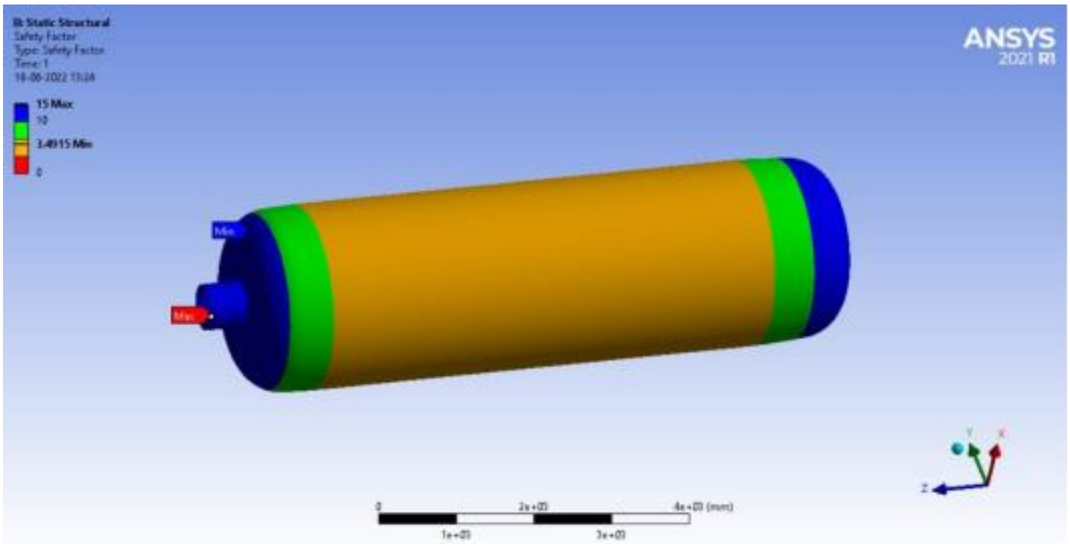


Fig:4.6.5: Structural analysis factor of safety result for 35Mpa for aluminium carbon fiber.

- Factor of Safety for aluminium carbon fiber at 35Mpa is observed as 15 maximumvalue and minimum value as 3.4915.

STRUCTURAL ANALYSIS RESULTS FOR ALUMINIUM AT 50MPa.

DEFORMATION

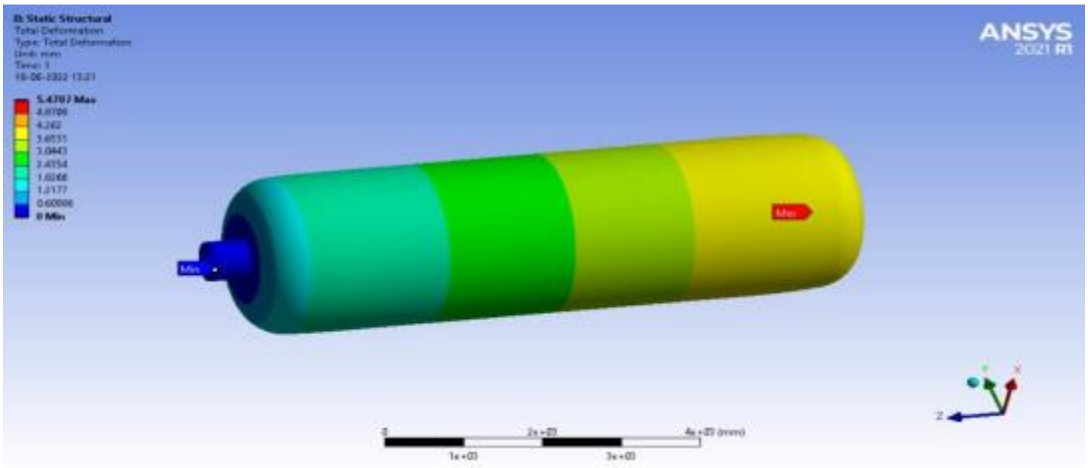


Fig:4.7.1: Structural analysis deformation result for 50Mpa for aluminium carbon fiber.

- Deformation for aluminium carbon fiber at 50Mpa is observed as 0.0013213 mmmaximum value and minimum value is 0.

STRESS

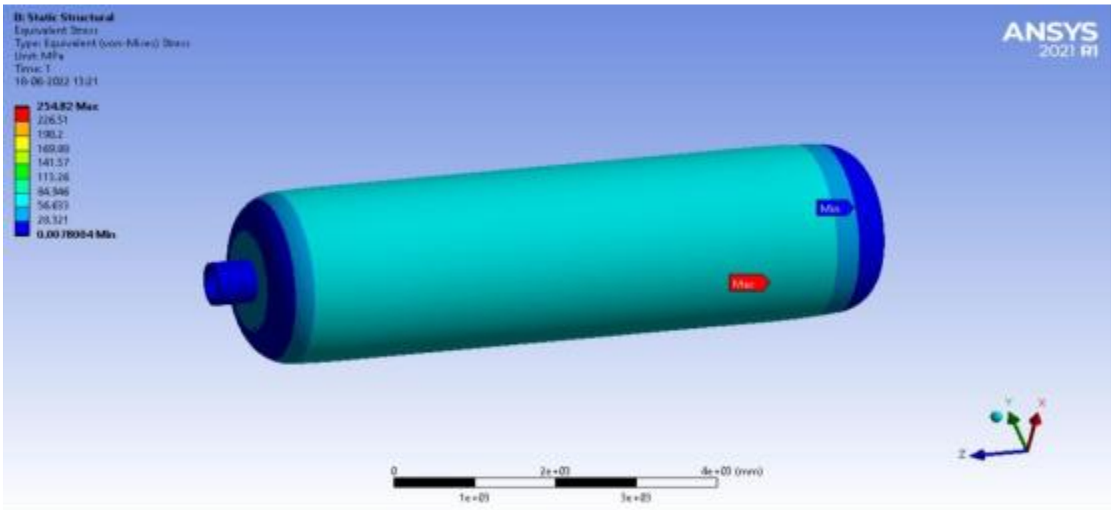


Fig:4.7.2: Structural analysis stress result for 50Mpa for aluminium carbon fiber.

- Stress for aluminium carbon fiber at 50Mpa is observed as 254.82 MPa maximumvalue.

STRAIN

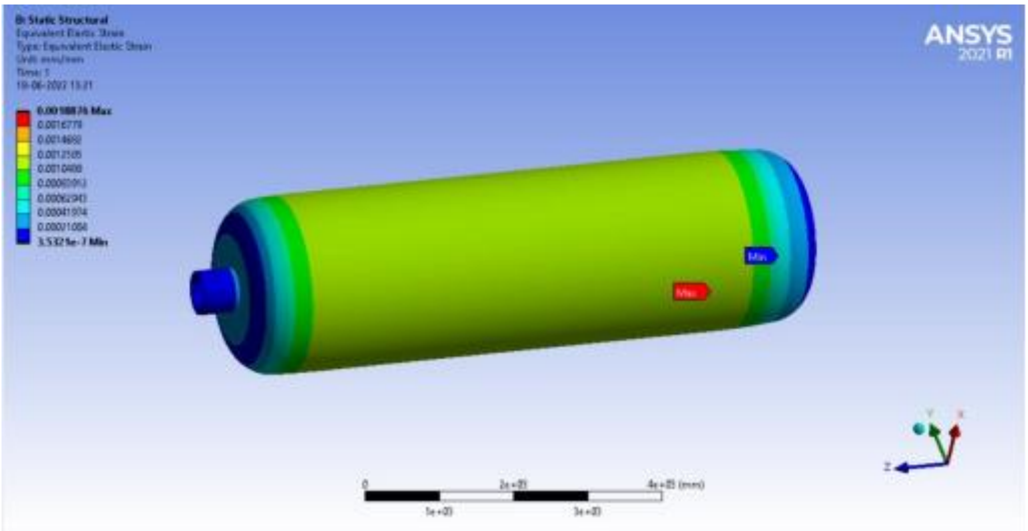


Fig:4.7.3: Structural analysis strain result for 50 MPa for aluminium carbon fiber.

- Strain for aluminium carbon fiber at 50Mpa is observed as 0.0018876 maximum valueand minimum value is 0.

SHEAR STRESS

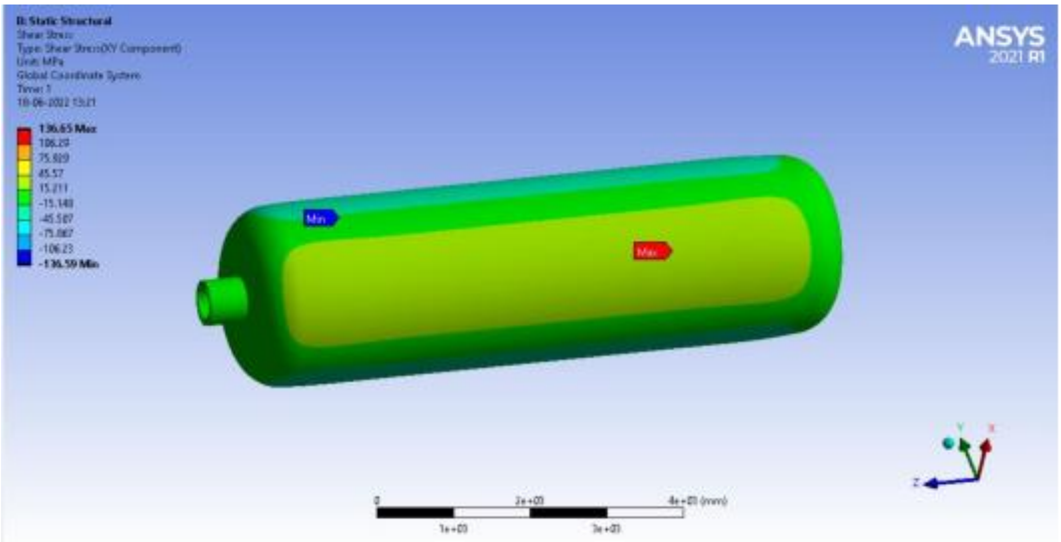
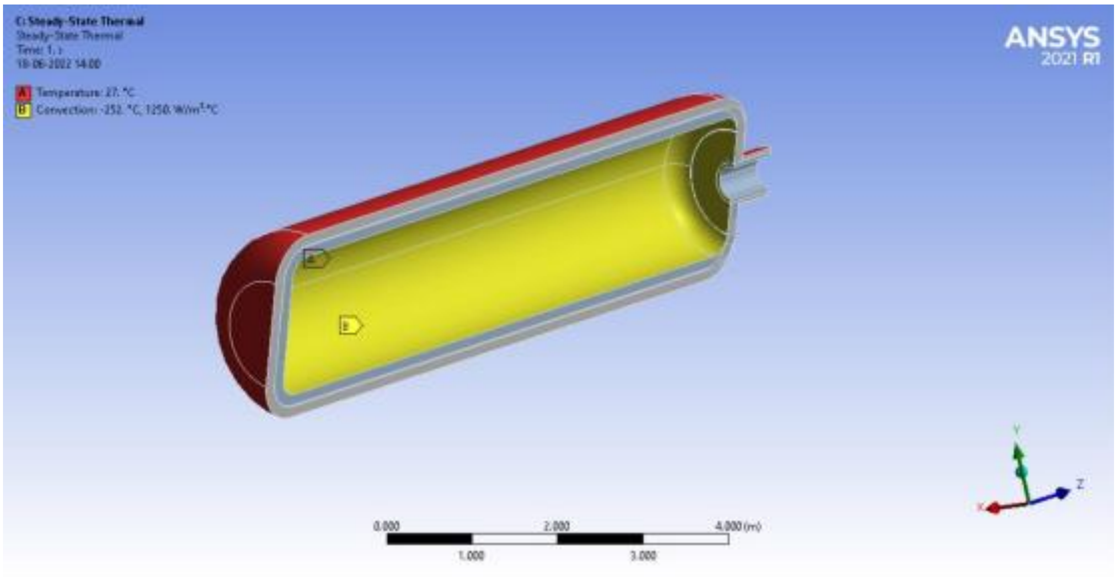


Fig:4.7.4: Structural analysis shear stress result for 50Mpa for aluminium carbon fiber.

- Shear stress for aluminium carbon fiber at 50Mpa is observed as 136.65 MPa maximumvalue.

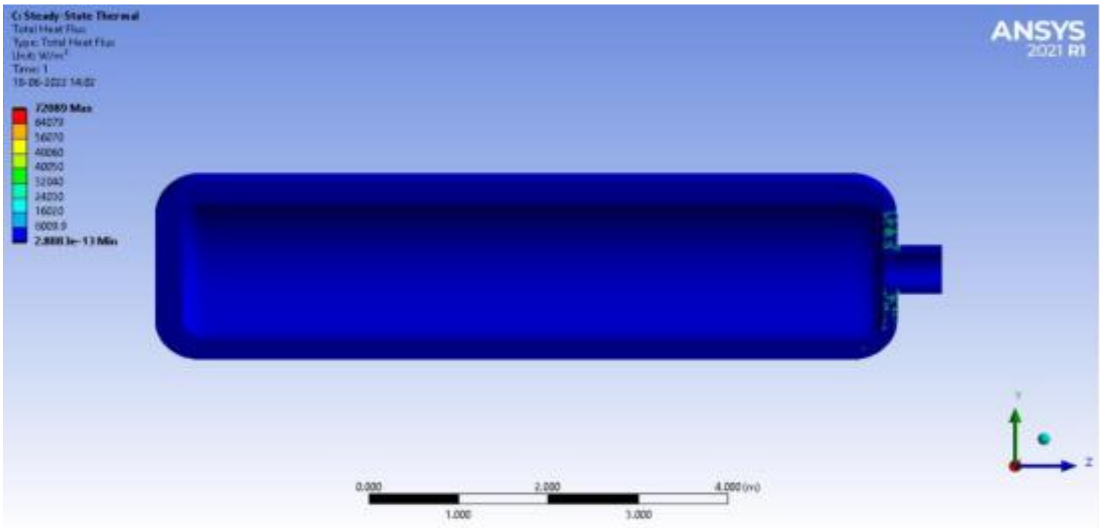
A Steady state thermal analysis calculates the effect of steady thermal load on a system or component, analyst were also doing the steady state analysis before performing the transient analysis. We can use this analysis to determine temperature, thermal gradient, heat flow rates and heat flux in an object that do not vary with time. A Steady state thermal analysis may be either linear with constant material properties or nonlinear with material properties that depend on temperature. The thermal properties of most material do vary with temperature, so analysis isusually nonlinear.



Fig;4.9.5: Applying boundary conditions for thermal analysisBoundary conditions

Inlet temperature = -250℃ Ambient temperature = 27℃

Materials = Titanium zirconium, Aluminium carbon Fiber



THERMAL ANALYSIS RESULTS FOR TITANIUM ZIRCONIUMHEAT FLUX

Fig:4.10.1: Heat flux analysis for titanium zirconium.

- Heat flux for titanium zirconium is observed as 72089 w/m2.

TEMPERATURE

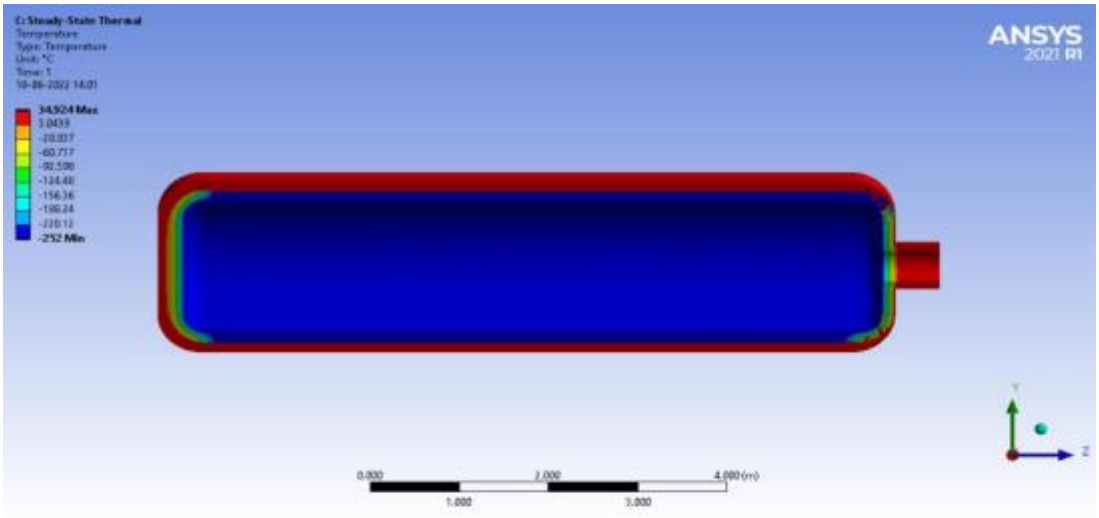


Fig:4.10.2: Temperature analysis for titanium zirconium.

- Temperature for titanium zirconium is observed as 34.924C.

THERMAL ANALYSIS RESULTS FOR ALUMINIUMCARBONFIBER

HEAT FLUX

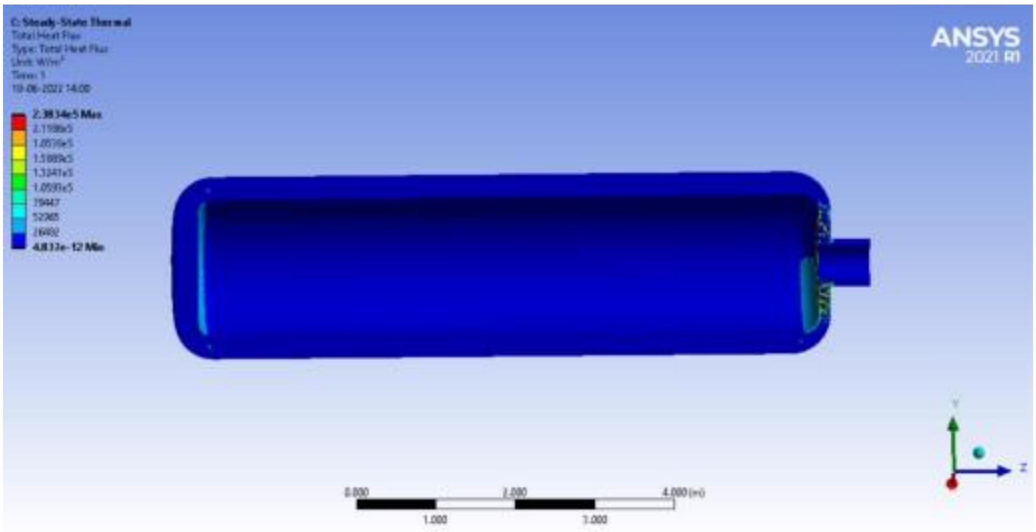


Fig:4.11.1: Heat flux analysis for aluminium carbon fiber.

- Heat flux for titanium zirconium is observed as 2.384e5 w/m2.

TEMPERATURE

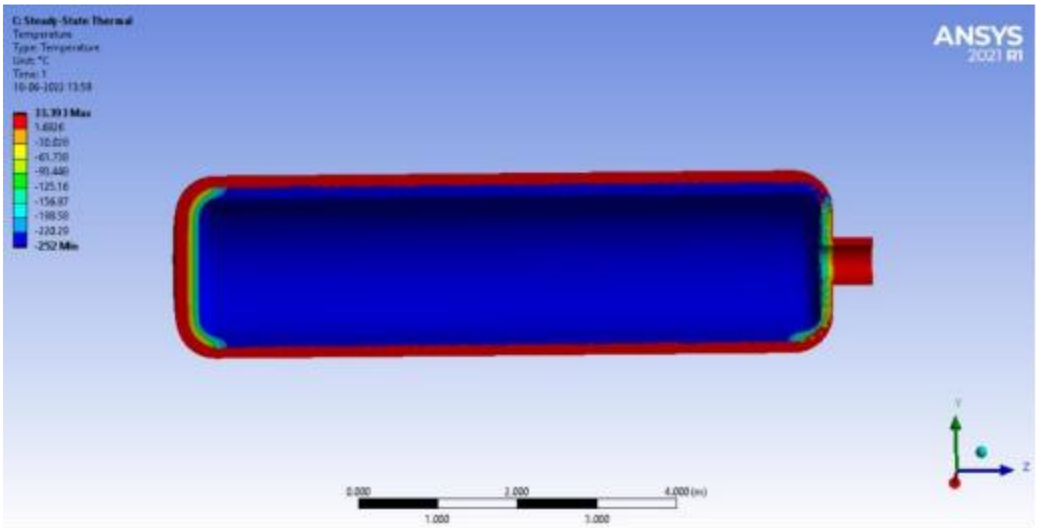


Fig:4.11.2: Temperature analysis for aluminium carbon fiber.

- Temperature for titanium zirconium is observed as 33.396C.

Results and Discussions

Static Structural Analysis Results

	STATIC STRUCTURAL ANALYSIS RESULT					
	PRESSURE	DEFORMATION (mm)	FACTOR OF SAFETY	SHEAR STRESS	STRAIN	STRESS (MPa)
ALUMINIUM CARBON FIBER	35MPa	3.8358	3.4915	95.653	0.0013213	178.38
	50 MPa	5.4797	2.4441	136.65	0.0018876	254.82
	75 MPa	8.2196	1.6294	204.97	0.0028314	382.23
TITANIUM ZIRCONIUM	35 MPa	2.1452	3.8479	98.426	0.0007391	184.78
	50 MPa	3.0645	2.6935	140.61	0.0010559	263.97
	75 MPa	4.5968	1.7957	210.91	0.0015838	395.95

TABLE 4: Static Structural Analysis Result

The Static Structural analysis had done the results are of as follows for the Titanium Zirconium the Maximum deformation is 8.2196 mm and for the Aluminium Carbon Fiber 4.5968 mm , the maximum factor of safety for the Titanium Zirconium is 3.84915 and for Aluminium Carbon fiber is 3.4915, the maximum Shear stress for Titanium zirconium is 210.91 MPa and for Aluminium Carbon Fiber is 204.97 MPa, the maximum Stain for Titanium Zirconium is 0.0015838 and for the Aluminium Carbon Fiber is 0.0028314. And the maximum Stress for Titanium Zirconium is 395.95 MPa and for the Aluminium Carbon Fiber is 382.23 MPa.

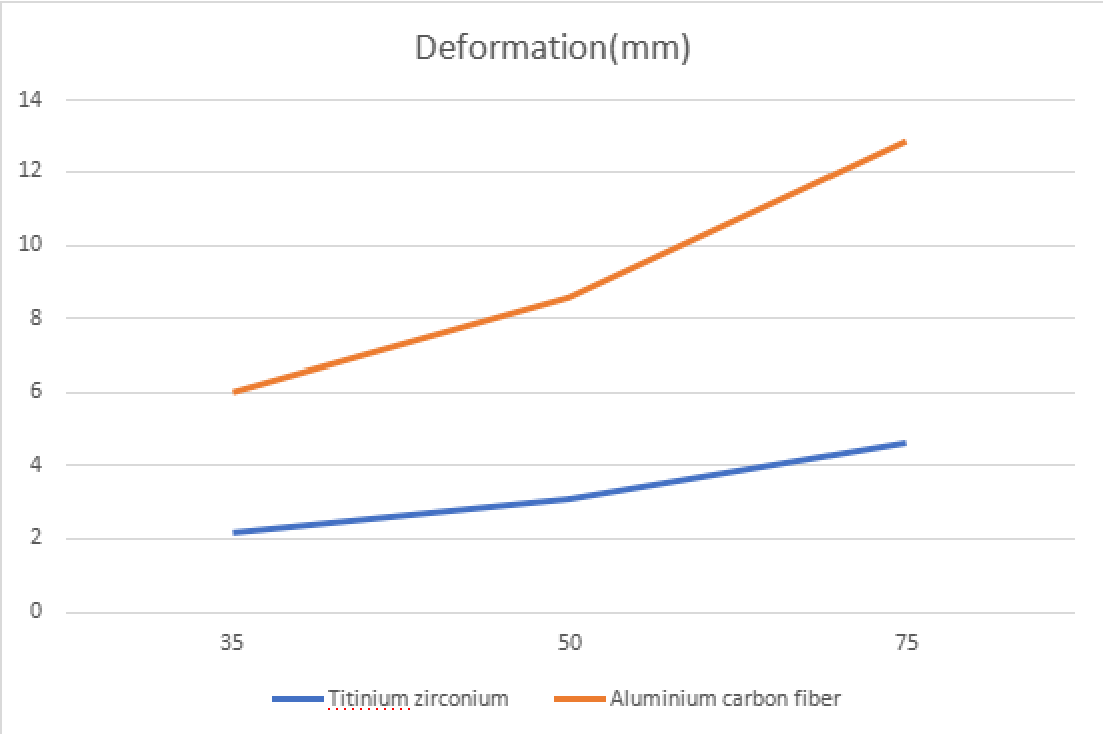
Thermal Analysis Results

THERMAL ANALYSIS RESULTS		
	TITANIUM ZIRCONIUM	ALUMINIUM
HEAT FLUX w/m2	72089	2.3834e5
TEMPERATURE	34.924	33.393

TABLE 5: Thermal Analysis Results

The Thermal Analysis had done the results are of as follows for the titanium zirconium as the Maximum Heat Flux is 72089 w/���^{2} and for the aluminium carbon fiber 2.3834e5 w/���^{2}. And the maximum Temperature for Titanium Zirconium as 34.924℃ and 33.393℃.

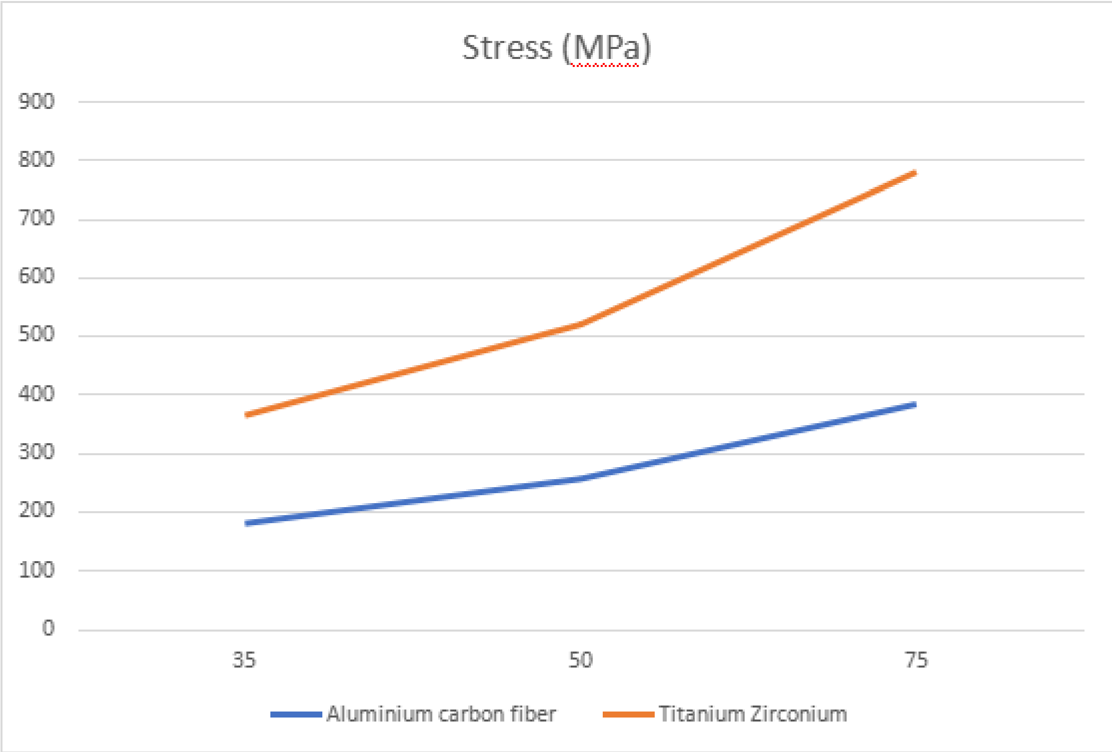
COMPARISON OF BOTH THE MATERIALS BY USING GRAPHS.DEFORMATION



Graph 1: Static analysis deformation results

From the above graph we can see the deformation of materials are varying with the pressure at 35MPa both material exhibits slightly same deformation as the pressure increases aluminium carbon fiber exhibits drastic change in deformation as compared to the titanium zirconium.

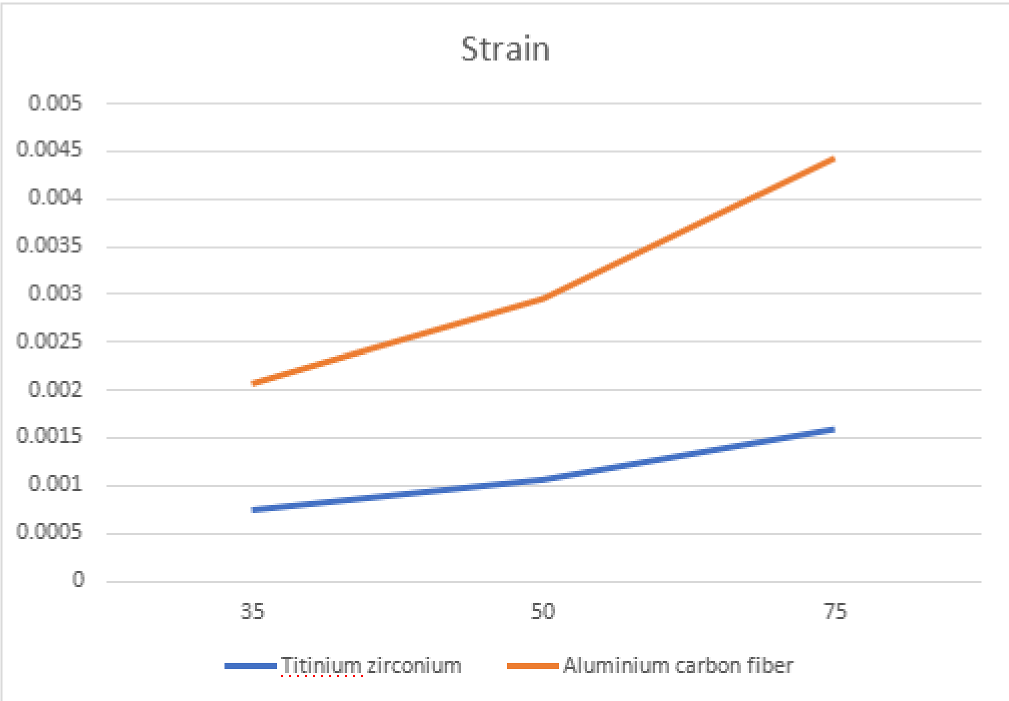
STRESS



Graph 2: Static Analysis For Stress Results

From the above graph we can see the Stress of material are varying with the pressure at 35MPa both material exhibits slightly same stress as the pressure increases aluminium carbon fiber exhibits drastic change in stress as compared to the titanium zirconium. Stress of the titanium zirconium is high when compared with aluminium carbon fiber.

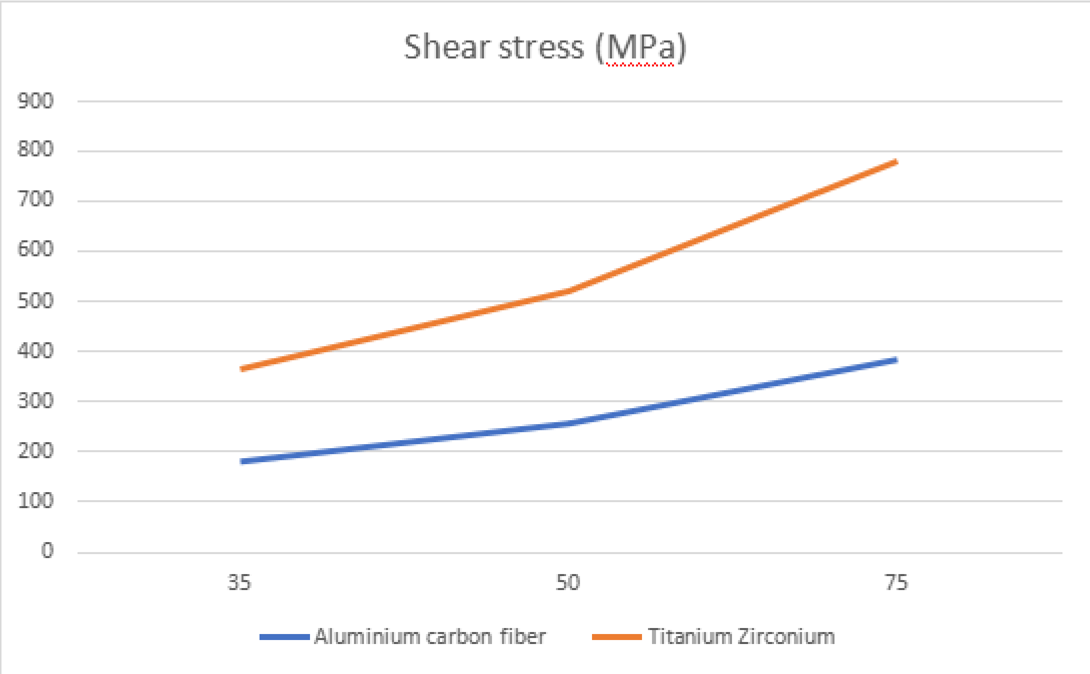
STRAIN



Graph 3: Static analysis strain results.

From the above graph we can see the strain of materials are varying with the pressure at 35MPa both material exhibits slightly same deformation as the pressure increases aluminium carbon fiber exhibits drastic change in deformation as compared to the titanium zirconium.

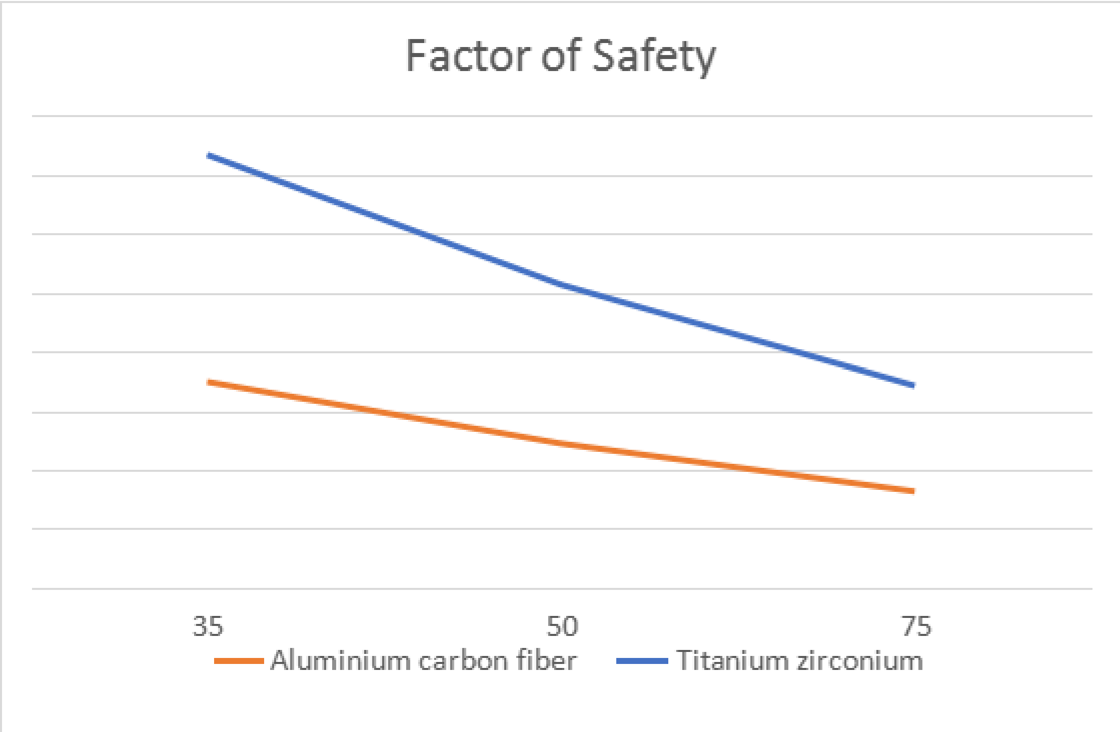
SHEAR STRESS



Graph 4: Static analysis shear stress results.

From the above graph we can see the Shear stress of materials are varying with the pressure both material exhibits slightly same shear stress as the pressure increases titanium zirconium exhibits high change in shear stress as compared to the aluminium carbon fiber.

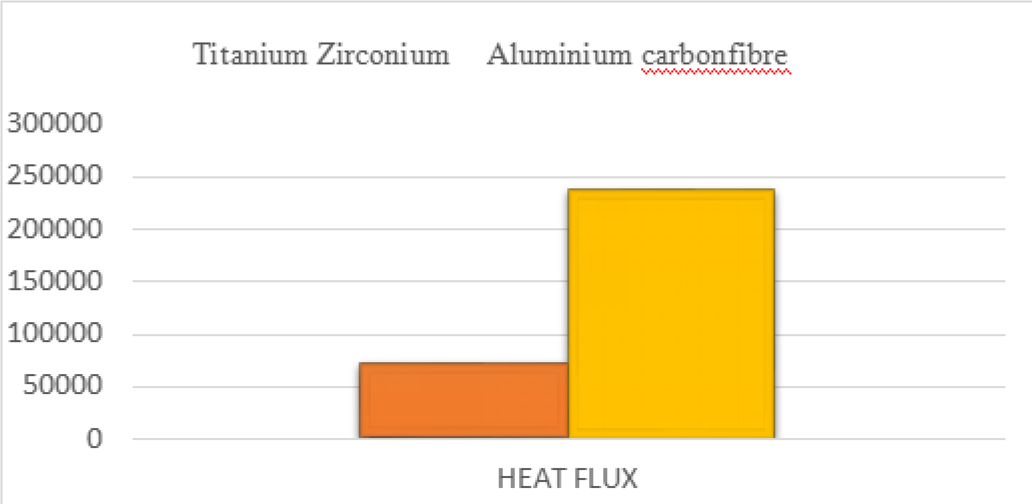
FACTOR OF SAFETY



Graph 5: Static analysis factor of safety results.

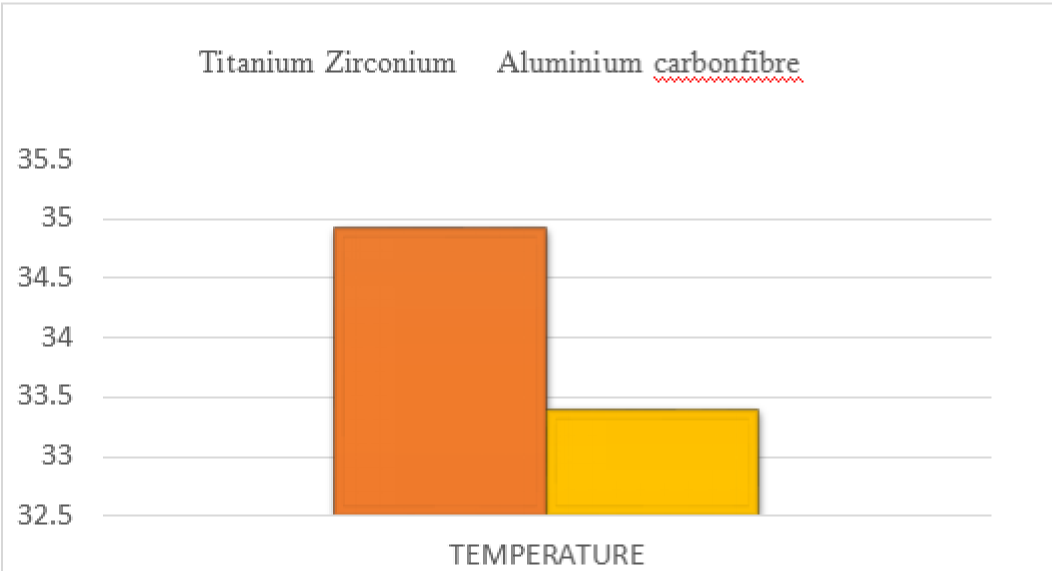
From the above graph we can see the Factor of Safety of materials are varying with the pressure at 35MPa both material exhibits slightly same deformation as the pressure increases aluminium carbon fiber exhibits drastic change in deformation as compared to the titanium zirconium.

GRAPHS



Graph 6: Heat flux analysis results

From the above graph we can see the Heat flux of titanium zirconium is highly less whencompared to aluminium carbon fiber.



Graph 7: Temperature analysis results

From the above graph we can see the titanium zirconium material conducts less heat transferwhen compared with the aluminium carbon fiber material.

CONCLUSION

In this project Hydrogen cylinder model developed with the help of Ansys workbench, analyzing with different materials, to suggest an optimum material for this liquid hydrogen cylinder. A hydrogen-storage material must be able to store hydrogen quickly under normal conditions that are without very high temperatures and pressures. Here two materials were chosen Titanium zirconium, Aluminum Carbon fiber, and analyzed with static structural and thermal boundary conditions.

The pressure vessel has been found to be a very complex structure whose behavior is influenced by a large number of phenomena zirconium are strong, durable and resistant to a variety of chemicals. Titanium, however, weighs a fraction of what steel weighs. To have the same strength with less weight, titanium seems like an ideal combination.

From static structural analysis results, by increasing pressure the deformation of Titanium zirconium is 4.59 mm is less when compared to aluminium zirconium deformation is 8.2 mm and factor of safety for the Titanium zirconium is 1.7957 and Aluminum Carbon fiber 1.6294.

By comparing the both the analysis Equivalent stress and shear stress increases with increase in pressures, for a given Titanium zirconium pressures combination exhibited higher equivalent stress and shear stress compared to Aluminum carbon fiber combinations.

Thermal analysis for the hydrogen storage tank Titanium zirconium exhibits the less Heat flux 72089 w/m2 than aluminium carbon fiber 2.3834e5 w/m2.

From the above results we can conclude that Titanium zirconium is best compare to aluminium carbon fiber.

FUTURE SCOPE

High storage capacity and safeties needs to be achieved; these parameters are strongly influenced by dynamic wall. In view of this, the temperature effect on performance and structural of the hydrogen fuel tank may be carried out. Further, thickness effect of combination of various materials may be studied by changing the volume fraction of carbon fiber and zirconium and its effect on performance may be evaluated.

Hydrogen transportation, distribution and storage remain the primary challenges for integrating hydrogen into the overall energy-economy system. On a mass basis, hydrogen has nearly three times the energy content of gasoline. While hydrogen has high energy density per unit mass, it has low volumetric energy density at room conditions (around 30% of methane at 15 °C, 1 bar) and an ability to permeate metal-based materials, which can present operational and safety constraints. This makes transporting hydrogen a challenge, because it requires high pressures, low temperatures, or chemical processes in order to be stored compactly.

References

1. Senthil kumar Bibin Chidambaranathan Ramachandran Manickam. Design and Analysis of Hydrogen Storage Tank with Different Materials by Ansys. Publishedunder licence by IOP Publishing Ltd. Citation S. Senthil Kumar *et al* 2020 *IOP Conf. Ser.: Mater. Sci. Eng.* 810 012016

2. Pawan N Naik , Dr. M K Venkatesh , Dr. R Keshavamurthy. Finite Element Analysis of Hydrogen Storage Composite Fuel Tank International Journal of Science and Research (IJSR) ISSN (Online): 2319-7064 Index Copernicus Value (2016): 79.57 | ImpactFactor (2017): 7.296

3. Juan pedro berro ramirez, damien halm, jean-claude grandidier, stéphane villalonga, fabien nony. Project: Durability of hydrogen pressure vessels of type IV. International Journal of Hydrogen Energy 40(38) , DOI:10.1016/j.ijhydene.2015.05.126 , July 2015

4. Rahul Krishna, Elby Titus, Maryam Salimian, Olena Okhay, Sivakumar Rajendran, Ananth Rajkumar, J. M. G. Sousa, A. L. C. Ferreira, João Campos Gil and Jose Gracio.Hydrogen Storage for Energy Application,

5. Karen Law, and Jayanti Sinha Nuclear Engineering Division, Argonne National Laboratory, Argonne, Illinois., Technical Assessment of Compressed Hydrogen StorageTank Systems for Automotive Applications. September 2010.

6. Shitanshu Sapre, Kapil Pareek, Mayank Vyas: Impact of refueling parameters on storage density of compressed hydrogen storage Tank1. Sept-2109.

7. Dong Ho Nguyen a, Ji Hoon Kim a,b, Thi To Nguyen Vo a, Namkeun Kim a, Ho SeonAhn a,c, Design of portable hydrogen tank using adsorption material as storage media: An alternative to Type IV compressed tank , March 2022Applied Energy 310(47):118552 , DOI:10.1016/j.apenergy.2022.118552.

8. Christopher Winnefeld, Thomas Kadyk ID , Boris Bensmann, Ulrike Krewer idand Richard Hanke-Rauschenbach : *Energies*, Volume 11, Issue 1 (January 2018) – 257 articles

9. Patrick Adam and Jacob Leachman., Design of a reconfigurable liquid hydrogen fuel tank for use in the Genii unmanned aerial vehicle.,AIP Conference Proceedings 1573, 1299 (2014); Published Online: 17 February 2015

10. Al-Nawas B., Bragger U., Meijer H.J., Naert I., Persson R., Perucchi A., Quirynen M., Raghoebar G.M., Reichert T.E., Romeo E., et al. A double-blind randomized controlled trial (RCT) of titanium-13zirconium versus titanium grade IV small-diameter bone level implants in edentulous mandibles. Results from a 1-year observation period. Clin. Implant. Dent. Relat. Res. 2011. [(accessed on 30 July 2012)].