

Vertical unfired pressure vessel components engineering essay

[Profession](#)



**ASSIGN
BUSTER**

The American Society of Mechanical Engineers was organized in 1880 as an educational and proficient society of mechanical applied scientists. After old ages of development and public remark, the first edition of the Code, ASME Rules of Construction of Stationary Boilers and for Allowable Working Pressures, was published in 1914 and officially adopted in the spring of 1915. The first Code regulations for force per unit area vass, entitled Rules for the Construction of Unfired Pressure Vessels, followed in 1925. From this simple get downing the Code has now evolved into the present 11 Section papers, with multiple subdivisions, parts, subdivisions, and compulsory and non-mandatory appendices. Almost all force per unit area vass used in the procedure industry in the United States are designed and constructed in conformity with Section VIII Division 1. In this undertaking, some general constructs standards related to ASME Code Section VIII are discussed. These include allowable emphasis, factors of safety, joint efficiency and force per unit area testing. The aim of this undertaking is to plan and analysis Unfired Vertical Pressure Vessel based on ASME Code Section VIII Division 1 and criterions. This undertaking merely concerned to plan chief portion of force per unit area vas like shell, caputs, noses and supports. The regulations in Section VIII Division 1 do non cover all applications and constellations such as planing leg supports. When the regulations are non available, another method must be used.

Problem statement

The force per unit area vass that non follow any standard codifications can be really unsafe. In fact many fatal accidents have occurred in the history of their operation and development. They are many criterions and codifications

that vary from state to state. The common criteria and codifications that have been used are ASME Boilers and Pressure Vessel Codes, API Standards, PD5500, British Standards, European Codes and Standards and other International Codes. Even though there are computer machine assisted force per unit area design available in the market, but due to concern benefit, the system may not be salable or pricey. In addition the expression and constructs applied in the system are ever unknown by the users.

Research range

This undertaking focuses on design and analysis of Unfired Vertical Pressure Vessel based on ASME Code Section VIII Division 1. Based on this codification, force per unit area design are application for the containment of internal and external force per unit area up to 3000 pounds per square inch. This force per unit area could be obtained from an external beginning or by the application of heat from a direct or indirect beginning or any combination of them. The ASME Code is building codification for force per unit area design and contains demands, specific prohibitions ; and non-mandatory counsel for force per unit area design stuffs, design, welding and proving. To guarantee the aim of this undertaking is achieved, some of the of import elements must be consider. There is:

Planing chief constituents of Unfired Vertical Pressure Vessel by refer to ASME Code Section VIII Division 1 and criteria.

Analysis of maximal stress value of chief constituents of force per unit area design by finite component utilizing ANSYS package.

Aims of Undertaking

The intent of this undertaking is to plan and analysis of Vertical Unfired Pressure Vessel based on ASME Code Section VIII Division 1. This research worker points two aims to be achieved at the terminal of this research. The aims are:

1. To plan Vertical Unfired Pressure Vessel constituents based on ASME Code VIII Division 1 and Standards.
2. To analyse maximal tantamount emphasis (von-Misses) , maximal shear emphasis, maximal distortion and safety factor in shell by finite component utilizing ANSYS package.

Significance of surveies

The undertaking will convey a great important non merely for the fertiliser industry but besides to the all the fabrication sector that used a assorted force per unit area vas for day-to-day operation. Nowadays, most the fabrication industry in Malaysia which used force per unit area vas for operational intent depends on their country of application. As a consequence, their operation, design, industry is regulated by technology governments backed up by Torahs. All force per unit area vass are manufactured with the maximal safe operating force per unit area and temperature. By finishing this undertaking, pupil will derive exposure to the ASME codification and criterions.

Chapter 2. 0

LITERATURE REVIEW

2. 1 Introduction

The force per unit area vass such as cylinder, grapevine or armored combat vehicles are design and concept to hive away gas or fluids under force per unit area. The gas or fluid that being stored may be through alteration of province inside the force per unit area vas, for illustration instance of steam boilers or it might unite with other reagents, such as a chemical works. The force per unit area vass must plan with a perfect attention because cleft of force per unit area vass will do an detonation which may do of decease and loss of belongings. The stuff that be used to build force per unit area vass may be malleable such as mild steel or brittle such that dramatis personae Fe. In by and large, force per unit area vass and others storage armored combat vehicle such as hydraulic cylinders, gun barrels, pipes, boilers and armored combat vehicles are of import to the chemical, crude oil, petrochemical, atomic industries and so on. Chemical reactions, separations, and storage of natural stuffs ever occur in this category of equipment. By and large, pressurized equipment is required and been used for a wide scope of industrial works for storage and fabrication intents [1] .

2. 2 Types of Pressure Vessel

The size and geometric signifier of force per unit area vass diverge greatly from the big cylindrical vass used for high-pressure gas storage to the little size used as hydraulic units for aircraft. Some of the vass are buried in the land or deep in the ocean, but most are positioned on land or supported in

platforms. There are chiefly two types of force per unit area vass normally available in industry:

Spherical Pressure Vessel

This type of force per unit area vass are known as thin walled vass. This forms the most typical application of plane emphasis. Airplane of emphasis is a category of common technology jobs affecting emphasis in a thin home base. Spherical vass have the advantage of necessitating dilutant walls for a given force per unit area and diameter than the tantamount cylinder. Therefore they are used for big gas or liquid containers, gas-cooled atomic reactors, containment edifices for atomic works, and so on.

Degree centigrades: Userszalie87Desktopspherical force per unit area vas 2. jpg

Figure 2. 1 Spherical Pressure Vessel [beginning: hypertext transfer protocol: //communities. ptc. com/thread/39900]

Cylindrical Pressure Vessel

This type of a vas designed with a fixed radius and thickness subjected to an internal pot force per unit area. This vas has an axial symmetricalness. The cylindrical vass are by and large preferred, since they present simpler fabrication jobs and do better usage of the available infinite. Boiler membranophone, heatmoneychangers, chemical reactors, and so on, are by and large cylindrical.

A C: Userszalie87Desktoppressure-vessel-500x500. jpg C:

Userszalie87Desktopvertical_expansion_tank. gif

<https://assignbuster.com/vertical-unfired-pressure-vessel-components-engineering-essay/>

Figure. 2: Cylindrical (Horizontal & A ; Vertical) Pressure Vessel [beginning: [hypertext transfer protocol: //www. energyflowsystems. com/pv. htm](http://www.energyflowsystems.com/pv.htm) and [hypertext transfer protocol: //www. pumpsukltd. com](http://www.pumpsukltd.com)]

2. 3 Main Components of Pressure Vessel

The chief force per unit area vas constituents are as follow:

2. 3. 1 Shell

The shell is the chief constituent of any vass that contains the force per unit area. Material of shell usually come in home base or rolled steel. Commonly, some force per unit area vas shells has a rotational axis and be welded together to organize a construction. Most pressure vas shells are cylindrical, spherical, or conelike in form.

2. 3. 2 Head

All force per unit area vas shells must be closed at the terminals by caputs.

Heads that normally used are typically in curved instead than level.

Configurations of curving form stronger and allow the force per unit area vas 's caputs to be thinner, lighter and less expensive instead than level caputs.

Inside a vas, caputs can besides be used.

Heads are normally can be categorized by their forms. Ellipsoidal, hemispherical, torispherical, conelike, toriconical and level are the common types of caputs. Figure 2. 3 shows assorted types of caputs. Ellipsoidal would be the most common type of caputs, which is used during the designing of a new force per unit area vas. [11]

Figure 2. 3: Typical Types of Heads [beginning 11]

<https://assignbuster.com/vertical-unfired-pressure-vessel-components-engineering-essay/>

2. 3. 3 Nozzles

A nozzle is a cylindrical constituent that penetrates and mounts whether at the shell or caputs of a force per unit area vas surface. The nozzle terminals are by and large flanged. Flanges map is to let the necessary connexions.

Flanges besides use to allow easy disassembly for modus operandis care or easy entree. Nozzles normally are used for the undermentioned applications

[11] :

Attach piping for flow recess or mercantile establishment of the vas.

Attach instrument connexions such as degree gages, thermowells, or force per unit area gages.

Provide entree to the vas inside at manholes.

Provide for direct fond regard of heat money changer or sociable.

Nozzles sometimes extended into the vas inside for some applications, such as for recess flow distribution or to allow the entry of thermowells.

2. 3. 4 Support

The type of support that is designed and used depends on the orientation of the force per unit area vessel whether horizontally or vertically. In any state of affairs, the force per unit area vessel support must be adequate to back up the applied weight and other tonss. Design force per unit area of the vas is non being considered in the design of its support because the support is non be pressurized. But, design temperature should be considered for

support design. It should be considered from the position of stuff choice and proviso for differential thermic enlargement.

Several sorts of supports are as follow [11] :

Skirt

This type of support by and large been used for tall, perpendicular, cylindrical force per unit area vass. This type of support is a cylindrical shell subdivision which is be weld either to the underside of the vas shell or to the bottom caput for the cylindrical vass. Skirt support for spherical vas is welded to the vas near the mid plane of the shell. The skirt is usually design long plenty to supply flexibleness so that radial thermic enlargement of the shell does non do high thermic emphasiss at its junction with the skirt.

Leg

Small perpendicular membranophones are usually supported by legs that are welded to the underside of the force per unit area shell. The maximal ratio of support provides for leg length to beat diameter is typically 2: 1. The figure of legs is designed depends on the membranophone size and the tonss to be carried. Support legs are besides normally designed for spherical force per unit area vass. The support legs for little perpendicular vass and spherical storage vass usually made from high C stuff such as structural steel columns or pipe subdivisions, which provides a more efficient and perfect design.

Saddle

Horizontal membranophones are usually supported by saddle. This type of support divides the weight burden over a big country of the shell to avoid an unneeded emphasis in the shell at two different locations. The breadth of the saddle is considered by the specific size and design conditions of the force per unit area v_a . One saddle support is usually fixed or anchored to its foundation. A typical strategy of saddle support is shown on Figure 2. 2. 4.

Figure 2. 4: Typical Scheme of Saddle [beginning 11]

2. 4 Overall Design Procedure of Pressure Vessels

Pressure vass as constituents of a complete works are designed to run into assorted demands as determined by the interior decorators and analysts responsible for the overall design. The first measure in the design process is to choose the necessary relevant information, set uping in this manner a organic structure of design demands, as shown in Figure 2. 5. Once the design demands have been established, suited stuffs are selected and the specified design codification will give an allowable design or nominal emphasis that is used to dimension the chief force per unit area v_a thickness. Extra codification regulations cover the design of assorted vessel constituents such as noses, rims, and so on. Following these regulations an agreement of the assorted constituents are finalized and analyzed for failure. Most of the types of failure relevant to coerce vessel design are stress dependent and therefore it is necessary to guarantee the adequateness of the emphasis distribution and look into against different types of postulated failure manners. The proposed design is eventually iterated until the most economical and dependable merchandise is obtained. The functional

demands cover the geometrical design parametric quantities such as size and form, location of the incursions, and so on. Some of these parametric quantities may hold to be fixed in coaction with the overall design squad, but in a bulk of state of affairss the force per unit area vas interior decorator acts freely on the footing of his or her experience. In the process in planing force per unit area vass, safety is the chief factor that must be consider, particularly for the high force per unit area works such as atomic reactor force per unit area vass, due the possible impact of a possible terrible accident. In general nevertheless, the design is a via media between consideration of economic sciences and safety. The possible hazards of a given manner of failure and its effects are balanced against the attempt required for its bar. The ensuing design should accomplish an equal criterion of safety at minimal cost. Safety can non be perfectly assured for these two grounds.

First, the existent signifier of lading during service may be more terrible than was anticipated at the design phase: unnatural, unpredictable tonss necessarily occur during the force per unit area vas 's life-time. Second, our cognition is rarely equal to supply a qualified reply to the break of stuffs, province of emphasis under certain conditions, and so on. It is true that although the cardinal mechanism of failure is non sufficiently understood, it is possible to set up preventative steps based on semi empirical methods. Following this line of thought, the force per unit area vass could be classified harmonizing to the badness of their operations since this will impact both the possibility of failure and its effects. These considerations lead to the categorization of vass runing from atomic reactor force per unit area vass at

one terminal to belowground H₂O armored combat vehicles at the other. The design factor used in the ASME Boiler and Pressure Vessel Code¹ is intended to account for unknown factors associated with the design and building of the equipment. The design expression and the emphasis analysis methods are by and large approximative and have constitutional premises. Typically it is assumed that the stuff is homogenous and isotropic. In the existent universe the stuff has defects and discontinuities, which tend to divert from this premise.

Figure 2. 5: Design Procedure

Chapter 3. 0

Methodology

3. 1 Overview

In this chapter, the information in choice of force per unit area vas is described and the application of selected force per unit area vas is been discussed. To plan of force per unit area vessel the choice of Code are of import as a mention usher to accomplish the secure force per unit area vas. The choices of ASME Code Section VIII div 1 are described. The criterion of stuff choice used are explains in this chapter. Beside of that, the design and analysis package to obtain the consequence are introduced. Alternatively of that, design procedure methodological analysis is besides described.

3. 2 General Design Considerations: Pressure Vessels

3. 2. 1 Materials

General stuff demand have been described in paragraphs UG-4 through UG-15. There are some points that must be considered which is related to the general stuff demands that will be discussed below. [2]

The chief factors of stuff choice that must be considered are [12] :

Strength

Strength is a stuff 's ability to digest an imposed force or emphasis applied.

Strength is an of import factor in the stuff choice for any peculiar application.

Strength determines the midst of a constituent that must be to defy the forced tonss.

Corrosion Resistance

Corrosion defines as the weakening of stuff by chemical reaction. Material 's opposition to corrosion is the most of import factor that influences its choice for a specific application.

Stipulate a corrosion allowance is the common method that used to specify corrosion in force per unit area vass constituents.

Fracture Stamina

Fracture stamina defines as the capableness of a stuff to defy conditions that could do a brickle break. The break stamina of a stuff can be determined by utilizing Charpy V-notch trial to specify the magnitude of the impact energy and force that is required to fracture a specimen.

Fabricability

Fabricability defines as the easiness of building and to any particular fiction patterns that are required to utilize the stuff.

Normally, force per unit area vass use welded building. The stuffs used must be weldable so that constituents can be assembled onto the accomplished force per unit area vas.

The force per unit area vas design codifications and criterions include lists of acceptable stuffs ; in conformity with the appropriate stuff criterions.

3. 2. 2 Design and Operating Temperature

In ASME Code Section VIII Div 1, upper limit and minimal design temperatures can be established in Paragraph UG-20. The maximal design temperature can be define as the maximal temperature used in vessel design and it shall non be lesser than the average metal temperature estimated under normal operating conditions for the portion that want to be considered. [3]

The operating temperature is the gas or unstable temperature that occurs under the normal operating conditions. Before planing a vas, the operating temperature must be set based on the upper limit and minimal metal temperatures that the force per unit area vas may meet any state of affairs. [4]

3. 2. 3 Design and Operating Pressure

Design force per unit area of the vas can be established in Paragraph UG-21.

In this paragraph, the demand of the vas to be designed for any terrible

<https://assignbuster.com/vertical-unfired-pressure-vessel-components-engineering-essay/>

force per unit area and temperature that is coincidentally expected in normal operation has been provided. When set up the maximal operating force per unit area, all conditions such as start-up, closure, and any identified disquieted conditions can be considered. Set force per unit area of the force per unit area alleviation device in an operating system must be above the operating force per unit area by a sufficient sum so that the device does not trip by chance. A vas must be designed to defy the maximal force per unit area to which it is likely to be subjected in operation status. Before planing a vas, the operating force per unit area must be set based on the maximal internal or external force per unit area that the force per unit area vas may meet.

The design force per unit area is usually taken as the force per unit area at which the alleviation device is set for vas that under internal force per unit area. To avoid specious operation during minor procedure disturbances, usually the operation force per unit area is 5 to 10 per cent above the normal on the job force per unit area. The hydrostatic force per unit area in the base of the column should be added to the operating force per unit area if make up one's mind the design force per unit area. [2]

3. 2. 4 Design Maximum Allowable Stress

Maximum allowable emphasis that have to be consider in planing a vas which be used for internal and external force per unit area has be describe in Paragraph UG-23. The allowable tensile emphasis are tabulated in ASME Code Section II, Part D of the Boiler and Pressure Vessel Code. In UG-23 (a) indicates that for stuff that has been identified as meeting more than one

stuff specification, the allowable emphasis for the specification may be used and provided that all the restrictions of the specification is satisfied. In UG-23, standard for the maximal allowable longitudinal compressive emphasis to be used for cylindrical shells that are subjected to longitudinal compressive tonss besides have been provided. The first status is that the maximal allowable longitudinal compressive emphasis can non be greater than the maximal allowable tensile emphasis. The 2nd status is based on buckling of the constituent. In Paragraph UG-23 (degree Celsius) , the wall thickness of a force per unit area vas shell defined by these regulations and it should be determined and the induced maximal membrane emphasis does non transcend the maximal allowable emphasis value in tenseness has been stated. [2]

Typical design emphasis factors for force per unit area constituents are shown in Table 3. 1.

Table 3. 1: Design emphasis factors

Property

Material

Carbon

Carbon-manganese, unstained metals

low metal steels

Austenitic chromium steel steels

Non-ferrous

metals

Minimal output

emphasis or 0.2 per centum cogent evidence emphasis, at the design temperature

1.5

1.5

1.5

Minimum tensile strength, at room temperature

2.35

2.5

4.0

Mean emphasis to

green goods rupture

at 105 H at the

design temperature

1.5

1. 5

1. 0

3. 2. 5 Thickness of shell under internal force per unit area

Information and demand of thickness or maximal allowable force per unit area for a shell under internal force per unit area are provided in paragraph UG-27. The equations for circumferential emphasis which is the emphasis moving across the longitudinal seam for cylindrical shell are as follows [1] :

or (3. 2. 5. 1)

Figure 3. 1: Shell Under Internal Pressure

For cylindrical shells for longitudinal emphasis which the emphasis moving across the circumferential articulations, the equations are

or (3. 2. 5. 2)

T = lower limit needed thickness of shell, in. (in the corroded status)

P = internal design force per unit area, pounds per square inch

R = inside radius of shell under consideration, in. (Corroded status)

S = maximal allowable emphasis from the applicable allowable emphasis tabular array in Section II, Part D

E = Joint efficiency for welded articulations (Table UW-12) , or the ligament efficiency between gaps (UG-53) .

For spherical shells,

or (3. 2. 5. 3)

These equations are really simple. However, there are some related issues that must be discussed. These two equations are usually based on thin wall theory.

3. 2. 6 Thickness of shell under external force per unit area

The information and demand that used to plan shells and tubings under external force per unit area is given as a design burden is given in paragraph UG-28. The definitions for assorted geometries are diagrammatically shown in Figure 3. 2. a (Fig. UG-28. 1) . [2]

Figure 3. 2. a: Diagrammatic Representation of Lines of Support for Design of Cylindrical Vessels Subjected To External Pressure (Beginning: Fig. UG-28. 1 of Section VIII Div. 1 of the ASME 2010 Code)

Figure 3. 2. b: Maximal Arc of Shell Left Unsupported Because of Gap in Stiffening Ring of Cylindrical-Shell under External Pressure (Beginning: Fig. UG-29. 2 of Section VIII Div. 1 of the ASME 2010 Code)

Stiffness ring that has been provided with uninterrupted around the perimeter of the vas is to defy external force per unit area. Between the ring and the shell, spreads have been allowed ; nevertheless, the ring has to be uninterrupted and the discharge of the spread is limited by Figure 3. 2. b. The extra demands of UG-29 (degree Celsius) (1) through UG-29 (degree

Celsius) (4) should be satisfy when the discharge of the spread between the ring and shell does non run into the Figure 3. 2. b demands. [2]

3. 2. 7 Formed Heads

Information and regulations for the design of formed caputs are given in paragraph UG-32. The needed thickness of spheroidal caputs expression is given by

or (3. 2. 7. 1)

D = diameter of the oval major axis

Figure 3. 3: Ellipsoid caput (Beginning: 7)

Other expressions to plan caputs are as given in UG-27. Ellipsoidal caputs has a ratio of 2: 1 if at that place does non hold a major to minor diameter. The torispherical caput with the metacarpophalangeal joint radius requires a thickness for a equal to 6 % of the inside Crown radius and the inside crown radius equal to the outside diameter of the is given by [7]

or (3. 2. 7. 2)

Where: L = inside crown radius of the formed caput

Figure 3. 4: Torispherical caput (Beginning: 7)

3. 2. 8 Openings and Supports

When planing an gap in a force per unit area vas, there is a stress ensuing from the hole that is formed on the shell. This is similar to the classical emphasis concentration consequence of a hole in a home base that is loaded

in grip. The codifications for support do not see loads other than force per unit area. Openings in shells should be round, egg-shaped, or obround. If the connexion is slanting to the surface of the shell, the egg-shaped gap in the shell will be used. The proof trial in Paragraph UG-101 should be applied if the strength of vessel with such gaps cannot be determined. [2]

There is no bound to the size of a gap that may be designed on a force per unit area vessel. The gap and support regulations in paragraph UG-36 through UG-43 stated in ASME Code will be applied to gaps not transcending the undermentioned vessel size. For illustration, vessel of 60 inches inside diameter and less, the gap may be every bit as large as one half the vessel diameters, but not to transcend 20 inches. Then, for vessel over 60 inches inside diameter, the gap may be every bit as large as one third the vessel diameter, but not to transcend 40 inches. [2]

Design for Internal Pressure

The entire transverse sectional or country of support A in any plane through the gap for a shell or caput under internal force per unit area that has been required shall be not less than

$$A = dtrF + 2tn \text{ thyrotropin-releasing hormone } (1 a?' fr1) (3. 2. 8. 1)$$

Design for External Pressure

(1) The support that capable to force per unit area (external) must be considered for gaps in individual walled vessel must merely 50 % of that required in design for internal force per unit area, where t_r is the wall thickness required by the regulations for vessel under external force per unit

area and the value of F shall be 1.0 in all external force per unit area support computations. [2]

(2) The support required for gaps in each shell of a multiple walled vas shall follow with above information when the shell is capable to force per unit area (external) and with design for force per unit area (internal) above when the shell is capable to internal force per unit area, no affair there is a common nose secured to more than one shell by strength dyer's rockets. [2]

3. 2. 9 Nozzles

The lower limit wall thickness of nozzle cervixs should be determined as given expression below. For entree gaps and gaps used merely for review [2]:

$$t_{UG-45} = T_a \quad (3. 2. 9. 1)$$

For other noses:

Determine terbium.

$$t_{erbium} = \min [t_{b3}, \text{soap} (t_{b1}, t_{b2})] \quad (3. 2. 9. 2)$$

$$t_{UG-45} = \text{soap} (T_a, t_{erbium}) \quad (3. 2. 9. 3)$$

where

T_a = lower limit cervix thickness required for internal and external force per unit area utilizing UG-27 and UG- 28 (plus corrosion allowance) , as applicable. The effects of external forces and minutes from auxiliary tonss

(see UG-22) shall be considered. Shear emphasis caused by UG-22 burdens shall not transcend 70 % of the allowable tensile emphasis for the nozzle stuff.

t_{b1} = for vessel under internal force per unit area, the thickness (plus corrosion allowance) required for force per unit area (presuming $E p 1.0$) for the shell or caput at the location where the nozzle cervix or other connexion attaches to the vessel but in no instance less than the minimal thickness specified for the stuff in UG-16 (B) .

t_{b2} = for vessel under external force per unit area, the thickness (plus corrosion allowance) obtained by utilizing the external design force per unit area as an tantamount internal design force per unit area (presuming $E p 1.0$) in the expression for the shell or caput at the location where the nozzle cervix or other connexion attaches to the vessel but in no instance less than the minimal thickness specified for the stuff in UG-16 (B) .

t_{b3} = the thickness given in Table UG-45 plus the thickness added for corrosion allowance.

t_{UG-45} = lower limit wall thickness of nozzle cervix

In Paragraph UG-45, the regulations for minimal nozzle cervix thickness have been provided. A nozzle cervix or any other connexion shall not be thinner than that required to fulfill the thickness demands for the stresses defined in paragraph UG-22. Except for manhole and other gaps that are provided merely for entree, extra demands of paragraph UG-45 may necessitate a thicker nozzle cervix. [2]

3. 2. 10 Legs support

Legs supports usually are used to back up perpendicular force per unit area v_a . Legs support can be made detachable from the v_a . These supports can be bolted or welded to blast home bases. Leg supports design method is similar to that for bracket support. If the legs are welded to the shell, so the shear emphasiss in the dyer's rocket will be given by [2] :

(3. 2. 10. 1)

Where, tW = Weld Height

LW = Weld Length.

These sorts of supports are suited merely for little and moderate force per unit area v_a as there is a concentrated local emphasis at the joint.

Figure 3. 5: Leg Support

3. 2. 11 Joint Efficiency Factors

The strength of a welded articulation will depend on the type of articulation and the quality of the welding. The soundness of dyer's rockets is checked by ocular review and by non-destructive testing (skiagraphy) . The possible lower strength of a welded articulation compared with the virgin home base is normally allowed for in design by multiplying the allowable design emphasis for the stuff by a `` welded articulation factor " J . The value of the joint factor used in design will depend on the type of joint and sum of skiagraphy required by the design codification. Typical values are shown in Table 3. Taking the factor as 1. 0 implies that the joint is every bit every bit

strong as the virgin home base ; this is achieved by radiographing the complete dyes rocket length, and cutting out and refashioning any defects. The usage of lower joint factors in design, though salvaging costs on skiagraphy, will ensue in a thicker, heavier, vas, and the interior decorator must equilibrate any cost nest eggs on review and fiction against the increased cost of stuffs. [2]

Table. 2: Maximum allowable articulation efficiency

Type of articulation

Degree of skiagraphy

100 %

topographic point

none

Double-welded butt

or equivalent

1. 0

0. 85

0. 7

Single-weld butt

articulation with adhering strips

<https://assignbuster.com/vertical-unfired-pressure-vessel-components-engineering-essay/>

0.9

0.80

0.65

In ASME Code Section VIII Division 1, joint efficiency factors influence the degree of scrutiny of articulations on force per unit area vas. The grade of scrutiny influences the needed thickness through the usage of Joint Efficiency Factors, E. This factor is sometimes referred to as Quality Factors or weld efficiencies serve as emphasis multipliers applied to vessel constituents when some of the articulations are non to the full radiographed. Basically, ASME Code Section VIII Division 1 vass have variable factors of safety and it depending on the radiographic scrutiny of the chief vas constituents articulations. For this undertaking, to the full radiographed longitudinal butt-well articulations in cylindrical shell use a Joint Efficiency Factor, E of 1.0. There are four joint classs require that have been identified in ASME Code Section VIII Division 1. They are classs A, B, C and D as shown in figure below. [2]

Figure 3. 6: Welded Joint Categories (Beginning: 2010 ASME VIII Div1)

3. 2. 12 Corrosion allowance

The corrosion allowance is the extra thickness of metal added to let for stuff lost by corrosion and eroding, or scaling. The allowance to be used should be agreed between the client and maker. Corrosion is a complex phenomenon, and it is non possible to give specific regulations for the appraisal of the corrosion allowance required for all fortunes. The allowance should be based

<https://assignbuster.com/vertical-unfired-pressure-vessel-components-engineering-essay/>

on experience with the stuff of building under similar service conditions to those for the proposed design. For C and low-alloy steels, where terrible corrosion is non expected, a minimal allowance of 2. 0 millimeters should be used ; where more terrible conditions are anticipated this should be increased to 4. 0 millimeters. Most of design codifications and criterions available stipulate a minimal allowance of 1. 0 millimeter. [2]

3. 3 Finite Element Analysis by ANSYS

This undertaking is set out to verify finite component analysis, FEA when applied to coerce vessel design. Finite Element Analysis is a simulation technique. Function of this technique is to measure the behaviour of constituents, equipment and constructions for assorted lading conditions including applied forces, force per unit areas and temperatures. There are many complex technology jobs with non-standard form and geometry can be solved utilizing this analysis [5] . Consequences that can be achieve by this analysis such as the emphasis distribution, supplantings and reaction tonss at supports for any theoretical account. There are figure of scenarios can be done such as design optimisation, material weight minimisation, form optimisation, codification conformity and more by utilizing this analysis [10] . The finite elements analysis was performed utilizing ANSYS package. ANSYS widely used in the computer-aided technology (CAE) field in many industries [10] . ANSYS package helps applied scientists and interior decorators to build computing machine theoretical accounts of constructions, machine constituents or systems by using runing tonss and other design standards and to analyze physical responses such as emphasis degrees, temperature distributions, force per unit area and more. It permits an rating

of a design without holding to construct and destruct multiple paradigms in proving. In this undertaking, the analysis will be test on cylindrical shell of the unfired perpendicular force per unit area vas to see the maximal distortion, maximal tantamount (von-Misses) and maximal shear emphasis of the shell 's stuff.

Figure 3. 1: Example of ANSYS analysis ; Maximum shear emphasis of Elliptical Head [beginning 1] .

Chapter 4. 0

RESULT AND ANALYSIS

4. 1 Design Data and Calculation

Table 4. 1: Pressure Vessel Design Data

Design codification

: ASME Section VIII Division 1

Type of vas

: Vertical

Inside diameter

: 1300. 0 millimeter

Temperature

Design

: 70. 0 A°C

Operating

: 30. 0 A°C

Pressure

Design

: 44 BarG

Operating

: 24. 9 BarG

Corrosion allowance

: 3 millimeter

Type of fluid

: Natural gas

Max. Liquid degree

: Not applicable

Radiography

: Full moon

Joint efficiency

: 1. 0

Type of caput

: 2: 1 Ellipsoidal

Weight

Empties

: 4791 kilogram

Operating

: 4850 kilogram (approximate)

4. 1. 1 Material

For choosing stuff for building these force per unit area vas constituents, there are several regulations should be see that available in paragraphs UG-4 through UG-15. For this undertaking, stuff that will be usage is in C and low metal steel 's category which is SA-516-70. This type of stuff has been taking based on design force per unit area and design temperature because it is suited for moderate and lower temperature service applications. [2]

4. 1. 1. 1 Properties of Material

Table 4. 2: Properties of Material

Material

SA-516 Gr 70

Form

Home plate

Composition

C-Mn-Si

Tensile strength

552 MPa

Output point

260 MPa

Density

7.85 g/cm³

Melting Point

1510 A°C (2750 A°F)

4. 1. 2 Design Pressure

Refer to ASME codification in paragraph UG 21, the design force per unit area is a force per unit area that is used to plan a force per unit area incorporating system or piece of equipment. With the design force per unit area, it is recommended for applied scientist to plan a vas and its constituents. Design force per unit area must 5-10 % higher than operating force per unit area, whichever is the higher, will carry through this demand.

<https://assignbuster.com/vertical-unfired-pressure-vessel-components-engineering-essay/>

The force per unit area of the fluid and other contents of the force per unit area was also considered. For this undertaking, design force per unit area is 44.0 BarG. [2]

4. 1. 3 Operating Pressure

Operating force per unit area is a force per unit area that is less than the maximal allowable on the job force per unit area at which the force per unit area was usually operated. Recommended value is 30 % below maximal allowable on the job force per unit area. [2]

4. 1. 4 Maximum Allowable Stress Value

Refer to ASME codification in paragraph UG 23, the maximal allowable stress value that the maximal stress allowed in stuff that used to plan force per unit area was constituents under this regulations. The allowable stress value for most stuff at design temperature is the lower $2/7$ the minimal effective tensile strength or $2/3$ the minimal yield strength of the stuff. For this undertaking, the allowable stress value is obtained from tabular array in ASME Code Section II ; Part D. Below is allowable stress value that simplified from the tabular array in subdivision II, Part D. [2]

Material

Metal temperature non transcending deg, F

Maximum Allowable Stress, pounds per square inch

SA-516 Gr 70

-20 to 650

<https://assignbuster.com/vertical-unfired-pressure-vessel-components-engineering-essay/>

17500

Table 4. 3: Maximal Allowable Stress Value

4. 1. 5 Thickness of Shells under Internal Pressure

$T = PR$ per UG 27 (degree Celsius)

(SE- 0. 6P)

$= (44 \times 10^5) (653 \text{ millimeter})$

$(1206. 58 \text{ Bar}) - 0. 6 (44 \text{ Bar})$

$= 24. 35 \text{ millimeter}$

24. 35 millimeter + corrosion allowance, 3 millimeter = 27. 35 millimeter

So, usage $T = 28 \text{ millimeter}$

Maximal Allowance Working Pressure, MAWP

$P = SEt$ per UG 27 (degree Celsius)

$R + 0. 6t$

$= (1206. 58 \times 10^5) (1) (28 \text{ millimeter})$

$650 \text{ millimeter} + 0. 6 (28 \text{ millimeter})$

$= 51. 98 \text{ Barrooms}$

Stress, I? hoop = $P (R + 0. 6t)$

Et

$$= (4.4 \times 10^6) (0.650 \text{ m} + 0.6 (0.028 \text{ m}))$$

$$(1) 0.028 \text{ m}$$

$$= 105.25 \text{ MPa}$$

$$\text{Stress, } l? \text{ long} = P (R - 0.4t)$$

2Et

$$= (4.4 \times 10^6) (0.650 \text{ m} - 0.4 (0.028 \text{ m}))$$

$$(2) 0.028 \text{ m}$$

$$= 50.19 \text{ MPa}$$

$$\text{Factor of safety} = l? \text{ yield}$$

l? hoop

$$= 120.658 \text{ Mpa}$$

$$105.25 \text{ MPa}$$

$$= 1.14$$

4. 1. 6 2: 1 Ellipsoidal Head thickness

$$T = PD \text{ per UG 27 (vitamin D)}$$

$$(2SE - 0.2P)$$

$$= (44 \times 10^5) (1303 \text{ millimeter})$$

$$2 (1206.58 \times 10^5) (1) - 0.2 (44 \times 10^5)$$

$$= 23.85 \text{ millimeter}$$

$$23.85 \text{ millimeter} + \text{corrosion allowance, } 3 \text{ millimeter} = 26.85 \text{ millimeter}$$

So, usage $T = 28$ millimeter

$$H = D$$

$$4$$

$$= 1300$$

$$4$$

$$= 325 \text{ millimeter}$$

Maximal Allowance Working Pressure, MAWP

$$P = 2SEt \text{ per UG 27 (vitamin D)}$$

$$D + 0.2t$$

$$= 2 (1206.58 \times 10^5) (1) (23.85 \text{ millimeter})$$

$$1303 \text{ millimeter} + 0.2 (23.85 \text{ millimeter})$$

$$= 44 \text{ Barrooms}$$

$$\text{Stress, } I? = P (D + 0.2t)$$

2 T

$$= (4.4 \times 10^6) (1.303 \text{ m} + 0.2 (0.024 \text{ m}))$$

$$2 (1) (0.024 \text{ m})$$

$$= 119.88 \text{ MPa}$$

4. 1. 7 2: 1 Nozzle and Flanges

4. 1. 7. 1 (Inlet and Outlet)

T = PR per UG 45

$$(SE - 0.6P)$$

$$= (44 \times 10^5) (152.4 \text{ millimeter})$$

$$(1206.58 \times 10^5) - 0.6 (44 \times 10^5)$$

$$= 5.68 \text{ millimeters} \sim 6 \text{ millimeter}$$

6 millimeter + corrosion allowance, 3 millimeter = 9 millimeter

So, usage T = 9 millimeter

Length of pipe 12 " = 211.85 millimeter

Flanges

Based on slip-on Flanges - ANSI B16.5 300lbs

Table 4. 4: Slip-On Flanges - ANSI B16.5 300lbs for 12 Inch

Nominal pipe size

<https://assignbuster.com/vertical-unfired-pressure-vessel-components-engineering-essay/>

Outside diameter

Overall diameter

Inside diameter

Flanges thickness

Overall length

Hub diameter

Face diameter

No. of holes

Bolt hole

Diameter of circle of holes

12 "

323. 8

520. 7

327. 1

50. 80

73. 15

374. 6

381. 0

16

31. 70

450. 8

4. 1. 7. 2 (Manhole)

T = PR per UG 45

(SE- 0. 6P)

= (44 x 10⁵) (254 millimeter)

(1206. 58 x 10⁵) - 0. 6 (44 x 10⁵)

= 9. 47 millimeters ~ 9. 5 millimeter

9. 5 millimeter + corrosion allowance, 3 millimeter = 12. 5 millimeter

So, usage T = 12. 5 millimeter

Length of pipe 20 " = 252 millimeter

Flanges

Based on slip-on Flanges - ANSI B16. 5 300lbs

Nominal pipe size

Outside diameter

Overall diameter

Inside diameter

Flanges thickness

Overall length

Hub diameter

Face diameter

No. of holes

Bolt hole

Diameter of circle of holes

20 "

508

774.7

513.1

63.50

95.20

587.2

584.2

24

35

685.8

Table 4. 5: Slip-On Flanges - ANSI B16. 5 300lbs for 20 Inch

4. 1. 7. 3 (Liquide Outlet)

$T = PR$ per UG 45

(SE- 0. 6P)

$= (44 \times 10^5) (25. 4 \text{ millimeter})$

$(1206. 58 \times 10^5) - 0. 6 (44 \times 10^5)$

$= 0. 95 \text{ millimeters} \sim 1 \text{ millimeter}$

1 millimeter + corrosion allowance, 3 millimeter = 4 millimeter

So, usage $T = 4 \text{ millimeter}$

Length of pipe 20 " = 271. 8 millimeter

Flanges

Based on slip-on Flanges - ANSI B16. 5 300lbs

Nominal pipe size

Outside diameter

Overall diameter

Inside diameter

Flanges thickness

Overall length

Hub diameter

Face diameter

No. of holes

Bolt hole

Diameter of circle of holes

2 "

60.3

165.1

62

22.30

33.20

84

91.90

8

19. 10

127. 0

Table 4. 6: Slip-On Flanges - ANSI B16. 5 300lbs for 2 Inch

4. 1. 8 Leg support

For planing leg support, there are no specific regulations or codifications that describes in ASME Code Section VIII Div 1. So, in this undertaking, the leg supports was designed based on available support that be designed for knock out membranophone by Petronas Fertilizer Sdn. Bhd.

4. 2 Detailss pulling by Catia

Figure 4. 1: Unfired Vertical Pressure Vessel

[Please mention Appendix 1]

Figure 4. 2: Shell

[Please mention Appendix 2]

Figure 4. 3: Top Ellipsoidal Head

Figure 4. 4: Bottom Ellipsoidal Head

[Please mention Appendix 3 & A ; 4]

Figure 4. 5: Leg Support

[Please mention Appendix 5]

<https://assignbuster.com/vertical-unfired-pressure-vessel-components-engineering-essay/>

4. 3 Inactive Structural Analysis Result and Discussion

From the finite component analysis for all burden instances by inactive structural analysis utilizing ANSYS package, there are consequences are obtained.

4. 3. 1 Inactive Structural Analysis of Shell with Nozzles

Degree centigrades: Userszalie87AppDataRoamingAnsysv140preview. png

Figure 4. 6a: Entire Deformation of Shell with Nozzles

The figure above shown the entire distortion of the shell with nozzle attached. From the consequences of analysis, it was observed that the maximal distortion occurred at the junction of force per unit area vas 's shell and the nose. The maximal distortion was 0. 52119 millimeter.

Degree centigrades: Userszalie87AppDataRoamingAnsysv140preview. png

Figure 4. 6b: Equivalent (von-Mises) Stress

Based on figure above, the maximal emphasiss occurred at the nozzle cervix. The maximal emphasis value obtained is 141. 28 MPa. The maximal tantamount emphasis obtained from the analysis was big than maximal allowable emphasis because of affiliated nose cervix due to sudden alteration in the shell geometry and the resulting of alteration in emphasis flow.

Degree centigrades: Userszalie87AppDataRoamingAnsysv140preview. png

Figure 4. 6c: Maximal Shear Stress

The figure above represented the maximal shear emphasis that occurs on the shell. There are colourss that represent the degree of emphasis that occur on the shell surface. The bluish colour indicate the country which the emphasis was lowest and the ruddy colour indicated the maximal emphasis occur while the force per unit area has been applied.

Degree centigrades: Userszalie87AppDataRoamingAnsysv140preview. png

Figure 4. 6d: Safety Factor

From the analysis of shell with noses attached, the minimal value of factor safety obtained is 0. 85406. Because of some deficiency, the value of safety factor is rather low compared to theoretical value. It is because the maximal tantamount emphasis that been obtained was big than maximal allowable emphasis.

4. 3. 2 Inactive Structural Analysis of Shell without Nozzles

Degree centigrades: Userszalie87AppDataRoamingAnsysv140preview. png

Figure 4. 7a: Entire Deformation of Shell without Nozzles

For the analysis of shell without nose attached, the consequence has been shown above. Compared with the old analysis on shell with the noses, the value of maximal distortion is less which is merely 0. 33246 millimeters.

Degree centigrades: Userszalie87AppDataRoamingAnsysv140preview.

pngFigure 4. 7b: Equivalent (von-Misses) Stress

The figure shown supra is the consequence of equivalent (von-Mises) emphasis that occurs on the shell surface at about design force per unit area of 4. 4 MPa. The ruddy colour represents the maximal emphasis which is 116. 67 MPa. The maximal emphasis occurs at the underside of the shell. The maximal allowable emphasis for this shell is 120. 658 MPa. So, the value obtained in this analysis was below than maximal allowable emphasis. It can be said that this shell was safe.

Degree centigrades: Userszalie87AppDataRoamingAnsysv140preview. png

Figure 4. 7c: Maximal Shear Stress

Based on figure above, the maximal emphasiss occur on the surface indoors shell. The minimal shear emphasis occurs on the top shell surface 16. 272 MPa and the maximal shear emphasis value obtained is 61. 08 MPa which is represented with ruddy colour.

Degree centigrades: Userszalie87AppDataRoamingAnsysv140preview. png

Figure 4. 7d: Safety Factor

From the analysis of shell without noses attached, the minimal value of factor safety obtained by computation is 1. 14. The value of safety that obtained by this analysis is 1. 03 because the maximal tantamount emphasis that be obtained is less than hoop emphasis in manual computation. So the per centum of factor safety between value from computation and analysis is approximately 9. 6 % and it 's acceptable.

Chapter 5. 0

Summary

5. 1 Decision

As the undertaking is completed, it can be concluded that the aims of this undertaking are successfully done. This undertaking had lead to several decisions. However, major decisions are as below:

From overall survey of ASME Code Section VII Division 1 in planing perpendicular force per unit area vas, it be said that the chief demand that used to plan this type of vas was be studied decently. Because of some deficiency of information is ASME Code such as regulations for planing leg support, the constituent had been designed merely based on available designed that widely used in industry. This undertaking merely focused on design demands in ASME Code, so the regulation for fiction and review did non be involved.

From the analysis of shell with affiliated nose, the maximal distortion of the shell has been obtained. The distortion value was below the allowable deforming for the shell stuff. Then, the maximal tantamount emphasis (von-Misses) besides has been obtained over the maximal allowable emphasis. This was because of the geometry of the shell has been changed during nozzle attached. This job occurred besides because of the alteration is stress flow during the tonss has been applied. Because of over maximal tantamount emphasis obtained, the value safety factor had been affected. The value of safety factor obtained was less than 1 ; it might be non good plenty but it still can be considered.

From the analysis of shell without nose, the maximal distortion is less than distortion in shell with affiliated nozzle analysis. Then, the value of maximal tantamount emphasis (von-Misses) obtained was less than maximal allowable emphasis. The value was approximated to the computation value at about 3.3 % . So, the value of safety factor obtained besides near to the computation value in term of maximal allowable emphasis per upper limit tantamount emphasis. Hence, the shell was in safe status when the operating force per unit area been applied.

However, although the codification for design a force per unit area was had been studied decently, some of information was non described in inside informations. So, this design was non excessively safe and good plenty for fiction. Many demands still had to be considered to do this design perfect. There were many codifications and regulations should be studied and understood decently. By the manner, as been stated earlier, this undertaking has achieved the aims and fulfills the demand of Final Year Project II.

5. 2 Recommendation

Apparently, in term of design regulations, there are many facets to looking farther betterment to hold a complete and perfects perpendicular force per unit area was. The design codifications and criterions must be suitably revised to do certain the design is safe plenty.

Because of deficiency of information from the ASME Codes Section VIII Division 1 in planing this force per unit area was, some of the standards required can non be applied. Some of the information in ASME Code is confidential and need to inquire for their permission before used it.

<https://assignbuster.com/vertical-unfired-pressure-vessel-components-engineering-essay/>

Sometimes engineer, interior decorator or organisation demands to purchase their codifications and criterions which are really expensive.

There are others codifications and criterion in planing force per unit area vas available. There besides has package to plan force per unit area in the market. Possibly by utilizing others codifications and criterion or package may better the process in planing force per unit area vas