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DESIGN AND ANALYSIS OF PRESSURE VESSEL

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ABSTRACT

The oil and gas field deals with various processes such as refining, chemical mixings and blending, liquefaction, purification, storage of fluids and chemicals under stipulated pressure and temperature require boilers, tubes and pipes, heat exchanger pressure vessels, etc. These have been a very important part of technical and technological systems such as chemical and reactive processes in Oil and gas field. This project work deals with a detailed design and analysis of pressure vessel taken as a problem definition from client Shri Krishna Transport (Kutch). A detailed design of various parts of vessels like shell, closure, support, flanges, nozzles etc. Design is carried according to rules of ASME code section VIII; Division I. The ASME is an American Society of Mechanical Engineers that regulates the design and construction of boilers and pressure vessels. The BPVC is a standard that provides rules for the design, fabrication and inspection of boilers and pressure vessels. Code provide rules that permit the use of materials and alternative methods of construction that are not covered by existing BPVC rules. The analytical design as per client Shri Krishna Transport (Kutch) design data and general notes have been analyzed and validated using Software tools such as PV -elite, Compress or ANSYS, and detailed modelling using Auto-CAD tool. It also deals with the study of various parts like flanges, support etc. Various methods of fabrication and testing such as LPT, RT, and Hydro Test are also included.

I. INTRODUCTION

SevenStar ENGINEERS AND FABRICATORS, Kiravali are manufacturer and Supplier of plant/systems and Equiments. Mr. MOHAMMED AKIL is Mechanical Engineer. He started his career with Indo Berlin Industries who supplied the major plants to HOC Ltd. around 1970. He subsequently worked for manufacturers like G.R. Engineering & Lloyds Steel Industries Ltd. He has also worked with well-known consultants like Tata Consulting Engineering and Simon Carve India Ltd.

Mr. Akil has diversified experience in the equipment industry. He has worked on Chemical, Petrochemical, Fertilizers, Nuclear Power, Thermal Power, Pharmaceuticals and Polyester Fiber Industry. He has been involved with marketing and sales, mechanical design, process design, estimation, purchase planning, production planning, production & quality control plant maintenance and ISO-9001:2015 documentation. He promoted Process Equipment Engineering and SevenStar Process Equipment , which supplies:

1. Air Drying Plants.
2. Liquid Drying Plants.
3. Low Pressure Dehumidifie
4. Liquid Benzene Dryer (with Udhe and UOP for Nirma ltd.)

He also designed and engineered India and Asia's first Benzene Vapour Recovery System in 2002, which won an international award. He supplied off gas dryer to ONGC through Duke- offshore and Burn Std. Co. In 2005 along with IIT and Clique Development Consultant was instrumental in designing equipment for India's largest Solar Water Heating System to Mahananda Dairy at Latur Road.

He was felicitated by Thane Belapur Industries Association for his contribution to installing large common effluent treatment plant of Navi Mumbai.

Mr. Akil has also traveled abroad to receive management training. MEMBERSHIPS:

1. PPMAI

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2. Institution of Engineers

3. Indian Welding Society

Pressure vessels are vessels operating uncle an external or internal pressure exceeding 1.03 Kg/cm7g. Elgin has manufactured several pressure vessels for respected customers like FMC Corp. UB petro products, Reliance Group, etc for the past 20 years.

We have performed under inspection by reputed international agencies like Bureau Veritas, RINA , TUV, DNV and almost all national agencies including EIL. DESIGN/MANUFACTURING CODE

- Elgin products conform to the following codes:

1. ASME Sec VIII Div 1

2. IS 2825

They also provide vessels conforming to international codes like:

1. BS 5500

2. COADAP

1. EN 13445

We can provide design verification on software's like PVElite, COMPRESS, CADEM. etc.

- **Material:**

We can provide vessels of following materials

1. Carbon Steel

2. Stainless Steel: SS304, SS 316, SS316L

3. Clad Steel

4. Aluminium

Pressure Vessel

A Pressure vessel is a container designed to hold gases or liquid at a pressure substantially different from the ambient pressure. Construction methods and materials may be chosen to suit the pressure application, and will depend on the size of the vessel, the contents, working pressure, mass constraints, and the number of items required.

Need and use of Pressure Vessel

Pressure vessels are used in a variety of applications in both industry and private sector. They appear in these sectors as industrial compressed air receivers, boilers and domestic hot water storage tanks. Other examples of pressure vessels are diving cylinders, recompression chambers, distillation towers, pressure reactors, autoclaves.

II. METHODOLOGY

Shell

It is a primary component that contains the pressure. Pressure vessel shells in the form of different plates are welded together to form a structure that has a common rotational axis. The main body of the pressure vessel is

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known as a shell. The process of pressure vessel generally occurs in this region. Generally manhole and hand hole is located in this region. No other nozzle is mainly mounted on it. Internal pressure of the vessel acts more in this region.

Fig: Shell

Dish end

The pressure vessel must be closed; so heads are manufactured typically on a curved rather than the flat. The reason is that curved configuration is stronger and allows heads to thinner, lighter and less expensive than the flat heads.

The upper and lower part of a pressure vessel is known as a dish end. Mostly the inside area of dish remains empty since no processes of pressure vessel occurs. Mostly many of the nozzle is mounted on the dish end. The manufacturing process of dish end is easy because dish is a single piece and only a pressing process is to be done.

Fig: Dish end

Nozzle

Nozzle is a cylindrical component that penetrates in the shell or head of a pressure vessel. It is the sub assembles part of pressure vessel which is mounted on a shell & dish as par requirement. Nozzle is used to transfer/receive working medium from the pressure vessel and mounted equipment like pressure indicator etc.

Fig: Nozzle

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Saddle Support

Saddle supports are commonly used to support Horizontal pressure vessels. A Pressure vessels are subjected to pressure loading i.e. internal or external operating pressure different from ambient pressure. The pressure vessels are of horizontal or vertical type. For horizontal vessel the saddle supporting system plays an important role in the performance of the equipment. A proper saddle supporting system improves safety and facilitate to operate the pressure vessel at higher pressure conditions which finally leads to higher efficiency.

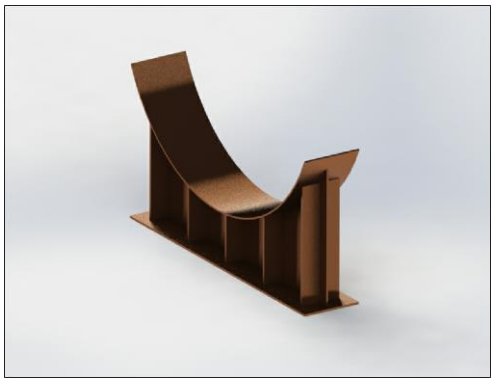

Fig: Saddle supports

III. MODELING AND ANALYSIS

To design and analysis the General Arrangement drain pots per ASME section viii division 1 guidelines for the client specification.

Table: Design data

DESIGN AND OPERATION DATA		
DESCRIPTION		VESSEL
DESIGN PRESSURE	Kg/cm²g	ATM.
WORKING PRESSURE	Kg/cm²g	ATM.
DESIGN TEMPERATURE	°C	100
WORKING TEMPERATURE	°C	-
HYDRO TEST PRESSURE	Kg/cm²g	WATER FILL
JOINT EFFICIENCY		0.7
RADIOGRAPHY		N.A.
STRESS RELIEF		N.A.
FLUID HANDELED, DENSITY		LIQUID, 1.5/M3
EMPTY WEIGHT Kgs		3300 Kg.
CAPACITY		22.5M3
HYD. WT.		
INSPECTION BY		CLIENT
CORROSION ALLOWENCE		1.5

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Table: Bill of material

ITEM	DESCRIPTION	QTY.	MATL.	SIZE
28	NAME PLATE	1	SS304	175 X 110 x 2 THK.
27				
26	CANVAS BELT	6	CANVAS	150W x 6 THK. x 5900 LONG.
25	PLATFORM	2	MS	
24	LADDER	1	MS	
23	BOLTS & NUT	24	GI	M16 x 75 LONG
22	SADDLE	6	MS	
21	BACKING FLANGE	1	SS304	50NB x 6 THK. FLANGE
20	GASKET	1	NYLON/TEFLON	50NB x 3 THK.
19	50NB COVER	1	SB209 ALLOY 1060	50NB x 16 THK. COVER.
18	50NB FLANGE	1	SB209 ALLOY 1060	50NB x 20 THK. FLANGE.
17	50NB PIPE FOR SUPPLY	1	SB209 ALLOY 1060	60.3 O/D. x 8 THK.
16	RF. PAD FOR 100NB NOZZLE	1	SB209 ALLOY 1060	75W x 10 THK.
15	BOLTS & NUT	4	SS304	M16 x 75 LONG
14	BACKING FLANGE	1	SS304	100NB x 6 THK. FLANGE
13	GASKET	1	NYLON/TEFLON	100NB x 3 THK.
12	100NB COVER	1	SB209 ALLOY 1060	100NB x 16 THK. COVER.
11	100NB FLANGE	1	SB209 ALLOY 1060	100NB x 20 THK. FLANGE.
10	PIPE FOR 100NB FILLING NOZZLE	1	SB209 ALLOY 1060	114.3 O/D. x 8 THK.
9	RF. PAD FOR MH1	1	SB209 ALLOY 1060	75W x 10 THK.
8	BOLTS & NUT	16	SS304	M12 x 65 LONG
7	BACKING FLANGE	4	SS304	450NB x 6 THK. FLANGE
6	GASKET	1	NYLON/TEFLON	450NB x 3 THK.
5	MANHOLE COVER	1	SB209 ALLOY 1060	450NB x 16 THK. COVER.
4	MANHOLE FLANGE	1	SB209 ALLOY 1060	450NB x 16 THK. FLANGE.
3	MANHOLE NECK MH1	1	SB209 ALLOY 1060	457 O/D. x 12 THK.
2	DISH END	2	SB209 ALLOY 1060	1800 I/D. x 10% TORISPHERICAL DISH
1	SHELL-1	1	SB209 ALLOY 1060	1800 I/D. (5693) x 7500 x 12THK.

BILL OF MATERIAL

Table: Nozzle schedule

MARK	NB	SCH.	O/D	P.C.D.	R.F.ø	I/D	R.P.ø	T	TH	'N' NOS. 'D' ø
N3	50	80	152	121	92	62	160	3.91	19.1	4 NOS 19 ø
N2	100	80	190	153	127	90.7	220	5.49	24	4 NOS 20 ø
N1	100	80	190	153	127	90.7	220	5.49	24	4 NOS 20 ø
MH1	450	10THK	635	533	504	461	600	6	20	12 NOS 20 ø

TYP. NOZZLE WELD DETAIL

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Drawing

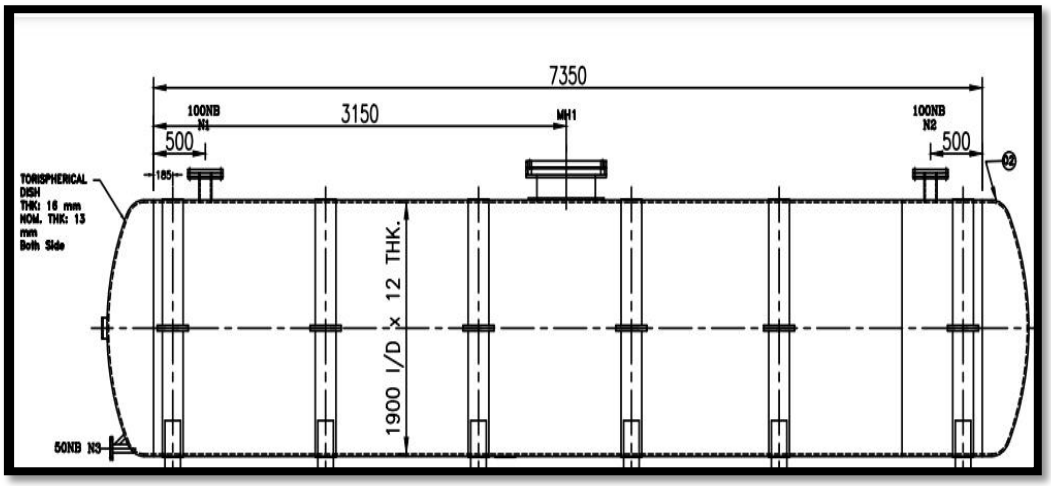

Fig: General arrangement

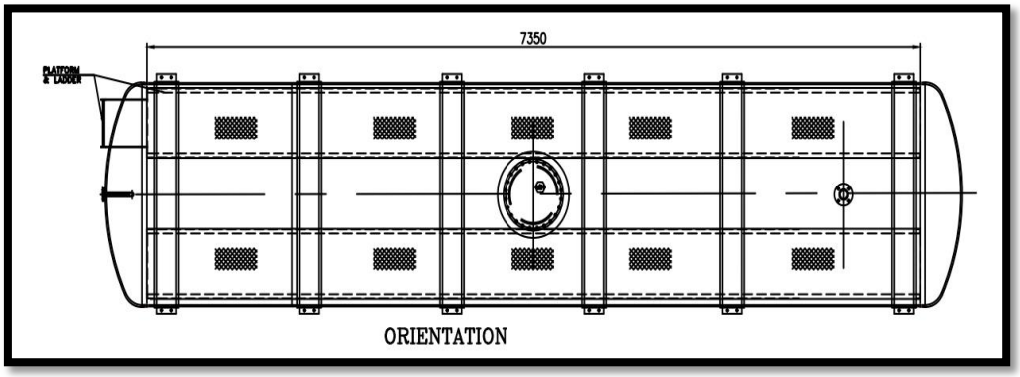

Fig: Nozzle plan

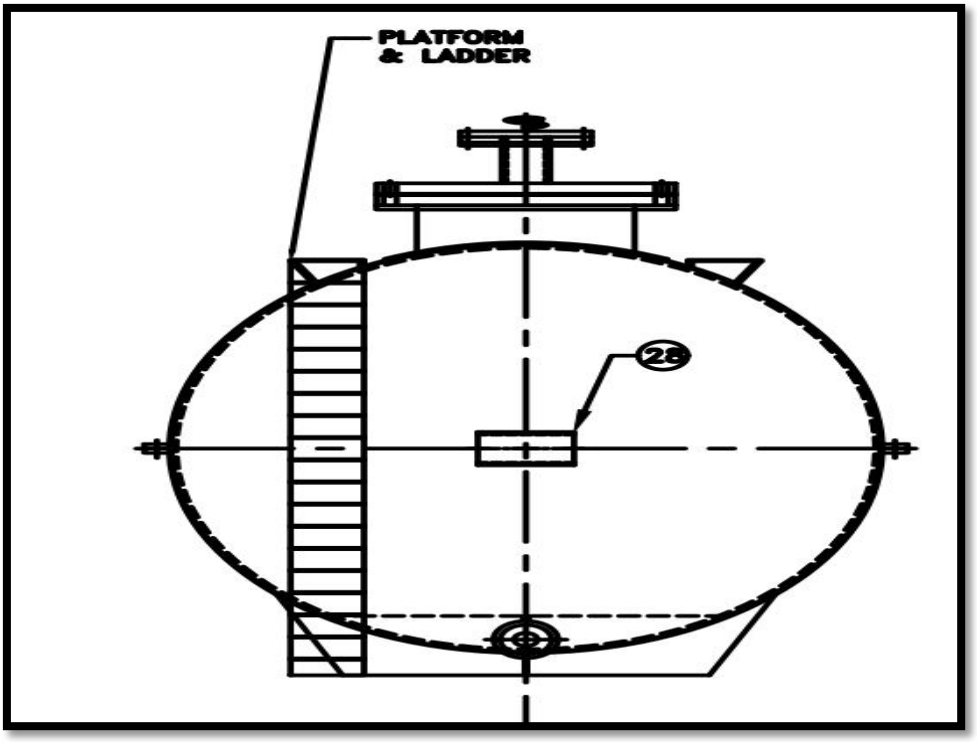

Fig: Side view

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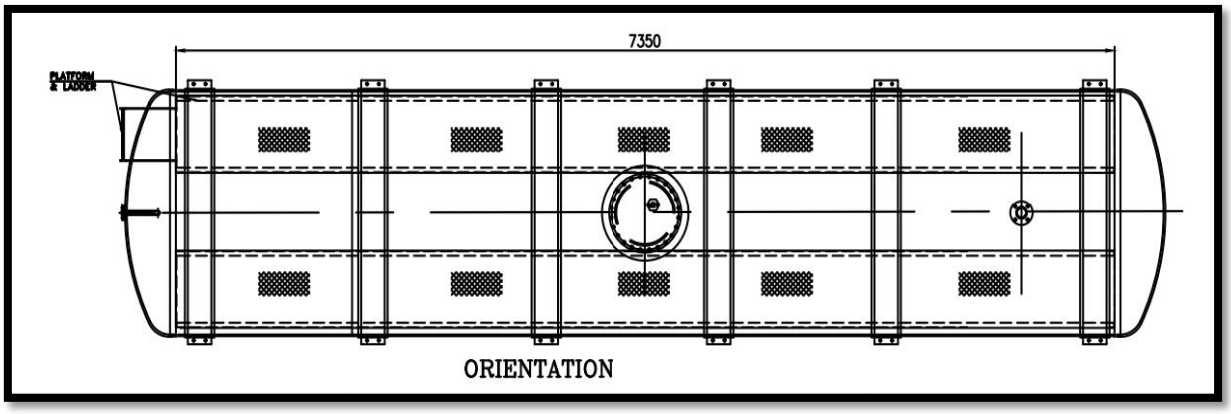

Fig: Top view

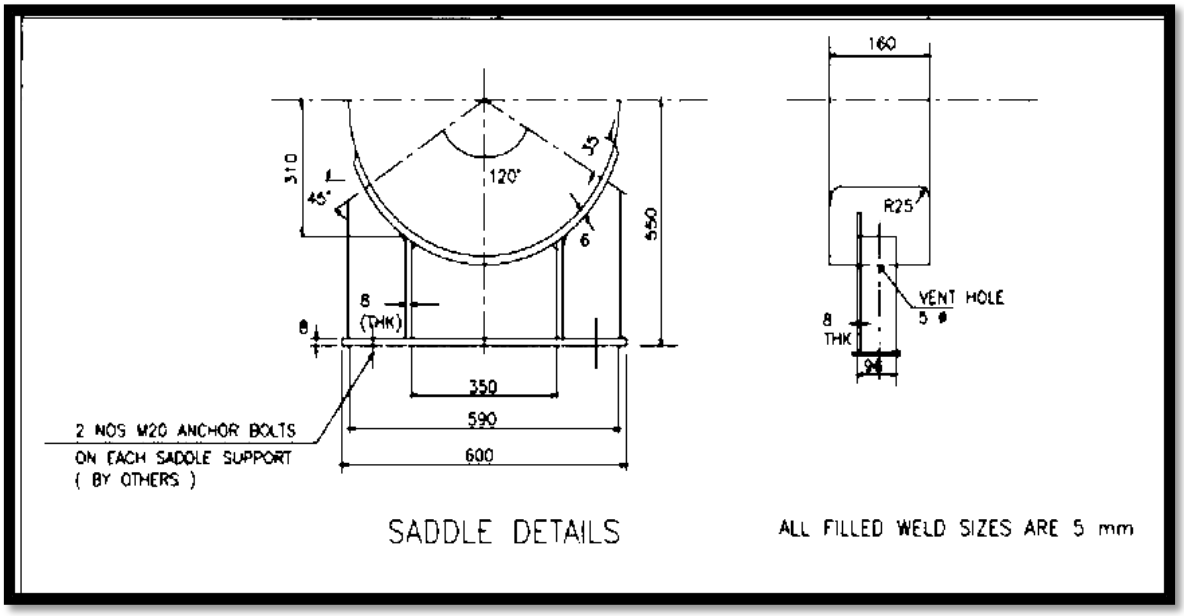

Fig: Saddle details

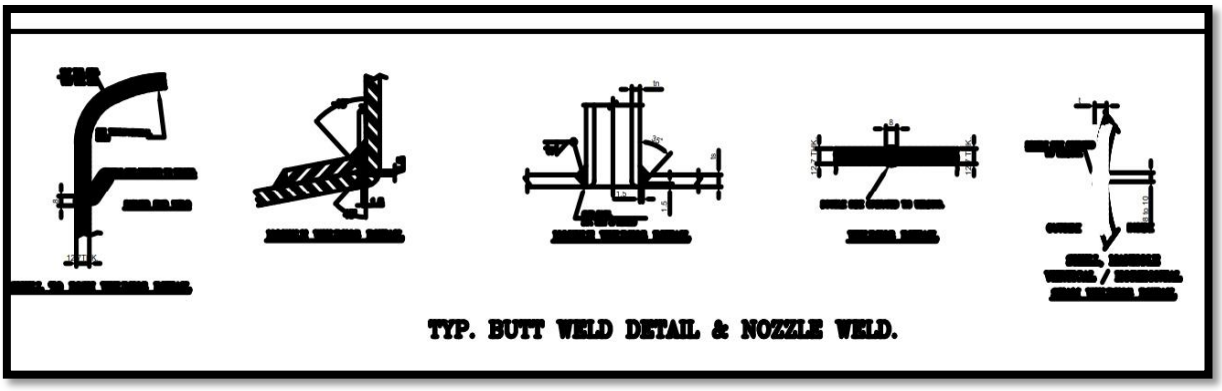

Fig: Weld detail

Objective and Scope of Project

- To understand components of General arrangement, drain pot and its applications.
- To design the components of industrial water heater vessel by analytical method in reference with A.S.M.E section viii Div. 1.
- To validate the design using software PV-Elite version 2017.

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- Comparison of analytical and software calculation.
- Modelling of vessel in PV-Elite software.

IV. RESULTS AND DISCUSSION

Design Results

Table: Design results

Parameter	Analytical thickness	Software thickness
Shell	6.23mm (take 8mm)	6.45mm (take 8mm)
Dish end	mm (take 8mm)	6.39mm (take 8mm)
Nozzle N1	4.74mm	2.00in
Nozzle N2	2.55mm	8.00in
Nozzle N3	2.23mm	0.50in
Nozzle N4	2.08mm	1.00in
Nozzle N5	2.23mm	1.00in
Nozzle N6	2.08mm	0.50in
Nozzle N7	4.74mm	2.00in
Nozzle N8	2.55mm	2.00in
Support	8mm	8mm

V. CONCLUSION

- Understood components of General Arrangement of pressure vessel and its applications.
- Designed and manufacturing components of industrial pressure vessel by analytical method in reference with A.S.M.E section viii Div. 1.
- Validated the design using software PV-Elite version 2017.
- Compared of analytical and software calculation.
- Modelled the vessel in PV-Elite software.

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I also take this opportunity to thank my Friends for their support and encouragement at every stage of my life.

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