International Research Journal of Engineering and Technology (IRJET) e-ISSN: 2395-0056
Volume: 07 Issue: 05 | May 2020 www.irjet.net p-ISSN: 2395-0072

Design and Fabricated Structure for Storage Tank to Reduce the Stresses Acting on it Thereby Increasing its Lifecycle

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Abstract - *We observed that when some material was stored in the storage tank then after some days there was a change in the shape of the tank due to the radial stress acting on it.*

So this project deals with this issue by designing and fabricating the structure on the periphery of the tank with the help of Clamp, Beam, and Columns. With the help of this structure the radial stress will reduce on the tank and it will also increase the life cycle of the tank.

***Key Words*: Tank, HDPE, Beam, Column, Clamp.**

1. INTRODUCTION

Storage tanks are container that hold liquid, compressed gases or mediums used for the short or long term storage of heat or cold. Storage Tank are most commonly used in every field weather it is household or industries. The use of storage tank is very beneficial to for everyone for storing goods and material. Industries mainly used the storage tank to store the heavy material or chemical. Mostly Industries use MS material storage tank which is highly costly as compared to other storage tank like HDPE. HDPE is the type of storage tank which is low in cost and are suitable for highly reacted chemical for storing as they are less reactive.

The tank gets expand in its size as the material is heavy or due to the stress acting on the tank. So to overcome this problem we are designing and fabricating the structure on the periphery of the storage tank. We are clamping the tank with the help of MS material and placing it with the help of support structure of I-Beam. The clamp and I-beam are connected through the channel C. This will reduce the stresses acting on the tank which will definitely increase its lifecycle.

The designed structure is very beneficial for the tank and can store any type of material without the expansion of the tank. The use of HDPE is very beneficial to the industries due to its low cost compared to MS tank.

2. OBJECTIVE AND SCOPE

2.1 OBJECTIVE

Our main objective is

- To avoid the contact between storing material and mild steel.
- To reduces the stress acting on HDPE storage tank.
- To increase the Life Cycle of the storage tank.
- Less space occupy.
- Low cost of tank.

2.2 SCOPE

Storage tanks are used to store liquids and gases. High pressure HDPE tanks are used in aircraft and space industries. They are used in chemical industries to store chemicals as they are non-corrosive in nature.

- Chemical Container
- Fireworks
- Food storage container
- Plastic bags
- Fuel tanks

3. METHOLOGY

- Review of existing literature work related to HDPE and storage container.
- The concept of creating the project with the usage of I-Beam, Channels, Clamps.
- The initial layout design was determined which shows the pictorial representation of the structure of storage tank that is to be made.
- The study of various material reaction with HDPE.
- Then the design is carried out in which calculation are done keeping in mind the consideration of stress acting on it and storage capacity.

- Calculation of stress, load on the I-beam and expansion of the storage container.
- Representation on the AutoCAD software.

4. COMPONENTS USED

4.1 High Density Poly-Ethylene:

Fig 1

HDPE is the number 2 plastic. Its toughness make it difficult to tear and helps it resist bursting. It is Sturdy and commonly used in laundry detergent and bleach bottles. It can be made translucent or opaque. Colour HDPE containers tend to have greater strength than see-through bottles and jugs made from HDPE. The opaque, colour plastic resists cracking or corrosion, which makes it a good receptacle for detergents and household cleaners. It is difficult to remove odours and residues from high-density polyethylene. HDPE is relatively inexpensive to make and can be easily make many products such as toys, soda bottles, trash cans, traffic cones and plastic "lumber" for decks and outdoor furniture.

4.2 I- Beam

Fig 2

An I-Beam which is also known as H-beam, Universal beam. It is a beam with an I or H shaped cross-section. The horizontal element of the I-Beam is known as "flange", and the vertical element is called as "web". I-beam are usually made of structural steel and are commonly used in construction site and engineering works.

The web section resist shear force, while the flange section resist the bending moment experienced by the beam. The I-shaped section is very efficient for carrying both bending and shear loads in the plane of the web.

4.3 STRUCTURAL CHANNELS

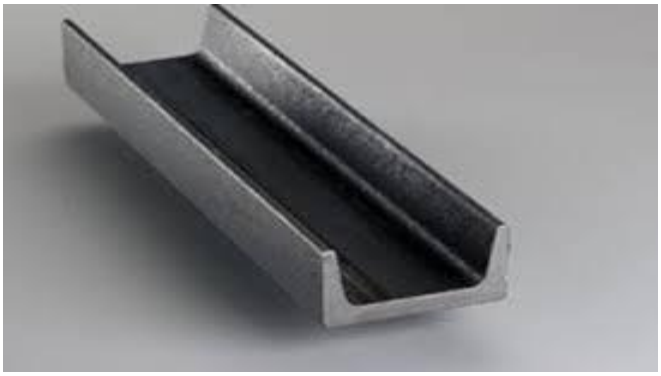

Fig 3

The structural channel, usually known as a C-channel is a type of beam, which is mostly used in building construction sites and engineering works. Its cross section generally consists of a wide "web", and two "flanges" at the top and bottom of the web, sticking out on one side of the web. It is used where the flat and the back side of the web can be mounted to another flat surface for the maximum contact area.

4.4 CLAMP

Fig 4

A clamp is a device which is used to hold objects tightly together to prevent the movement and separation through the application of inward pressure. There are many types of clamps which are available for different purposes. Some are temporary, as they are used to position components while fixing them, while the others are intended to be permanent. Anything which performs the action of clamping may be called a clamp, and it this gives rise to a wide variety of usage across many fields.

4.5 MILD STEEL

Fig 5

Steel is made up of carbon and iron, in which iron percentage is more than carbon. Steel can have about 2.1 percent carbon present in it. Mild steel is the commonly used in construction materials. It is very strong component and it can be made from the natural materials which is easily available. It is known as mild steel because of its low carbon content present in it.

Mild steel is especially chosen for construction due to its weldability and machinability strength. Because of its high strength and malleability, it is quite soft. This means that it can be easily machined compared to harder steels.

It is also easily welded to itself and to other steels. It takes on a nice finish and is polish able. However, it cannot be hardened through heat treatment processes, as higher carbon steels can. This is not entirely a bad thing, because harder steels are not as strong, making them a poor choice for construction.

5. PROPERTIES OF HDPE TANK

Made of High density polyethylene (HDPE) polypropylene (PP) by the unique spiral winding process.

With German technology it can withstand an extreme temperature range of -40 to 60°C (HDPE) and up to 100°C. Specifically made for storing various liquids/chemicals for small, medium or large scale industries, in various capacities up to 60000 liters.

It is light in weight, easy to transport and install.

Hydrochloric acid is most suitable store in HDPE Tanks or in PP tanks. Industrial Poly Tanks and vessels are manufacturing spiral wound HDPE tanks and spiral wound PP tanks as per the customer's specification up to 60000 liters in capacity.
The spiral HDPE tanks and spiral PP tanks are available in various size and shapes as per the requirement.

Spiral HDPE and spiral PP Tanks are well known for their features like:

- Leak-proof
- Corrosion resistant
- Light weight
- Easy to install
- Maintenance free

6. CALCULATION

The Calculation is done by considering that a Sterling is there inside the tank which rotates and produces the stresses.

Symbol Used

a = Minor length of rectangular plate, m

b = Major length of rectangular plate, m

P = Concentrated load, N

v = Poisson's ratio

E = Young's modulus, N/m^2

t = plate thickness, m

e = radius of area with force applied

s_m = maximum stress, N/m^2

y_m = maximum deflection, m

Calculation:

Shaft diameter = 220mm

Shaft speed = 150 RPM

Velocity of the surface of shaft = 150rpm×3.14×220mm

= 103620 mm/min

= 1.73m/sec

Velocity of the edge of blade = 150×3.14×1200

= 565200mm/min

= 9.42m/sec

At start of motor force acting on Clamp

Clamp 1:

$F_1 = m \times a$

$= 3077kg \times 1.73m/s$

$= 5.3KN$

Clamp 2:

$F_2 = m \times a$

$= 6462Kg \times 1.73m/s$

$= 11.18KN$

Clamp 3: (Corresponding to shaft blade)

$F_3 = m \times a$

$= 9847Kg \times 9.42m/s$

$= 92.76KN$

Clamp 4: (Corresponding to shaft blade)

$F_4 = m \times a$

$= 13231Kg \times 9.42m/s$

$= 124.64KN$

Clamp 5:

$F_5 = m \times a$

$= 16616Kg \times 9.42m/s$

$= 156.52KN$

Stress equation at center:

$$\sigma_m = \frac{1.5P}{\pi t^2}[(1+v)\ln\frac{2b}{\pi e}+1-k_2]$$

Deflection at center

$$y_m = k_1 \frac{Px^2}{Et^3}$$

$K_1 = 0.171$ (given)

$K_2 = 0.124$ (given)

Poisson's ratio V= 0.3 for steel

Maximum stress on small portion of selected area on plate

$$\sigma = \frac{1.5 \times 160 \times k}{3.14 \times 0.01^2}[(1+0.3)\ln\frac{2(0.16)}{\pi(0.01)} + 1 - 0.124]$$

$\sigma = 2975.7\ N/m^2$

now,

$E = 200GPa$

$E = 200 \times 10^9 N/m^2$

$$y_m = \frac{0.171\ [160k \times (0.1)^2]}{200 \times 10^9 \times 0.01^3}$$

$= 0.00137m$

$= 1.37mm$ (deflection)

7. SOFTWARE PRESENTATION

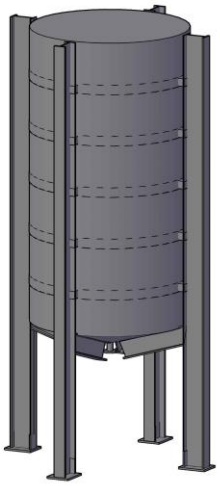

Fig 6: 3D Model

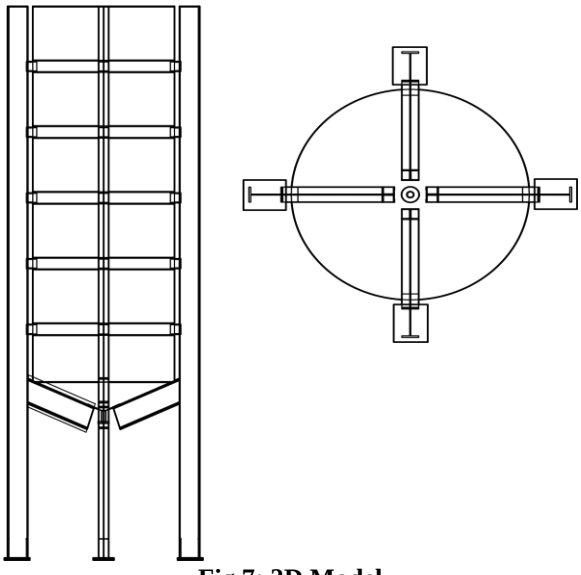

Fig 7: 2D Model

8. CONCLUSION AND FUTURE SCOPE

8.1 CONCLUSION

The detailed literature review of HDPE storage tank was carried out by doing analysis of several research paper. According to our calculation, the stress acting on the HDPE tank can be reduced by clamping the mild steel plate on the outer surface of the tank.

This will reduce the expansion of the HDPE tank by the support of the I-beam around it. And this will reduce the space occupy by the storage tank. This will also reduce the cost of the tank for chemical storing. It will definitely increase the life cycle of the HDPE storage tank.

8.2 FUTURE SCOPE

Further research on this project may lead towards the more suitable ideas which industries can apply. Highly reacted chemical can be stored in the HDPE tank as they are very less reactive with it.

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