



Automation in Pressure Vessel Engineering Drawing By Using PV-Elite Data in AutoLISP Programming

Baskaran. B¹, Ram Prasad. S², Mariappan.M³, Samson Jayakumar. J⁴
M.E Scholar¹, Assistant Professor², Associate professor³, HOD⁴
Department of Mechanical Engineering
Mookambigai College of Engineering, Pudukkottai, Tamil Nadu, India

Abstract:

Pressure vessels are leak proof containers that are commonly used in industries to carry both liquid and gases under high pressure and temperature. It has many parts contained in it such as nozzles, supports, shell and head etc. In industries, pressure vessels are commonly designed to withstand the required pressure and temperature based on ASME, SECTION VIII (DIVISION-1). Once the design is completed the next step is to generate pressure vessel drawing. However manual drafting using AutoCAD consumes a lot of time, Further manual calculation of weight of pressure vessel is a tedious process. In this project, automation is achieved in generation of pressure vessel drawing using AutoLISP Programming. The major parameters to be considered in design of pressure vessels are maximum allowable working pressure, design metal temperature, type of material and the properties of fluid medium used. ASME CODE SECTION VIII addresses mandatory and non mandatory appendices requirements, specific prohibition, vessel materials, design, fabrication, examination, inspection, testing, certification and pressure relief regarding construction of pressure vessel. In this project mechanical design of horizontal pressure vessel based on this standard has been done incorporating PV-ELITE software. PV-ELITE provide a solution to automated design of pressure vessel as per the code with the given input parameters like type of materials, pressure, temperature, and diameter and corrosion allowance. It performs stress analysis and arrive the design parameters required to build the pressure vessels as graphical and numerical output. To build a pressure vessel the necessary design parameters are outer diameter of shell, thickness of the shell, shell length, straight flange distance, knuckle radius of head, crown radius of head, head thin. out, nozzle projection length etc. these parameters are arrived using PV-ELITE software. With these parameters as input a LISP program is developed to generate pressure vessel drawing in AutoCAD with necessary dimensions automatically. The proposed work is believed to minimize the drafting time required to generate pressure vessel drawing drastically.

Keywords: Pressure Vessel Design, ASME SECTION VIII (DIVISION-1) CALCULATION, (PV-Elite) Software Result, Auto LISP Programming, VLISP window, Load the lisp files, Achieve the design in AUTOCAD.

I. INTRODUCTION

A pressure vessel is a closed container designed to hold gases or liquids at a pressure substantially different from the ambient pressure. The primary purpose of pressure vessel is to separate two or more areas of different pressures. Pressure vessels of varied construction are used for handling and storage of liquids or gases. Pressure vessels are used in a variety of applications in industry and the private sector. They appear in these sectors as industrial compressed air receivers and domestic hot water storage tanks. Pressure vessels are diving cylinder, recompression chamber, distillation towers, autoclaves and many other vessels in mining or oil refineries and petrochemical plants, nuclear reactor vessel, pneumatic reservoir, hydraulic reservoir under pressure and storage vessels for liquefied gases such as ammonia, chlorine, propane, butane and LPG various parts like top head, bottom head, shell and nozzles etc. Pressure vessels are leak proof containers, as the name implies, their main purpose is to contain a given medium under pressure and temperature. This pressure and temperature comes from an external source or by the application of heat from a direct or indirect source or any combination of them. They may be of any shape and size ranging beer canes, automobile tires or gas storage tank, to more sophisticated ones encountered in engineering applications. Pressure vessels commonly have the cylindrical, spherical, ellipsoidal, conical or a combination of these

shapes. For example, the distillation column is a vessel used in oil and petroleum refining process. The heat exchanger used in many types of industries to transfer heat from one fluid to another fluid, acted as same. Also, reactor is a vessel, which is used for chemical reaction of contained substance. The material comprising the vessel is subjected to pressure loading and hence stresses from all direction. The normal stresses resulting from this pressure are functions of diameter of the elements under consideration, the shape of the pressure vessel as well as the applied pressure.



Figure.1. Pressure Vessel

II. DESIGN CODES

Pressure vessels are always works under certain pressure and temperature along with contain sometime lethal substances

which are hazardous for both human and environment. Considering this, safety implications and hazards arising from the operation of pressure vessels, there is an obvious need to standardize engineering and fabrication practices. To assure minimum safety standards, several design codes have prepared and developed. The most widely used Standards are the ASME boiler and pressure vessel code, published by American Society of Mechanical Engineers (ASME). ASME section VIII deals with the design for pressure vessels, materials specification, fabrication, opening and reinforcement, testing and marking, inspection and other mandatory or non mandatory appendixes. Section VIII contains three divisions, covering the different pressure ranges: Division 1: up to 3000 psi (200 bar)

Division 2: up to 10000 psi (690 bar)

Division 3: above 10000 psi (above 690 bar)

ASME section VIII, Division 1, deals with conventional pressure vessels means design by rule, while division 2, deals with stringent alternative rules means design by analysis, and division 3 deals with design of Nuclear Equipment. Vessels failure can be grouped into four major categories, which describe why a vessel failure occurs. Failures also grouped into types of failures, which describe how the failure occurs mean each failure contains its failure history, why and how it occurs. There are many reasons of vessels failure such as: Improper material selection, defected material. Incorrect design data, incorrect or inaccurate design method or process, inadequate shop testing. Improper fabrication process, poor quality control, insufficient fabrication process including welding, heat treatment and forming methods. In order to meet a safe design, a designer must be familiar with the above mentioned failure and its causes.

There have a few main factors to design safe pressure vessel. This study is focusing on analyzing the safety parameters for allowable working pressure. Allowable working pressures are calculated by using PV ELITE software which compile with the ASME section VIII, rules for construction pressure vessels. The objectives of the study is to design pressure vessel according to input data and analyze the safety parameters of each component for its allowable working pressure using; PV ELITE software.

III. LITERATURE REVIEW

Lin, B. T. and Hsu, S. H. [1] have described an automated design system for drawing dies using CAD software. Taking advantages of pre-built design knowledge base and data base, this system is able to output designs of the main components of a drawing, such as upper dies, lower dies and blank holders, upon users input of design information of blank lines, punch open lines, press data, and types of subcomponents such as hooks, guides, and stopper seats. This die design system is built on top of CATIA V5, and makes use of its built in modules, including part design, automation and scripting and knowledge advisor. Chavali .S.R, Sen C. and Mocko G. M and Summers J. D. [2] have discussed the development and usage of rule based design (RBD) in an industrial engineer-to order (ETO) application is presented. First, three different design and geometric modelling processes are discussed for specifying customized bottle packaging systems, assemblies, and components. These processes include:

(1) A manual method in which custom design specifications are uniquely created using two-dimension CAD software,

(2) A custom in-house Visual Basic automated system built on a commercially available three-dimension solid modelling package, and

(3) A commercially available rule based system integrated with a commercially available three-dimensional solid modeling software tool. The advantages and limitations of the different modelling approaches are presented and evaluated qualitatively. Chapman C. B and Pinfold M.

[3] describes a knowledge based engineering system (KBES). knowledge based engineering (KBE) is fundamentally about reuse in engineering knowledge to further multiply productivity by documenting rules & using them to automate design procedures. KBES to extend the current capabilities of automotive body in white (BIW) engineers. It allow them to respond dynamically to change within a rapid timeframe and to assess the effects of change with respect to the constraints imposed upon them by other product cycle factors, the systems operates by creating a unified model description that queries rules as to the suitability of the concept design and is built using a standard KBES to reduce project cost and system implementation. Dennis R. Moss [4] (pressure vessel design manual) book is may be used directly to solve problems, as a guideline, as a logical approach to problems, or as a check to alternative design methods. If more detailed solutions are required, the approach shown can be amplified where required. The user of this book should be advised that any code formulas or references should always be checked against the latest editions of codes, Le., ASME Section VIII, Division 1, Uniform Building Code, arid ASCE 7-95.

These codes are continually updated and revised to incorporate the latest available data. This book can eliminate the hours of research by providing a step-by-step approach to the problems most frequently encountered in the design of pressure vessels Shivam Chavan, Sushant khot, Mahesh kulkarni, Reshma aundhakar and Monali salunkhe [5] developed a lisp program for building plan, detailing of beam reinforcement, footing reinforcement and slab reinforcement for AUTOMATION IN CIVIL ENGINEERING DRAWING BY USING AutoLISP through International Research Journal of Engineering and Technology (IRJET) and their by increase the efficiency of work and reduce the time of work and make CAD efficient. Vijay kumar, Pardeep kumar [6] designed a pressure vessel through pv elite software and achieves the mechanical design calculation for Mechanical design of pressure vessel by using PV-ELITE software through International Journal of Scientific and Research Publications and their by increase the work flow and obtain precise output. Nayak h.b, Trivedi R.R, Araniya K.K [7] develop a program in solid edge software for obtaining the reactor nozzle drawing for Drawing Automation of Reactor Nozzle through International Journal of Engineering Research and Applications (IJERA) and their by achieve the automatic generation of reactor nozzle drawing.

Bhavik desai [8] developed a program in solid edge for analysis of pressure vessel reinforcement in Design Automation Nozzle Reinforcement Analysis for Pressure Vessel through International Journal of Innovative Research in Advanced Engineering and their by obtain reactor nozzle as a output drawing. (Sung-Yuen Jung & Chul Kim & Warn-Gyu Park & Hae-Yong Cho) [9]-Developing an automated system for predicting the shape and volume of an air pocket on the draw die Suvo, Lamar Stonecypher [10]- Customizing Autocad Using Auto Lisp Codes.

IV. MODELING OF INDIVIDUAL PARTS AND ASSEMBLING IN PV-ELITE SOFTWARE.

Table.1. Design Input Data

Component	units	Components	Units
Shell		Nozzle no.3	
Length	1410.16 CM	NPS	300 MM
Internal dia	3000 MM	Schedule	160
Thickness	40 MM	Material	SA516Gr.70
Material	SA515GR70	Length	540 MM
C.A	NIL		
Dished end (both side)		Saddle	
Type	Ellipsoidal	Width	304.8 MM
Internal dia	3000 MM	Wear plate width	254 MM
Material	SA515GR70	Contact angle	125DEG.
C.A	NIL	Wear plate thickness	32 MM
Nozzle no.1		Design Temp.	
NPS	300 MM	Internal	255°C
Schedule	80	External	45°C
Material	SA106B		
Length	500 MM		
Nozzle no.2		Design Pressure	
NPS	300 MM	Internal	35 kgf/cm ²
Schedule	100	External	1.1 kgf/cm ²
Material	SA105		
Length	300 MM		

PV Elite is a complete solution for the quick and comprehensive design of new pressure vessels for the process industry. PV Elite also evaluates and re-rates existing vessels including Fitness for Service analysis. The program considers the whole vessel, addressing all of the wall thickness rules and stress analysis requirements for vertical towers, horizontal vessels and heat exchangers. or, individual pressure vessel components may be graphically modeled and evaluated according to current safety codes. PV Elite provides engineers, designers, estimators, fabricators and inspectors around the world with solutions that match their pressure vessel design requirements. PV Elite's input, analysis and output have been designed to be clear, accurate and concise.

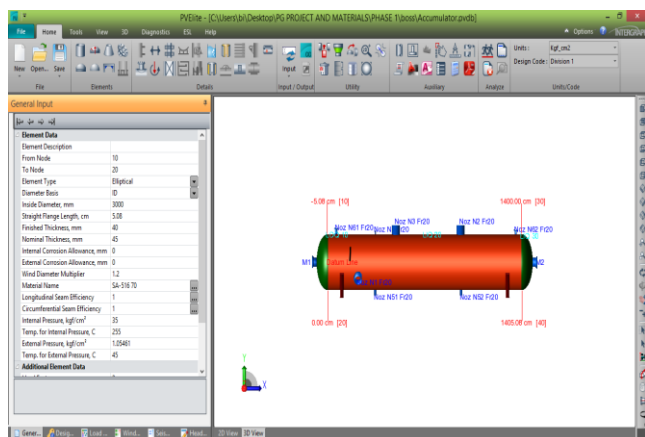


Figure.2. mechanical design of pressure vessel by pv-elite.

Horizontal pressure vessel is drawn as per element input data and the icon for each element can be found easily. The input parameters for each element also type in the suitable bar as can be seen on screen. Once all the elements were connected, the pressure vessel would be as shown in figure. After completion

of design in PV ELITE, design analysis has been carried out which shows results for each component as per input data. The results have shown safe and failure conditions as per ASME standard. Result analysis has been carried out in the form of equations, substitution and code references.

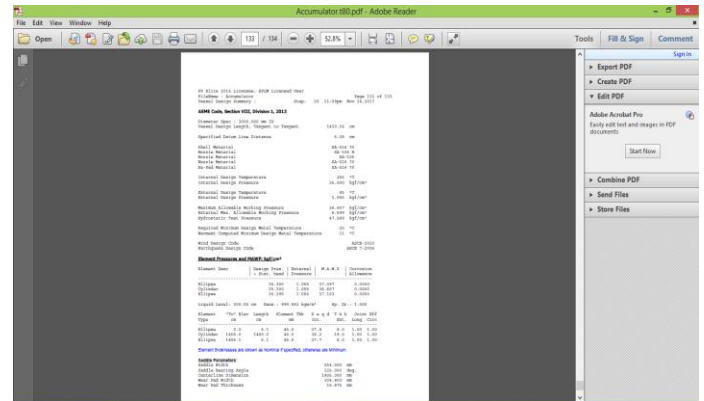


Figure.3. Pv-elite whole design calculation output summary

Table.2. Vessel Design Summar

ASME Code, Section VIII, Division 1, 2013	
Diameter Spec	3000.000 mm
ID Vessel Design Length, Tangent to Tangent	1410.16 cm
Specified Datum Line Distance	5.08 cm
Shell Material	SA-516Gr.70
Nozzle Material	SA-106 B
Nozzle Material	SA-105
Nozzle Material	SA-516 70
Re-Pad Material	SA-516 70
Internal Design Temperature	255 °C
Internal Design Pressure	35.000 kgf/cm ²
External Design Temperature	45 °C
External Design Pressure	1.055 kgf/cm ²
Maximum Allowable Working Pressure	36.607 kgf/cm ²
External Max. Allowable Working Pressure	6.599kgf/cm ²
Hydrostatic Test Pressure	47.589 kgf/cm ²
Required Minimum Design Metal Temperature	20 °C
Warmest Computed Minimum Design Metal Temperature	11 °C
Wind Design Code	ASCE-2010
Earthquake Design Code	ASCE 7-2005

Table.3. Element Pressures and Mawp: Kg/CM²

Element Desc	Design Pres+ Stat. head	External Pressure	M.A.W.P	Corrosion Allowance
Ellipse	35.300	1.055	37.097	0.0000
Cylinder	35.300	1.055	36.607	0.0000
Ellipse	35.295	1.055	37.103	0.0000

Table.4. Liquid Level: 300.00 cm, Dens: 999.552 kgm/m³, Sp.Gr: 1.000

STEP-1				
Element Desc	"To" Elev cm	Length cm	Element Thk mm	Reqd.thk Int.
Ellipse	0.0	5.1	45.0	37.8
Cylinder	1400.0	1400.0	40.0	38.2
Ellipse	1405.1	5.1	45.0	37.7
STEP-2				
Element Desc	Reqd.thk Ext.	Joint efficiency long	Joint efficiency Circ.	
Ellipse	8.0	1.0	1.0	
Cylinder	19.0	1.0	1.0	
Ellipse	8.0	1.0	1.0	

Table.5. saddle-parameters:

Saddle Width	254.000 mm
Saddle Bearing Angle	125.000deg.
Centerline Dimension	1905.000 mm
Wear Pad Width	304.800 mm
Wear Pad Thickness	15.875 mm
Wear Pad Bearing Angle	135.000deg.
Distance from Saddle to Tangent	802.000 mm
Baseplate Length	2997.200 mm
Baseplate Thickness	32.000 mm
Baseplate Width	254.000 mm
Number of Ribs (including outside ribs)	5
Rib Thickness	18.000 mm
Web Thickness	18.000 mm
Height of Center Web	228.600 mm

Table.6. summary of maximum saddle loads, operating case:

Maximum Vertical Saddle Load	125656.11 kgf
Maximum Transverse Saddle Shear Load	7195.86kgf
Maximum Longitudinal Saddle Shear Load	21940.97 kgf

Table.7. summary of maximum saddle loads, hydrotest case:

Maximum Vertical Saddle Load	111040.37 kgf
Maximum Transverse Saddle Shear Load	299.87kgf
Maximum Longitudinal Saddle Shear Load	332.73 kgf

Table.8.weights:

Fabricated - Bare W/O Removable Internals	113585.6 kgm
Shop Test - Fabricated + Water (Full)	220284.6 kgm
Shipping - Fab. + Rem. Intls.+ Shipping App.	113585.6 kgm
Erected - Fab. + Rem. Intls.+ Insul. (etc)	113585.6 kgm
Empty - Fab. + Intls. + Details + Wghts.	113585.6 kgm
Operating - Empty + Operating Liquid (No CA)	220281.3 kgm
Field Test - Empty Weight + Water (Full)	220284.6 kgm

The following steps describes the steps for solving the pressure vessel problem in pv-elite software.

- [1] START
- [2] Selection of Code
- [3] Input the data for Cylindrical and Conical Shell, Head, etc. (P,D,t)
- [4] Select the Material for the element.
- [5] Calculation of thickness for shell, head, nozzle.
- [6] Calculation Results
- [7] Input the parameters for lifting lug and leg support
- [8] Calculate Stress induced in all elements
- [9] Examine the results for stress generated in all elements
- [10] Conclude for safety of Vessel
- [11] STOP

V. PV-ELITE INBUILD CODES AND STANDARDS.

PV Elite keeps pace with worldwide vessel design codes and standards, incorporating code changes as they become mandatory. All of the major codes and standards are included.

- [1] European Norm (EN) 13445 rules for the analysis of unfired pressure vessels.
- [2] ASME BPV Code Section VIII, Divisions 1 & 2 for the design and analysis of vessels and heat exchanger components.
- [3] British Standard PD 5500 guidelines for the analysis of unfired fusion welded pressure vessels, heat exchanger components and tube sheets.
- [4] ASME/ANSI B16.5 and B16.47 standards for pipe flanges and flanged fittings, including equivalent pressure due to applied loads plus pressure ratings for flanges from the DIN standard.
- [5] ASME Section UHX, PD 5500 and Tubular Exchanger Manufacturers Association (TEMA) standards for designing and analyzing tube sheets and expansion joints in heat exchangers.

- [6] ASME B31.3 rules for replacing area around fabricated tees.
- [7] ASME STS code for stack analysis.
- [8] Welding Research Council (WRC) Bulletins 107, 297, 368 and PD 5500 Annex G rules for calculating local stresses in and around vessel attachments (lugs and nozzles).

VI. DISCUSSION

Design of pressure vessel can be finished quickly by applying numerous calculations in pv-elite software. The drawing process was simpler associated to the Autolisp programming in autocad software.

VII. AUTOLISP PROGRAMMING.

AutoLISP is the programming language for use with AutoCAD. It is the subset of high level of LISP language especially adapted from within the AutoCAD working environment. AutoLISP code can interact with the user through AutoCAD's graphical editor by use of primitive functions that allow the user to pick points, choose objects on screen, input numbers and other data. AutoLISP also has a built-in GUI mini-language, the Dialog Control Language, for creating modal dialog boxes with automated layout, within AutoCAD. Almost all activities user do manually can be performed automatically using AutoLISP. AutoLISP have rich set of functions that you user use to perform any activity in AutoCAD automatically. It has general programming functions for variable manipulation, decision control, loops, arithmetic operations, error handling and function handling. And special functions such as geometric functions, display control functions, query and command functions, user input functions and object handling functions. Once program is made user get drawing as a output within fraction of minutes. AutoLISP is generally used to customize the AutoCAD. It is very useful to draw the figures, for repeated commands like (line, offset, trim). Using AutoLISP drawing can be made more quicker and precise. In this paper we developed LISP program for pressure vessel plan and section view of head, shell, nozzle, lug supports projection and weight calculation,. etc. After the invention of AutoCAD, drafting of engineering drawing becomes easier. In Engineering drawing, drafting of element with small detailing at any scale is made possible. Main advantage of AutoCAD is easy to generate and achieve the output for production drawing formation, to achieve this output user must have thorough knowledge of AutoCAD command. But practically he becomes bore in detailing in drawing elements and errors may be happens for huge projects. To eliminate this problem, we can customize the AutoCAD. AutoLISP is the old but very powerful tool to Automation of drawing. In AutoLISP programmer sets arithmetic equations to get specific point of the drawing in terms of inputs given by user. After given inputs LISP draws the figure automatically.

VIII. PROGRAMMING IN AUTOLISP

Math functions that accepted as a multiple argument-Before programming in AutoLISP user must have basic structure of AutoLISP. If we want to do basic arithmetic function using LISP following basics should be understand

- (+ number number ...)add
- (- number number ...)subtract
- (* number number ...)multiply

(/ number number ...)divide

IX. NUMERICAL SOLUTION IN AUTOLISP

Now Consider Value of A= 10 and Value of B= 20 Then Operation Will Be Like Below

Table.9.

OPERATOR	DESCRIPTION	EXAMPLE
+	Adds two operands	(+ A B) gives 30
-	Subtracts second operand from the first	(- A B) gives 10
*	Multiplies both operands	(* A B) gives 200
/	Divides numerator by denominator	(/ B A) gives 2

X. IMPORTANT FUNCTUONS USED IN LISP PROGRAMMING

Table.10.

Getpoint	Needs you to pick a point on the screen.
Getint	Needs an Integer e.g.: 1.
Getreal	Needs a real number e.g.: 10.00.
Getstring	Needs a string of text.
Getdistance	Needs you to enter a value.
Getvar	Retrieves the value of an autocad system variable.
Setvar	Seta an autocad system variable to a specified value.
Setq	Sets the value of a symbol or symbols to associated expressions.

XI. COMMANDS USING IN AUTOLISP

Three types of command are used.

CAR, CADR, CADDR - It directs the point into X, Y, Z directions respectively. For example if user want to direct the point pt1 in X direction then will write it as: (car pt1)

LIST - The LIST function simply used to link the coordinates together into one point. For example if user wants to define Q1 in X and Y direction will write as: (list (car pt1) (cadr pt2))

ENTLAST - The entlast function is frequently used to obtain the name of a new entity that has just been added with the command function. To be selected, the entity need not be on the screen or on a thawed layer.

POLAR - Return the ucs 3D point at a specified angle and distance from a point.

XII. CO-ORDINATING OF FIGURE

The main work of creating the program is to define some specific points of the drawing. The points are defined as XY coordinate with respect to fixed point of drawing. These points are defined by simple mathematical relations with each other.

Once these points are defined, it automatically draws in the CAD drawing as per the inputs are given by the user. The inputs include the dimensions of drawing such as diameter, thickness, length, angle, width, depth of the section. For detailing of drawing like pressure vessel the respective values should be taken as per ASME & IS code requirement.

XIII. CO-ORDINATES OF HORIZONTAL PRESSURE VESSEL, INPUTS REQUIRED IN PROGRAM

Table.11.

Sr.no	Notations	Description
1.	d1	Shell inside diameter
2.	t1	Enter the shell thickness
3.	l	Enter the length of shell
4.	sf	straight flange length
5.	t2	web plate thickness
6.	mn1	Enter the shear plate width
7.	nz1	Enter the nozzle N1, N2 & N3 (inlet / outlet / spare) projection length
8.	nz2	Enter the nozzle N1 polar angle
9.	nz3	Enter the nozzle N1, N2&N3 ID
10.	nz4	Enter the nozzle N1, N2&N3 THK
11.	nzl1	Enter the nozzle N2 position from shell edge
12.	nzl2	Enter the nozzle N1 position from shell edge
13.	do1	Enter the drain nozzle N5 projection length
14.	cp	specify the center point of circle(SHELL)

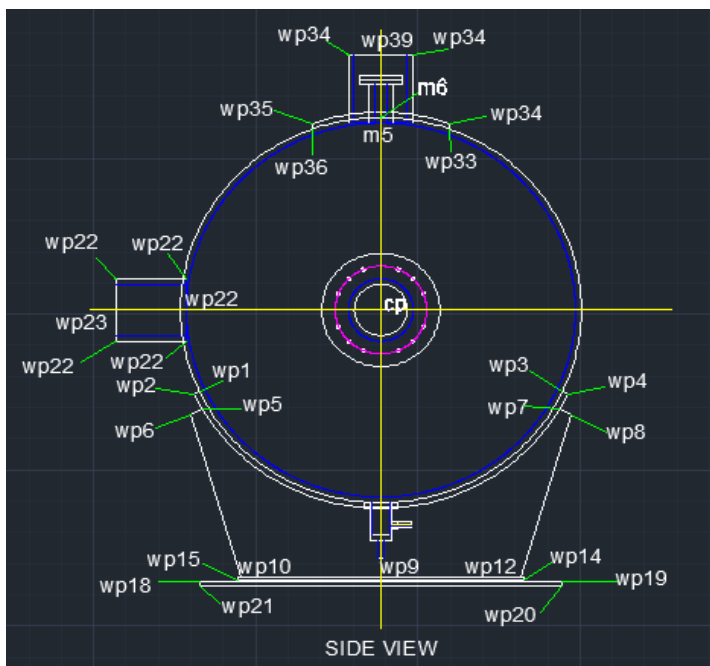


Figure.4. pressure vessel - side view.

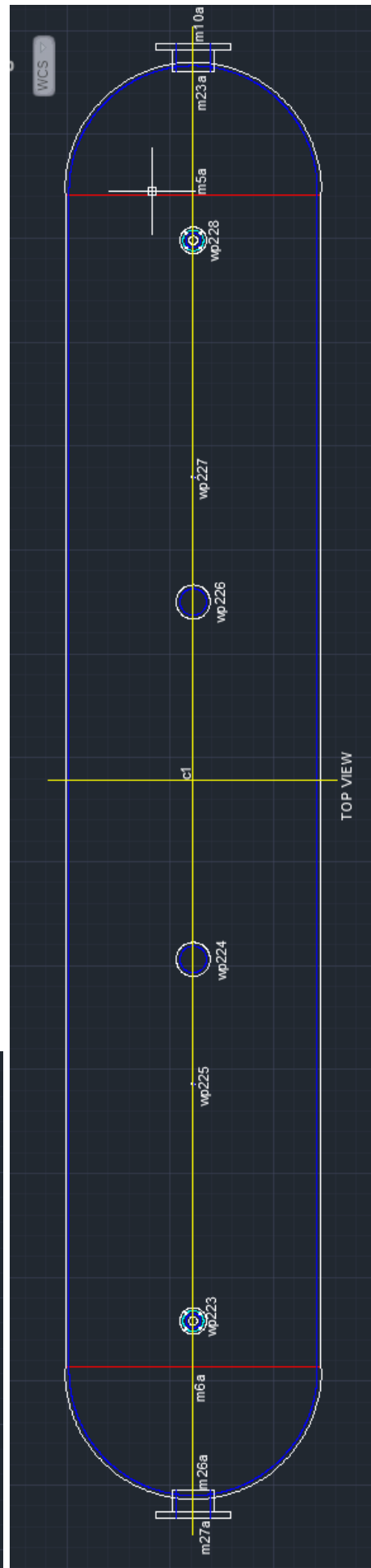


Figure.5. pressure vessel - top view (rotated to 90deg.).

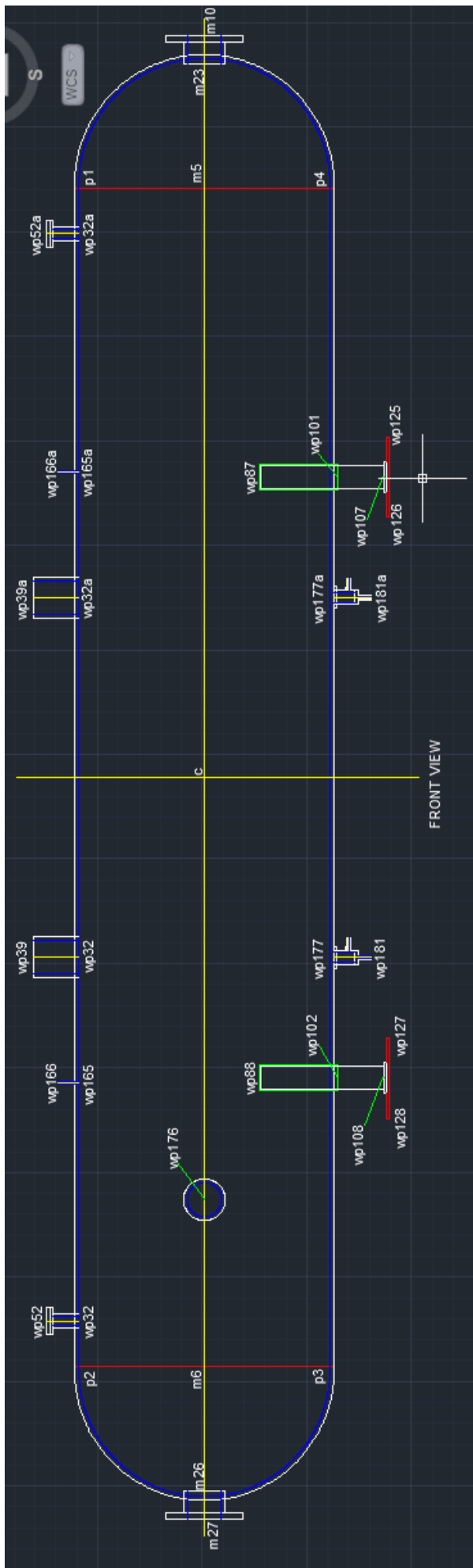


Figure.6. pressure vessel - front view (rotated to 90deg.).

XIV. RESULT

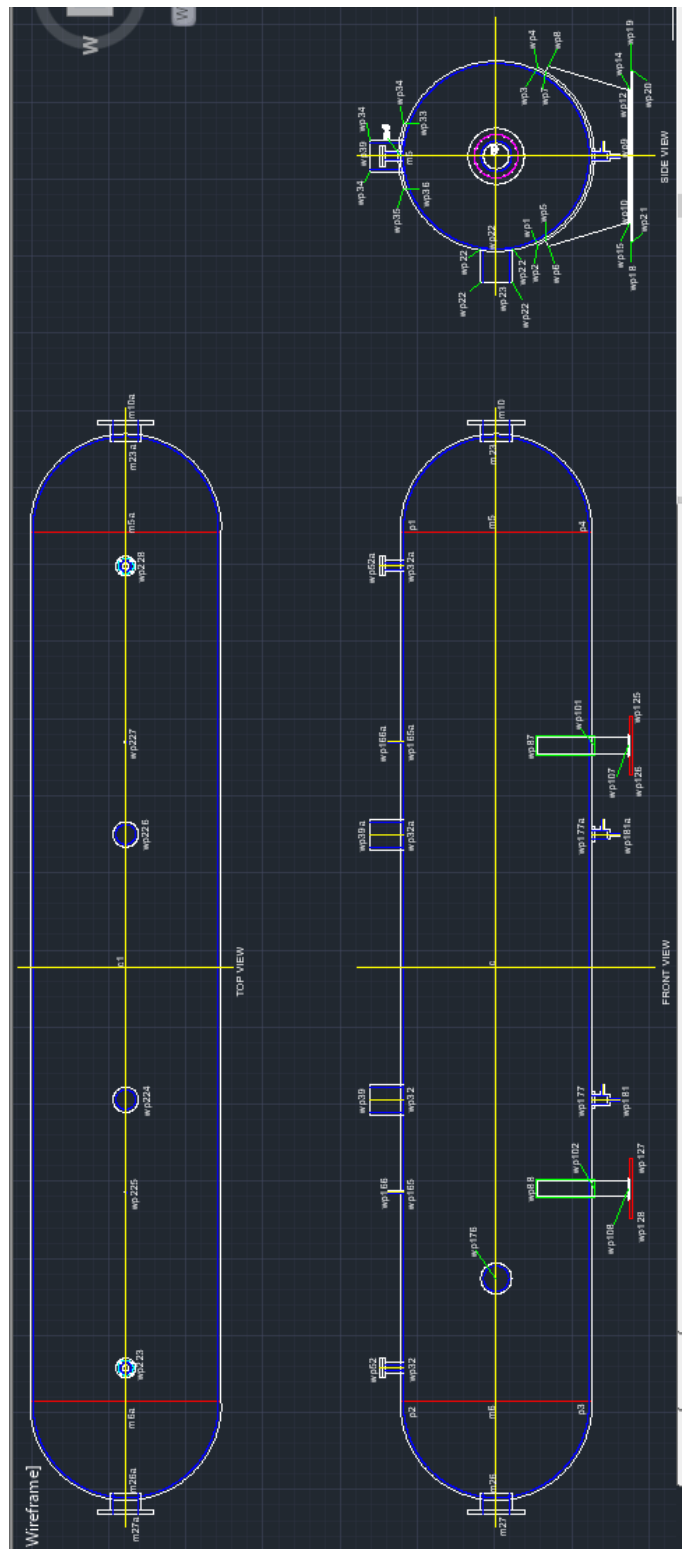


Figure.7.pressure vessel-assembled view(rotated to90deg .)

XV. ACHIEVE THE DESIGN IN AUTOCAD.

After entering the specific input in input form of macro, design calculation of pressure vessel has been carried out in visual basic program. Designed data of pressure vessel is been developed and optimized designed data has been is taken for generating drawing in pv-elite software and drawing is get created in auto cad. At last it may display the weight of pressure vessel in drawing itself. So by using this automation macro program, estimation team may save lot of time to calculate the weight of pressure vessel at time of enquiry.

Pressure vessel various parts like top head, bottom head, shell and nozzles etc. In industries the manufacturing drawing was prepared using AutoCAD as a drafting tool. There was a lot of time consuming in editing, revising the drawing such a fabrication drawing in AutoCAD. Thus, it is needed to automate the manufacturing drawing of pressure vessel.

[10]. Basic c program guide from learning center, trichy.

XVI. CONCLUSION

Design of pressure vessel for every individual case is time consuming and uneconomical process. Hence, in order to reduce the design cycle time, the software is developed for the design of pressure vessel and to generate the manufacturing drawing.

[1] The time required to generate drawing through models will be approximately 70 % less than current time schedule.

[2] Standardized engineering processes.

[3] Error proofing.

[4] Easy reusability.

[5] Reducing cycle time for drawing generation.

[6] With the help of automation users can generate automatically manufacturing drawing of pressure vessel front view, various parts detail, detail of all welds required for various welding joints, general notes, fabrication notes, title block. At the time of enquiry of any project, it was found that time taken by estimator for estimating cost of pressure vessel is 4 to 5 days because estimation team may not able to estimate weight of pressure vessel until design of different pressure vessel and modelling of pressure vessel may not be prepared by designers and cad engineers. By developing pressure vessel automation program, time taken by estimator to estimated weight of pressure vessel is been reduce from 4 days work to 4 to 5 hour work, pressure vessel automation program provides output as designed data of pressure vessel, weight of pressure vessel as well as it provide automatically generation of 2-D drawing in auto cad software.

XVII. ACKNOWLEDGEMENT

We acknowledge with thanks to our guide Ram Prasad. S (Assistant Professor) Mookambigai College of Engineering, who helps us and encourage us every time. We also thanks to all faculty and staff of Department of Mechanical Engineering for their constant encouragement to do this project. We also thank Management and Director of the institute for supporting all the way to complete this project in time.

XVIII. REFERENCE

[1]. The ABC's of AutoLISP by Omura George, 2001

[2]. KSM CAD academy reference guide..

[3]. Dennis R.moses- pressure vessel design manual.

[4]. AutoCAD user guide 2014

[5]. AutoLISP Developer's Guide- Autodesk

[6]. AutoLISP Reference Guide- Autodesk

[7]. limit state method of steel design by S Kanthimathinathan

[8]. AutoLISP Tutorial- CAD intension

[9]. Autolisp tutorial by Engineering Tutorials