CHAPTER THREE

APPLICATION STUDY

3-1: Introduction

In this chapter a Liquefied Petroleum Gas pressure vessel made of St 37-2 will be designed according to ASME BOILER & PRESSURE VESSEL CODE Sec VIII.

These calculation sheets are recommended for the a) - Preliminary material selection, b) - Preliminary determination of wall thickness and c) - Estimating volumes and weights to select the saddle.

3-2: Material selections

According to ASME and internationally adopted other design codes, pressure vessels are made of alloy steel, This research is an attempt to explore this field to know whether commonly used mild steel in an adequate alternative.

- ASME recommended for the pressure vessels to using ***SA 515-70*** or ***SA 516-70*** with allowable Stress value S = 120.658 MPa (17500psi)
- ARCELOR FCS COMMERCIAL Product catalogue 2005 recommended for the pressure vessels to using ***P235 S*** with yield point 235 MPa and tensile strength 360-480 MPa.

- Mild steel ***St 37-2*** with yield point 235 MPa and tensile strength 360-510 MPa and allowable Stress value S = 87.5634 MPa (12700psi)
- ***St 37-2*** will be used in this design because it's available in our country and cheap, the design will be tested using ANSYS analysis program to check the results.

3-3: Determining the dimension of the vessel

To avoid welding problem due to the difference between the shell thickness and dish end thickness a chart showing the relation between thickness and the diameter of vessel for both shell and dish end was developed, the result was plotted in figure 3.1.

The radius that results in a minimum difference in thickness between shell and dish end is chosen for the vessel to be design.

As a matter of fact the difference in thickness is minimal at the radius of 300m, but this radius will result in a very long vessel the radius of 700mm was chooses, since it correspond to a suitable difference in thickness (0.14mm)and in the same time a suitable length of the vessel.

It should be noted that this procedure of determining the radius is not adopted in ASME BOILER & PRESSURE VESSEL CODE Sec VIII, because ASME used a higher strength steel resulting in smaller differences between shell and dish end thickness.

Figure 3-1: A plot of Dish end thickness, Shell thickness versus radius of the pressure vessel

3-4: Design input data

- Code of Design and Construction ASME Sec VIII Div -1.
- Fluid handled = LPG.
- Design Pressure-Internal P =1.75 MPa.
- Design Pressure (External) = Nil.
- Allowable Stress value of ST 37-2 S = 12700 psi [-20° to 650° F].
- Nominal outside Radius R = 700 mm (from figure 3.1).
- Weld joint efficiency E = 1.
- Corrosion allowance C.A = 1m.

3-5: Shell thickness calculation for horizontal vessel

The thickness of shells under internal pressure shall be not less than that computed by the following formula.

$$t = \frac{PR}{SE + .4P} + C.A$$

$$t = \frac{254 * 27.56}{12700 * 1 + .4 * 254} + 0.035 = 0.58\ inch(14.7mm)$$

***∴Use t*=15mm**

3-6:Dished head thickness

The thickness of an unstayed ellipsoidal or torispherical head shall in no case be less than the required thickness of a seamless hemispherical head divided by the efficiency of the head-to-shell joint.

The required thickness of a dished head of semi- ellipsoidal form, in which half the minor axis (inside depth of the head minus the skirt) equals one-fourth of the inside diameter of the head skirt, shall be determined by:

$$t = \frac{PD}{2SE + 1.8P} + C.A$$

$$t = \frac{254 * 55.118}{2 * 12700 * 1 + 1.8 * 254} + .035 = 0.58\ inch(14.7\ mm)$$

∴Use t =15mm

3-7: Saddle for support of horizontal vessels

The design based on:

1. The vessel supported by two saddles
2. To resist horizontal force (F) due to the maximum operating weight of vessel as tabulated.
3. The maximum allowable stress is 2/3 of the compression yield point.
4. The minimum contact angle of shell and saddle 120°.

To select the saddle the table 3-1 can use according to specific diameter.

- Diameter of vessel= 4'- 7", Use 5' (1524 mm).
- Weight of vessel= 6200 kg.
- Saddle material: St 37-2.
- Contact angle = 120°.

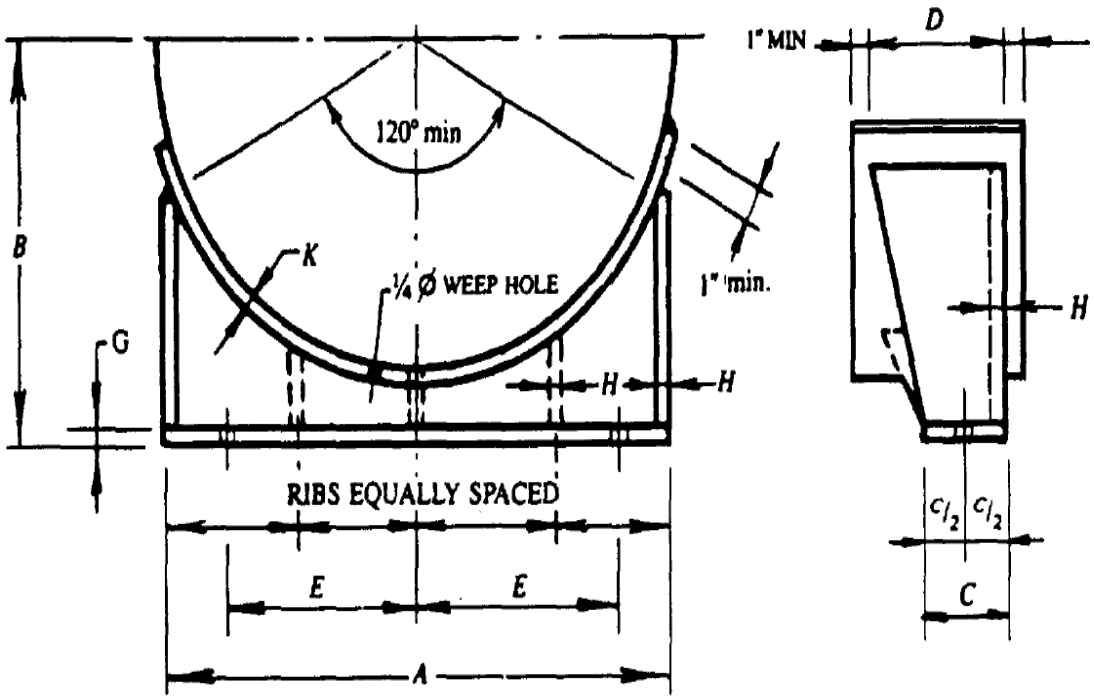

Figure 3-2: The specification of the saddle

The specification of the saddle will select using table 3.1 and the dimensions are shown according to labels A, B, C, D, E, G, H, and K showing in Fig 3.2 as:

- A = 4'- 4"(1321 mm).
- B = 3'- 3"(991 mm).
- C=6"(153 mm).
- D=11"(280 mm).
- E=1'- 8"(508 mm).
- Bolt diameter =3/4(19 mm).
- No. of ribs = 1 pc.
- Base G =3/4"(19mm Use 20 mm).
- Web flange ribs H = 3/8"(9.5 mm Use 10 mm).
- Wear K= 3/8"(9.5mm Use 10 mm).

Table 3-1: The specification of the saddle

NOMINAL DIAMETER OFVESSEL FT.-IN.	DIMENSIONS						NO. OF RIBS	PLATE THICKNESS IN.			MAXIMUM WEIGHT OF VESSEL LB.
	A FT.-IN.	B FT.-IN.	C IN.	D IN.	E FT.-IN.	BOLT DIAM IN.		BASE G	WEB FLANGE, RIBS H	WEAR K	
1-0	0-10½	1-0	4	4	0-3½	½	0	¼	¼	-	42,000
1-2	1-½	1-1	4	4	0-4	½	0	¼	¼	-	50,000
1-4	1-2	1-2	4	4	0-5	½	0	¼	¼	-	56,000
1-6	1-3½	1-3	4	4	0-6	½	0	¼	¼	-	62,000
1-8	1-5½	1-4	4	4	0-6½	½	0	¼	¼	-	70,000
1-10	1-7	1-5	4	6	0-7	½	0	¼	¼	-	76,000
2-0	1-9	1-6	4	6	0-7½	½	0	¼	¼	-	84,000
2-2	1-10½	1-7	4	6	0-8	½	0	¼	¼	¼	90,000
2-4	2-2½	1-8	4	6	0-8½	½	0	½	¼	¼	98,000
2-6	2-2	1-9	4	6	0-9	½	0	½	¼	¼	104,000
2-8	2-4	1-10	4	6	0-9½	½	0	½	¼	¼	112,000
2-10	2-5	1-11	6	11	0-10	½	0	½	¼	¼	128,000
3-0	2-6½	2-0	6	11	0-11	½	0	½	¼	¼	134,000
3-2	2-9	2-1	6	11	1-0	¾	0	½	¼	¼	144,000
3-4	2-11	2-2	6	11	1-1	¾	0	½	⅜	⅜	210,000
3-6	3-½	2-3	6	11	1-2	¾	0	½	⅜	⅜	220,000
4-0	3-6	2-6	6	11	1-4	¾	0	¾	⅜	⅜	252,000
4-6	3-11	3-0	6	11	1-6	¾	0	¾	⅜	⅜	282,000
5-0	4-4	3-3	6	11	1-8	¾	1	¾	⅜	⅜	312,000
5-6	4-9½	3-6	6	11	1-10	¾	1	¾	⅜	⅜	344,000
6-0	5-2½	3-9	9	18	2-0	¾	1	¾	⅜	⅜	402,000
6-6	5-8	4-0	9	18	2-2	¾	1	¾	½	⅜	436,000
7-0	6-1	4-3	9	18	2-4	1	1	¾	½	⅜	470,000
7-6	6-6	4-6	9	18	2-6	1	1	1	½	⅜	502,000
8-0	6-11½	4-9	9	18	2-8	1	1	1	½	⅜	536,000
8-6	7-4½	5-0	9	18	2-10	1	2	1	½	½	760,000
9-0	7-9½	5-3	9	18	3-0	1	2	1	½	½	806,000
9-6	8-3½	5-6	9	24	3-2	1	2	1	¾	½	852,000
10-0	8-8	5-9	9	24	3-4	1¼	2	1	¾	½	896,000
10-6	9-1½	6-0	9	24	3-6	1¼	2	1	¾	½	940,000
11-0	9-6½	6-3	9	24	3-8	1¼	2	1	¾	½	986,000
11-6	10-0	6-6	9	24	3-10	1¼	3	1	¾	½	1,030,000
12-0	10-5	6-9	9	24	4-0	1¼	3	1	¾	½	1,076,000