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Design Automation of Shell

KEYWORDS: Creo Parameteric 2.0., Customization Ribbon, Part Programing, Java (User Interface), SQL Server(Database)

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ABSTRACT *In Today's scenario Pressure Vessel is used for storing Gases or Liquids at Pressure substantially different from the Ambient Pressure in different industries like power plant, Sugar industries, Continuous Process Industries etc. all over the world and hence Pressure Vessel Manufacturers try to make best Pressure Vessel which fulfils all the requirements of industry with Lowest Cost and Safety. Pressure differential is dangerous and many fatal accidents have occurred in the history of pressure vessel development and operation. Consequently, pressure vessel design, manufacture, and operation are regulated by engineering authorities backed by legislation. For these reasons, the definition of a pressure vessel varies from country to country, but mainly involves the parameters such as maximum safe operating pressure and temperature. Generally worldwide American Society for Mechanical Engineering (ASME) Standard utilize for Design, Manufacturing, Testing of Pressure Vessel. Currently Industry is using PV-Elite/Compress like Pressure Vessel Design Special Software which serves Design Base on ASME Standard but software has some limitation like cannot generate Fabrication Drawing. This Paper Article Describe Solution of this limitation with running modelling software Creo Parametric. We consider Shell Component of Pressure Vessel in this Paper Article. Shell Design Automation System is organizing into 3 modules. Geometry Modelling develop into Creo Parametric 2.0 with Customization of Creo Ribbon. Input Parameter/Relation generate by Pro Programing in Creo Parametric. Graphical User Interface (GUI) develops by Java Language. The Proposed System is capable to automate all major activities of Design of Shell such as Selection of Material, Calculation of Require Thickness, Modelling of Shell, Fabrication Drawing etc. The System is User Interactive with Low Cost implication.*

1. Introduction

Pressure vessels are probably one of the most wide spread equipment within the different industrial sectors. In fact, there is no industrial plant without pressure vessels. Pressure vessels often have a combination of high pressures together with high temperatures, and in some cases flammable fluids or highly radioactive materials. Because of such hazards it is imperative that the design be such that no leakage can occur as well as cope with the operating temperature and pressure. It should be borne in mind that the rupture of a pressure vessel has a potential to cause extensive physical injury and property damage. Pressure vessels store energy and as such, have inherent safety risks. Plant safety and integrity are of fundamental concern in pressure vessel design and these of course depend on the adequacy of design codes. However, even when the code includes specific regulations to determine the thickness of the different components, and taking minimum thickness it will leads to make thinning vessel with required factor of safety at design temperature and pressure. With minimum thickness of the shell we can make light weight vessel and low cost vessel.

The success of manufacturing companies depends on their ability to produce high- quality products at the lowest cost. This applies to a Pressure Vessel industry that aims to create designs that are optimized for manufacture. In striving for lower cost, it may be worthwhile to focus on the design phase or manufacturing phase of product development, since most of the product cost is committed into Design Phase. This cost is, however, not often seen until it is allocated later or downstream in the product development process. Currently, design phase is often conducted on conventional computer-aided solid modelling design tools in the Pressure Vessel Industry, which takes time and entails the risk of missing design flaws. Design Automation Concept has become a practical method of visualizing manufacturing cost and enabling product analysis by simulating product development activities in design for manufacturing support tools.

The presented work shows how an automated design system can be used to capture and present the engineering knowledge extracted from performance, manufacturing and maintenance activities, creating a better foundation for making decisions regarding conceptual design. Engineers can then change the design and directly assess the life cycle cost allowing fast iterations, based on engineering knowledge from design, manufacturing and maintenance disciplines.

2. Shell Design Automation Process:-

Figure 1 Shows overall process flow for Design Automation of Shell. This process flows gives insight into various steps involve in integrate tool.

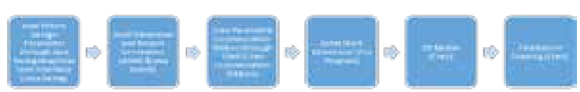

Figure 1. Shell Design Automation Process Flow

3. Design of Shell Component of Pressure Vessel:-

- **Shell Design as per ASME:-**

The Design of Shell begins with Selection of Design Parameter such as.

1. Design pressure
2. Allowable stress
3. Corrosion allowance
4. Shell Diameter
5. Radiography.

ASME Section VIII Division 1, UG 27 and Mandatory Appendix 1 Code describe Shell Design Standards as follows. Condition:-

i. $P \leq 0.385SE$

ii. $T \leq R/2$

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If Above two Conditions are satisfied than Shell will be consider as Thin and Shell Thickness as per ASME Section VIII Division 1 UG27 Code is,

T = PR/(SE-0.6P)

Eq. 1. Thin Cylindrical Shell Thickness as Per ASME Section VIII Division 1,UG27 Code

Else Shell will be consider as Thick and Shell Thickness as per ASME Section VIII Division 1 Mandatory Appendix 1 Part 1.2 Code is,

T=R ($Z^{(1/2)}$-1)

Where

Eq.2 Thick Cylindrical Shell Thickness as Per ASME Section VIII Division 1, Mandetroy Appendix 1

Equestion Solution gives minimum Require plate thickness for Pressure Vessel. Saftey factor of Thickness is Standardized to the value which is available in general use using preferred number of Series in Table 1.

Available Plate Size	1.6	2.0	2.5	3	3.2	4	5	6	8	10	12.5	15	20	22.5
25	30	32	35	40	45	50	55	60	65	70	75	80	90	100

Table 1. Available Standard Plate Thickness

- **Graphical User Interface (JAVA SWING):-**

Initially, the user specified Design Parameter. Pressure Vessel Shell dimensions are calculated using ASME Procedure to Satisfy Thickness requirement..

Figure 2. Graphical User Interface by Java with Example.

- **Creo Parametric Customization Ribbon:-**

Three Dimensional CAD model is created for Shell using Creo Parametric 2.00 Modelling Software. Figure Shows Creo Parametric 2.0.Customization ribbon with Pressure Vessel Tab and Cylindrical Shell, Spherical Shell Button.

Figure 3. Customization Tab of Creo Parameteric With Cylindrical and Spherical Shell Button

If User Select Cylindrical Shell or Spherical Shell Button from Pressure Vessel Tab, Shell Creo Parametric Model Open.

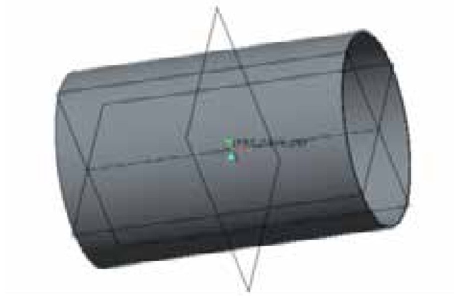

Figure 4. Cylindrical Shell by Creo Parameteric

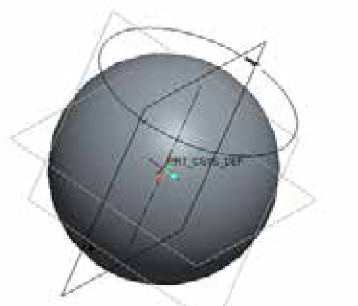

Figure 5. Spherical Shell by Creo Parameteric

- **Pro-Programing (Creo Parameteric 2.0):-**

By Pro Programing we can define Input Dimensions and Relations for Model.

- **Creo Parameteric Asks Input:-**

Parametric modelling uses parameters to control the dimensions and shape of CAD model. Generally, it is useful to explore design spaces by modifying parametric relations and to create multiple instantiations of designs. Now double click on the Model Dimension View Open. Again Double Click as per Defined Pro Program input Creo Parametric Software asks Input for the Shell Model.

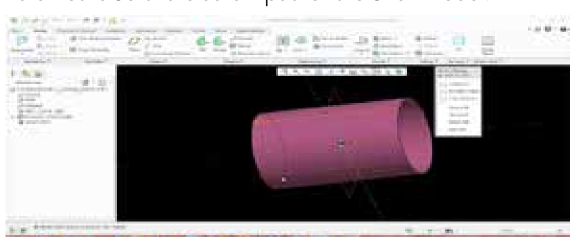

Figure 6. Creo Parameteric Asks Input

4. Example / Case Study:

- **Input Parameter:-**

Design Pressure	:	100 psi
Design Temperature	:	500 F.
Material of Construction	:	SA 675
Type	:	70
Radiogrphy	:	Spot Radiography = 0.85
Innternal Diameter	:	2400 mm
Corrosion Allowance	:	3 mm

Solution:-

Solution:-

Base on Material we can Find Allowable Stress (S) 19000 ksi.

Condition:-

i. 19000*0.85 = 6217.75

So Here Condition i. will be Satisfied so Thin Cylindrical Equestion.

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T = PR/(SE-0.6P) => T = 7.53073

ii. T ≤ R/2 = 1200 ≥T=7.53043
So Condition 1 & 2 satisfied above.

Shell Thickness = 7.43043 + Corrosion Allowance = 7.53043 + 3 = 10.53043

Final Require Thickness T = 12.5 mm (with Corrosion Allowance & Available Size)

Require Dimension To Change the Shape:-

Inside Diameter	:	2400 mm
Thickness of Shell	:	7.53075 mm (Without Corrosion Allowance , Minimum Size)
	:	12.5 mm (with Corrosion Allowance & Respect to Available Size)
Length of Shell	:	1000 mm

5. Conclusion:-
This research gives an idea about Design Automation in product development.Desing Automation can be seen as a tool for capturing knowledge and reusing it. This automated design tool helps in bridging the gap between design engineers and computational experts when analyzing product development process. An automated design system has been developed as a case study for Shell component of Pressure Vessel. The following conclusions can be drawn from this research regarding the design automation. Design automation allows freedom to designer from above routine work so that more time could be used to come up with new innovative solutions. Also Design Automation offers optimization of product concepts in conceptual design phase.

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