Design and Validation of Storage Tank

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Abstract— This paper describes the literature review of a DESIGN AND VALIDATION OF STORAGE TANK. Concept of 10 kl glucose storage tank is ready in AUTOCAD. Using the analytical method as per ASME code we are require FEA validation for production of tank. Main purpose of this analysis is to validate the tank structure for its strength, optimized sections, life and process flow for operating condition as well as test condition. The main objective of this paper is to design and analysis of multilayer high pressure tank features of multilayered high pressure tank. Various parameters of Solid process tank are designed and checked according to the principles specified in American Society of Mechanical Engineers (A.S.M.E). The stresses developed in Solid Multilayer storage tank is analyzed by using ANSYS, a versatile Finite Element Package.

Key words: CREO Perametric, ANSYS, Pressure Vessel

I. Introduction

There are several types of storage tanks, e.g., above-ground, flat-bottomed, cylindrical tanks for the storage of refrigerated liquefied gases, petroleum, etc., steel or concrete silos for the storage of coke, coal, grains, etc., steel, aluminum, concrete or FRP tanks including elevated tanks for the storage of water, spherical tanks (pressure vessels) for the storage of high pressure liquefied gases and underground tanks for the storage of water and oil. The trend in recent years is for larger tanks, and as such the seismic design for these larger storage tanks has become more main in terms of safety and the environmental impact on society as a whole.

A. Types of Storage Tank

- Atmospheric Tank
- High pressure
- Thermal storage tanks
- Milk tank
- Septic tank
- Mobile "storage" tanks. Etc.

This project is to investigate the problems associated with Process/storage tanks in industrial areas, with the aim of understand series of practical tips that will help with tank construction in the field. The aim is to overcome the problems that are particular to constructing Process/Storage tanks in cool/hot dry climates.

II. Objective

Main objective of this research was to develop a Finite Element Model (FEM) of the tank which is double walled structure made of SS304 material by using ANSYS software. The current phase of times is experiencing problems in Storage tank design in industrial areas. Here a small move towards designing Storage tank/Processing tank for focused by analysis. This research consists of analysis of Storage tank by considering stresses induced in all the parts of different standards .Familiarity with relevant industry codes and standards such as API, ASME, ANSI, NACE, BS and ISO standards.

A. Main Structure:

The tank is double walled structure made of SS304 material. Inner assembly consists of three major parts:

- Inner tank shell
- Inner tank top cone
- Inner tank bottom cone

Cladding assembly includes the following parts:

- Cladding shell
- Cladding top cone
- Cladding bottom cone

One central agitator mounted at the top of the tank structure and directly connected to the "Bevel gearbox". Gearbox is connected to the "Electric motor". "Agitator blades" are connected to the Gearbox by "Agitator shaft".

Glucose syrup is food syrup, made from the hydrolysis of starch. Maize (corn) is commonly used as the source of the starch in the US, in which case the syrup is called "corn syrup", but glucose syrup is also made from other starch crops, including potatoes, wheat, barley, rice and cassava. In the world of industrial processing specifically in the food and pharmaceutical fields glucose is a highly versatile and key ingredient. It is a compound that can take many forms and successfully fill many roles for the manufacturer.

B. Mechanical Properties of SS304

Property	**Value in SI UNIT**
Tensile Strength, Ultimate	505MPa
Modulus of Elasticity	193-200MPa
Shear Modulus	86GPa
Thermal Conductivity	16.2 W/m-K
Coefficient of Thermal Expansion, linear 250°C	17.8 µm/m-°C
Specific Heat Capacity	0.5 J/g-°C
Tensile Strength, Yield	215 MPa
Density	8 g/cc Or 0.284 lb/inc^3

Table 1: Mechanical Properties of SS304

III. Literature Review

I found that very few researches has been done on industrial Storage tank and among these papers I describe overview of some selected research papers.

A. Muhammad Amin et all [2]

have concluded for multilayer pressure vessels, they have to develop contact pairs between the successive layers so that load can be transferred accurately from inner shell to the band layers. Numerical analysis carried out using ANSYS software produces approximate results which are not the exact solutions as in case of analytical methods which give exact values. The area/surface contacts show a highly nonlinear behavior which is a major cause of result variations. In analytical formulation it was assumed that there should be no stress concentration but in case of FEA of the model using ANSYS software, they had merged key points and nodes of ribbon and inner shell with heads, to define welding which causes stress concentration at the weld areas.

B. Anumod A.S. et all[3] are Analyze Steel Storage Tank Under Siesmic Load using FEA.

In this paper, FEM is used to investigate the effect of bidirectional excitation on cylindrical tanks. First, the accuracy of the FEM strategy was validated. Then tanks were modeled and analyzed. The accuracy of FEM was also checked. Finally a simplified method was developed for an accurate, simple and faster way for the design of steel storage tanks under seismic load The main conclusions of this study may be summarized as follow: From the analysis of tanks with change in height only, it was observed that the sloshing wave height was increasing as the height increasing. But when reaching a maximum value the sloshing wave height got decreasing. From this it's concluded that there exists an optimum height to steel storage tanks. Using this procedure optimum height can be easily found out. From the analysis of tanks with change is diameter, it was observed that initially the sloshing wave height decreasing with the increasing diameter. When reaching a minimum value of sloshing wave height, then sloshing wave height increases with increase in diameter.

C. Manish M. Utagikar et all[4] are present the work carried out for determination of stresses in an open ended pressure vessel of elliptical shape.

In some situations, due to the limited space available, exit pipes are made of elliptical or round shape. In this study, the stresses in the elliptical pressure vessel are determined using finite element method. The material of the vessel is aluminum alloy. Internal pressure is applied to the vessel. Software „ANSYS‟ is used for modeling & analysis purpose. Considering the symmetry about both axes, only quarter model is prepared. PLANE82 elements are used for the analysis. Firstly analysis of circular pressure vessel is done. The results of the circular vessel are validated by analytical solution. Then using the same type of element & mesh density, analysis of elliptical pressure vessel is done. During the study, different parameters were varied & their effect on the stresses was observed.

D. Adithya M et all[5],

They conclude that the approach corresponds to design by rule and finite element analysis corresponds to design by analysis method are adopted and calculations were made according to ASME standards. This shows clearly that the design by analysis is most desirable method to evaluate and predict the behavior of different configurations of pressure vessel supported on saddle with/without stiffener rings. However in the initial stage the empirical formulae are very much required to decide design variables and limiting values. After analyzing the stress behavior of the pressure vessel with different configurations of saddle supports with/without stiffening, the location of saddle at distance which is less than the one fourth of the vessel length with adjacent stiffener rings is the most effective one. For this configuration the optimization of thickness is done. The weight of the vessel is reduced considerably by keeping the volume of the vessel constant. 22% weight reduction is achieved for the shell alone. This also shows that addition of stiffener rings helps to reduce the thickness of the shell which in turn helps in saving lot of material and cost associated with it.

E. Siva Krishna Raparla et all[8] are worked on Design and Analysis of Multilayer High Pressure Vessel

The following conclusions are drawn from their work.1) There is a percentage saving in material of 26.02% by using multilayered vessels in the place of solid walled vessel. This decreases not only the overall weight of the component but also the cost of the material required to manufacture the pressure vessel. This is one of the main aspects of designer to keep the weight and cost as low as possible. 2) The stress variation from inner side to outer side of the multilayered pressure vessel is around 12.5%, where as to that of solid wall vessel is 17.35%. This means that the stress distribution is uniform when compared to that of solid wall vessel. Minimization of stress concentration is another most important aspect of the designer. It also shows that the material is utilized most effectively in the fabrication of shell. 3) Theoretical calculated values by using different formulas are very close to that of the values obtained from ANSYS analysis. This indicates that ANSYS analysis is suitable for multilayer pressure vessels. 4) Owing to the advantages of the multi layered pressure vessels over the conventional mono block pressure vessels, it is concluded that multi layered pressure vessels are superior for high pressures and high temperature operating conditions.

IV. CONCLUSION

From literature study and analysis of existing (Analytical) design result shall be come in terms of Maximum principle stresses, allowable stresses, Factor of safety, Load condition & boundary condition And total deformation. If FOS is less than 1, design is unsafe so modification is required. If FOS is greater than 2, tank structure is over designed so optimization (weight reduction) is required. Also As the thickness of vessel goes on increasing, stresses go on reducing.

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