Design Automation of Heads

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Abstract: In Today's domain of Pressure Vessel is used for keeping Gases or Liquids at Pressure substantially different from the Ambient Pressure in different industries like Continuous Process, Chemical Industries etc. all over the world and hence Pressure Vessel Manufacturers try to make best Pressure Vessel which fulfills all the requirements of industry with least price and protection. Pressure differential is dangerous and many fatal accidents have occurred in the history of pressure vessel development and process. Therefore, pressure vessel design, fabrication, and process are regulated by engineering authorities backed by Legal Policy. For these reasons, the designation of a pressure vessel varies from nation to nation, but mainly involves the parameters such as maximum safe operating pressure and temperature. Mostly worldwide American Society for Mechanical Engineering (ASME) norm utilize for Design, Fabrication, Testing of Pressure Vessel. At Present companies are using PV-Elite/Compress like Pressure Vessel Design particular Software which serves Design support on ASME norm, but software has some drawback like cannot produce Fabrication Drawing. This document peace describe solution of this drawback with running modelling software Creo 2.0 (PTC). We consider HEADS part of Pressure Vessel in this document of piese.The Head Design automation System is organized into three parts. Geometry model builds up into Creo 2.0 with Customization of Creo Ribbon. Input Parameter/Relation creates by Pro-Programing in Creo. Graphical User Interface (GUI) builds by Java Swing Language. The planned system is capable to automate all major activities of Design of Head such as picking the choice of Material, estimation of require thickness, modelling of Head, manufacturing Drawing etc. The System is user interactive with low cost inference.

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

I. INTRODUCTION

Pressure vessels is mainly one of the most wide extebsuve equipment inside the different engineering sectors. In fact, there is no engineering plant without pressure vessels. Pressure vessels often have a grouping of high pressures together with high temperatures, and in a few cases combustible fluids or extremely radioactive materials. For the reason of such hazards it is very important 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 burst of a pressure vessel has a potential to cause extensive physical injury and property damage. Pressure vessels collect energy and as such, have intrinisic safety risks. Plant safety and integrity are of primary concern in pressure vessel design and these of course depend on the adequacy of design codes. However, even when the code includes specific policy 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 victory of manufacturing companies depends on their skill to produce high- quality products at the lowest cost. This applies to a Pressure Vessel industry that aims to make designs that are optimized for manufacture. In determining for lower cost, it may be useful to focus on the design phase or manufacturing phase of product development, since most of the product cost is dedicated into

Design Phase. This cost is, yet, not often seen until it is allocated later or downstream in the product manufacturing process. Currently, design part is repeatedly conducte on conventional CAD design tools in the Pressure Vessel Industry, which takes period and entails the threat of missing design flaws. Design computerization 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 computerize design system can be used to store and use the engineering knowledge extracted from routine process, developement and maintenance activities, creating a better base for making decisions regarding intangible design. Engineers can then change the design and directly assess the life cycle cost allowing fast iterations, based on engineering facts from design, development and maintenance disciplines.

II. HEAD DESIGN AUTOMATION PROCESS:-

Figure 1 show general process flow diagram for computerization desing of Heads. This process flows gives approaching various steps involve in integrate tool.

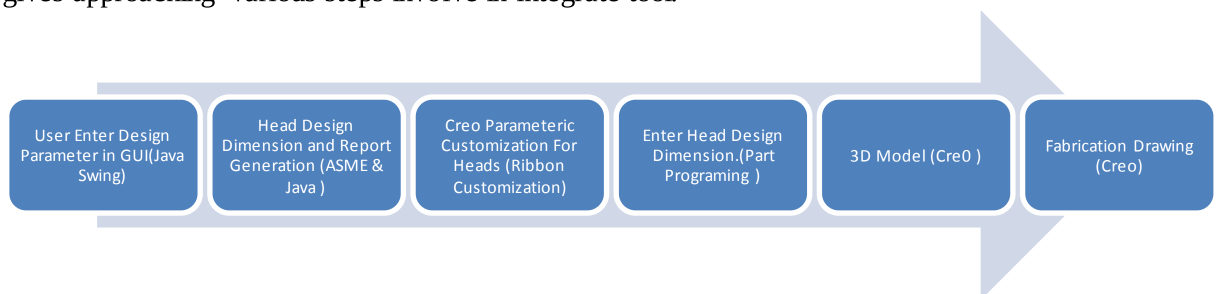

Figure 1. Head Design Automation Process Flow

III. DESIGN OF HEAD COMPONENT OF PRESSURE VESSEL

- **Head Design as per ASME:-**
  The Design of Heads begins with Selection of Design Parameter such as.

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

ASME Section VIII Division 1, UG 32 Paregraph and Mandatory Appendix 1 Artical 1-4 Paregraph Code describe Head Design Standards formula which is given into the Table 1.

Head	Hemi-Spherical	Ellipsoidal	Tori-Spherical	Conical
Condition	T < 0.356R P < 0.665SE	D/2h = 2:1	L = 1D r = 0.06D	α <= 30
Condition Satisfy than T =	$\frac{PR}{2SE-0.2P}$	$\frac{PD}{2SE-0.2P}$	$\frac{0.885PL}{SE-0.1P}$	$\frac{PD}{2\cos\propto(SE-0.6P)}$
Condition not Satisfy than T =	$R(Y^{\frac{1}{3}}-1)$	$\frac{PDK}{2SE-0.2P}$	$\frac{PLM}{2SE-0.2P}$	$\frac{PLM}{2SE-0.2P}$
	$Y = \frac{2(SEP+P)}{2SE-P}$	$K = \frac{\left[2+\frac{D}{2h}^{2}\right]}{6}$	$M = \frac{\left[3+\left[\frac{L}{r}\right]^{1/3}\right]}{4}$	$M = \frac{\left[3+\left[\frac{L}{r}\right]^{1/3}\right]}{4}$

Table 1. Formula for Head Design base on ASME Section VIII Division 1

Equestions answers give minimum require plate thickness for Pressure Vessel. Saftey issue, Thickness have standard value which is available in general use using preferred number of Series in Table 2.

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 2. 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..

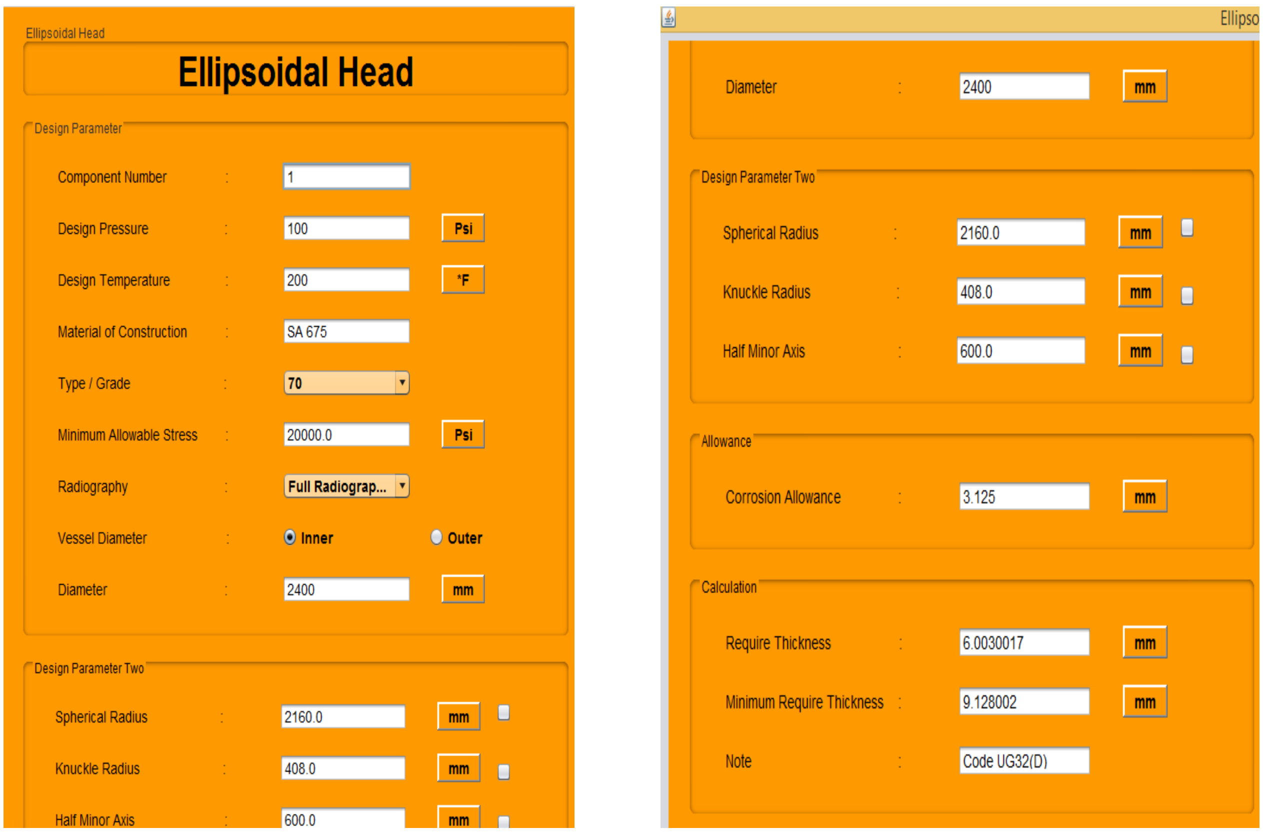

Figure 2. Graphical User Interface by Java with Example(Ellipsoidal Head).

Figure 2 shows GUI for Elliptical Head, similar kind of GUI developed using Java Swing for HemiSpherical Head, Tori Spherical Head, Conical Head.

- **Creo Parametric 2.0 Software Customization Ribbon:-**

  Three Dimensional CAD model is created for Head using Creo Parametric 2.00 modelling Software. Figure 3. shows Creo Parametric 2.0.customization ribbon with Pressure Vessel Tab for Hemi Spherical Head, Ellipsoidal Head, Tori Spherical Head and Conitact Head Button.

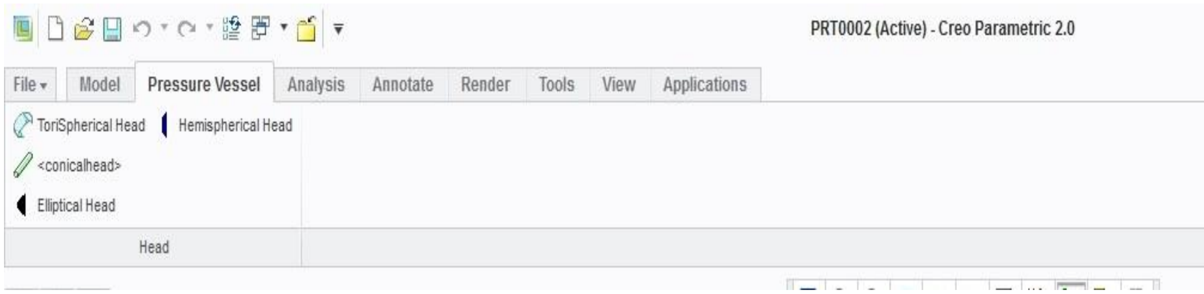

Figure 3. Customization Tab of Creo Parameteric With Pressure Vessel Tab for Heads

If User Select Hemi Spherical Head, Ellipsoidal Head, Tori Spherical Head and Conitact Head Button from Pressure Vessel Tab, Head Creo Parametric model open.

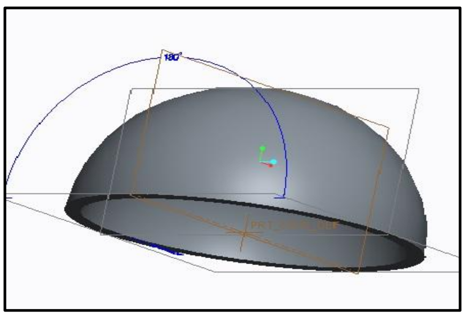

Figure 4. HemiSpherical Head by Creo Parameteric Parameteric

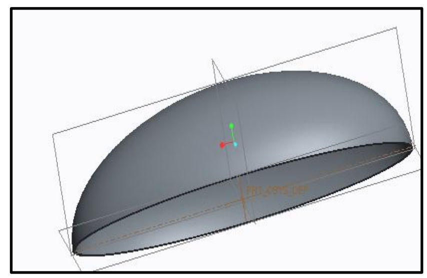

Figure 5. Elliptical Head by Creo

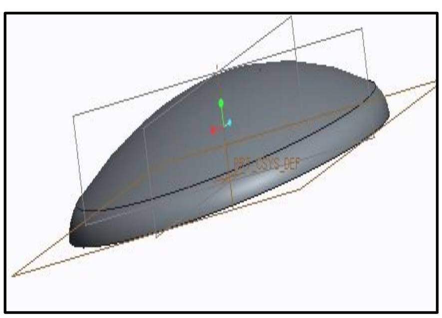

Figure 5.ToriSpherical Head by Creo Parameteric

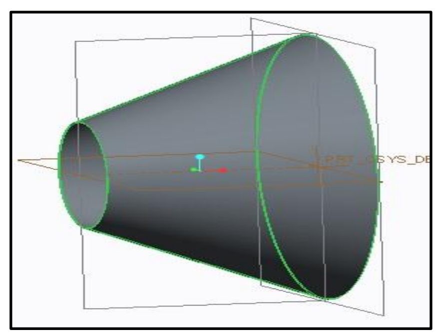

Figure 6. Conical Head by Creo Parameteric

- **ProPrograming :-**
  By Pro Programing we can identify Input Dimensions and Relations for Creo Parameteric Head Model.

- **Creo Parameteric Asks Input:-**
  Parametric modelling uses parameters to administerate the size and shape of CAD model. Generally, it is useful to find out design spaces by modifying parametric relations and to produce many 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 Head Model.

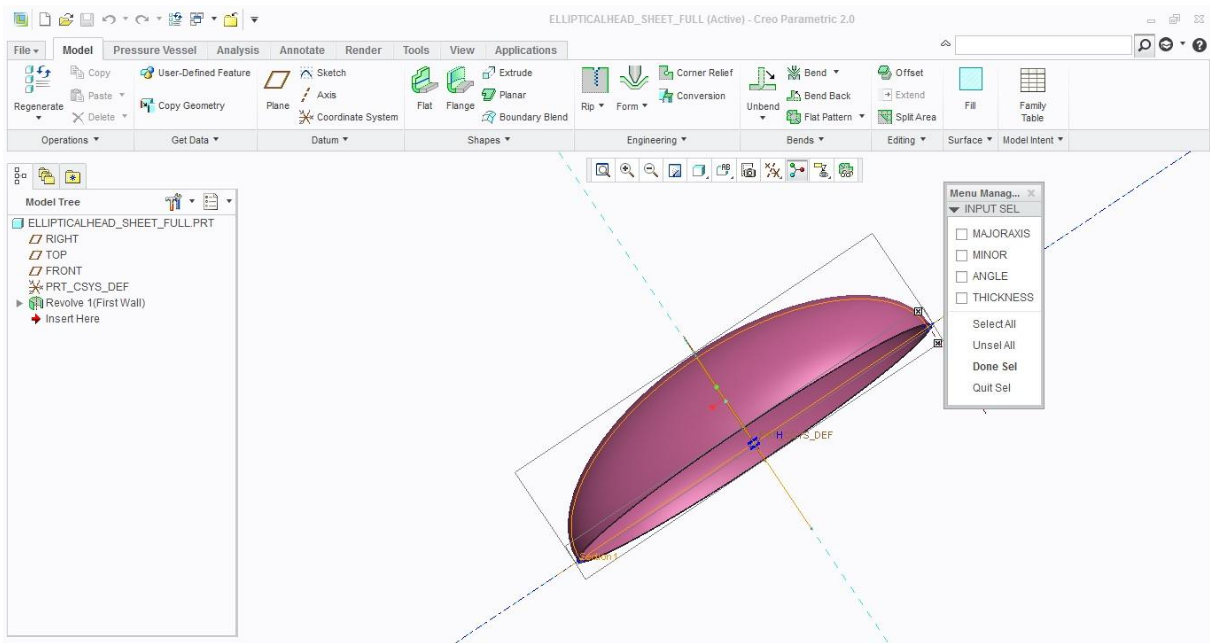

Figure 6. Creo Parameteric Asks Input

4. Example / Case Study:

- **Input Parameter:-**

Design Pressure : 100 psi
Design Temperature : 200 F.
Material of Construction : SA 675
Type : 70
Radiogrphy : Full Radiography = 1
Innternal Diameter : 96 inch = 2400 mm
Ratio : 2:1
Angle : 30
Corrosion Allowance : 0.125 inch = 3.125 mm

Solution:-

Base on Material we can Find Allowable Stress (**S)** 20000 ksi.

Head	Hemi Spherical	Ellipsoidal	Tori Spherical	Conical
Thickness as per PV Design Application	3.0015	6.0030	10.6239	8.1798

Thickness as per PV Design Application with CR	6.1265	9.1280	13.7540	11.3048
Thickness as per Pressure Vessel Handbook (Megyesy)	3.0500	6.0250	10.5754	8.2000
Thickness as per Pressure Vessel Handbook (Megyesy) with CR	6.6750	9.1500	13.7000	11.3250

IV. CONCLUSION

This investigate artical gives an inspiration about Design Automation in product development.Desing Automation can be seen as a device for capturing information and reusing it. This automated design tool helps in bridging the space between design engineers and computational experts when analyzing product manufacturing process. An automated design process has been developed as a case study for Head component of Pressure Vessel. The following conclusions can be drawn from this investigate regarding the design automation. Design automation allows freedom to designer from above daily work so that very time could be used to come up with new innovative solutions. Also Design Automation offers optimization of product concepts in initial design phase.

Nomenclature:-

P	=	Design Pressure (ksi)
D	=	Inside Diameter of Shell(mm)
R	=	Inside Radius of Shell (mm)
S	=	Allowable Stress of Material (psi)
E	=	Joint Efficiency
T	=	Thickness of Plate/Shell (mm)
L	=	Spheircal Radius (mm)
h	=	Half Minro Axis (mm) (Ellipsoida)
r	=	Crown Radius (mm)
α	=	Half Appex Angle (˚ Degree)

ACKNOWLEDGEMENTS

Authors would like to acknowledge Premier Engineering and Manufacturing Cor. For Dissertation Topic and other Facilites.

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