IJARSCT
ISSN (Online) 2581-9429
International Journal of Advanced Research in Science, Communication and Technology (IJARSCT)
International Open-Access, Double-Blind, Peer-Reviewed, Refereed, Multidisciplinary Online Journal
Impact Factor: 7.53
Volume 4, Issue 5, April 2024

Design and Manufacturing of Super Insulation Wrapping Machine for Cryogenic Tank

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Abstract: *Super insulating wrapping machine is use for wrapping the cryogenic insulation around an inner tank disposal within an outer tank of a cryogenic tank system. Cryogenic tank systems have an inner vessel disposed within an outer vessel for creating a space there between such that a vacuum can be maintained between inner and outer tank for insulation purpose. Heat is transferred by conduction, convection, radiation. Because there is a vacuum, there is no media for conduction & convection of heat. Outer tank may be insulated in variety of conventional fashion; the inner tank is wrapped with cryogenic insulation. Also the radiation is reduced by keeping reflecting surface of aluminium towards outside of inner vessel. So the heat conduction is at minimum extent which helps in liquid nitrogen in inner vessel with minimum loss in storage. It is mostly used to store liquid nitrogen 02). The liquid us temperature of nitrogen is -320.8 OF. Cryogenic insulation is very specialized insulation which requires very special properties. As opposed to usual insulation, Cryogenic insulation must be capable of operating at very low temperature between about -130 OF to -4500F while retain in functionality, especially functionality at those temperature. In order to have consistency in wrapping of super insulation and to increase productivity the super insulation wrapping machine is design with variable tensioning arrangement the insulation wrapping is done with adequate tightness. The overlap of each turn off insulation is maintained such that there is no direct heat transmission by radiation*

Keywords: Cryogenic tank, Liquid Nitrogen ,Wrapping Machine

I. INTRODUCTION

With the design and manufacturing of the Super Insulation Wrapping Machine the super insulated vessels called Cryo - dewar / Cryogen are manufactured. Basically, used for storing the liquid nitrogen at cryogenic temperature.
Cryogen is used for preservation of semen for artificial insemination of cattle at ultra lowtemperature, storage of biological samples for medical research applications as well as low volume transportation of liquid nitrogen.
Government Animal Husbandry Departments and Live stock Development Boards of various states, Milk Producers Unions, National Dairy Development Board, Medical Research Institutes and Engineering Industry are some of the customers of Cryogen.Cryogenic insulation is used for wrapping the inner vessel of Cryogen. Cryogenic insulation is a specialized insulation which requires special properties. As opposed to usual insulation, cryogenic insulation must be capable of operating at low temperatures, i.e. cryogenic temperatures between about -130^0 F. and -450^0 F. .

II. METHODOLOGY

Designing and analyzing warring tank fins for a final year project involves a combination of engineering principles, materials science, and computational methods. Here's a step-by-step methodology to guide you through the process:

1. **Conceptual Design:**
   - Sketching: Create initial sketches or CAD models of the fins based on the project objectives and literature review.
   - Parameters: Define key design parameters like fin shape, size, angle of attack, and attachment mechanism.

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2. Material Selection:

- Material Properties: Choose materials based on their mechanical properties, corrosion resistance, and cost.
- Manufacturing Process: Decide on the manufacturing method (e.g., machining, molding, 3D printing) based on the selected materials.

3. Finite Element Analysis (FEA):

- Modelling: Create a 3D model of the fin using CAD software.
- Analysis: Perform structural analysis using FEA to evaluate stress distribution, deformation, and factor of safety.
- Optimization: Modify the design based on FEA results to improve performance and reliability.

4. Prototype Development:

- Manufacturing: Fabricate a prototype of the fin using the selected materials and manufacturing process.
- Testing: Conduct initial tests to validate the design and performance of the prototype.

5. Performance Testing:

- Static Tests: Measure mechanical properties like strength, stiffness, and deflection under static loads.
- Dynamic Tests: Conduct dynamic tests to evaluate the fin's performance under operational conditions (e.g., vibration, water resistance).

6. Data Analysis and Interpretation:

- Results: Analyse the test data to assess the fin's performance and identify any design flaws or areas for improvement.
- Comparison: Compare the prototype's performance with the project objectives and industry standards.

7. Optimization and Refinement:

- Redesign: Make necessary modifications to the design based on test results and analysis.
- Validation: Validate the refined design through additional testing or simulations.

8. Documentation and Presentation:

- Report Writing: Document the entire design and analysis process, including methodologies, results, and conclusions.
- Presentation: Prepare a comprehensive presentation summarizing the project, design process, findings, and recommendations.

10. Feedback and Review:

- Peer Review: Seek feedback from peers, advisors, or industry experts to validate the project's credibility and effectiveness.
- Reflection: Reflect on the project's successes, challenges, and lessons learned for future improvements.

III. WORKING OF THE MACHINE

One of the most common methods in the prior art for wrapping the inner tank Involves the inner tank about its longitudinal axis While wrapping the tank With the paper wound from a roll and With metal foil unwound from a roll . This is generally achived by means of a pivot arm rotated about a central axis with a roll of the paper on each extremity of the pivot an and a roll of the foil near each roll of paper. The pivot arm is rotated in a plane generally parallel to the longitudinal axis of the inner tank, while the inner tank is being rotated about that longitudinal axis.

By this arrangement, a wrap of paper is placed on the tank and a wrap of foil Is placed on the wrap Of paper to form one layer Of a multi-layered insulation, since there is a roll of paper and a roll of foil at each extremity of the pivoted

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arm, two combination of foil and paper are simultaneously wrapped onto the rotating inner tank. The common prior art method may be referred to as the orbital method.

If the foil is substantially centered on the paper so that those edge portions of the paper are town and maintained, then the wrapping speed can be increased by rotation of the pivot arm and inner tank to a speed consistent with the accuracy of the particular wrapping machine.

Fig.1 working of machine

Standard Components:

- Electrical Motor
- Cross- Slide
- Compound Table
- Gear Box
- Chain
- Bearing
- Timing Belt
- Timing Pulley
- Sprocket
- Oldham Coupling

Properties of Cryo -Dewar:

- Light aluminium vacuum insulated container.
- Strengthened neck.
- Super insulation material in vacuum space.
- Economical storage.
- Very low evaporation rate (0.2%).

IV. RESULT

Fig.2 Wrapping Tank

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ADVANTAGES

1. 1.Thermal Insulation: The primary benefit of wrapping is thermal insulation, which helps maintain the temperature of the nitrogen inside the tank. This insulation prevents heat transfer from the surrounding environment, ensuring that the nitrogen remains at the desired low temperature.
2. Energy Efficiency: By reducing heat transfer, insulation helps minimize energy consumption required to keep the nitrogen at the desired temperature. This can lead to cost savings in energy bills over the long term.
3. Prevention of Frost Formation: Insulation helps prevent frost formation on the exterior surface of the tank, which can occur when the tank is exposed to ambient air temperatures significantly higher than the boiling point of nitrogen.
4. Reduced Risk of Thermal Stress: Insulation can help reduce thermal stress on the tank structure, which can occur due to rapid temperature changes. This helps prolong the lifespan of the tank and reduces the risk of structural damage.
5. Safety: Proper insulation reduces the risk of accidental contact with the cold surface of the tank, which can cause injury. It also helps maintain a safe working environment by preventing temperature fluctuations that could affect the integrity of the nitrogen storage system.

V. COCLUSION

Cryo-Dewar or Insulated pressure vessels arc being developed as an alternative technology for of liquid Nitrogen. This flexibility results in advantages compared to conventional Nitrogen storage technologies. Insulated pressure vessels are lighter and compact. For reduced cost and complexity it is desirable to use commercially available aluminum – fiber pressure vessels for insulated pressure vessels. The Cryo-Dewar reduces heat transfer by minimizing conduction of heat (the vacuum space and the FRP material are poor conduction of heat), by minimizing radiation (the inner vessels of cryo- Dewar are wrapped with aluminum foil) and minimizing convection (the vacuum space has very little gas to allow heat convection).

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