A **pressure vessel** is a closed container designed to hold gases or liquids at a pressure substantially different from the ambient pressure.
The pressure differential is dangerous and many fatal accidents have occurred in the history of their development and operation. Consequently, their 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 involves parameters such as maximum safe operating pressure and temperature.

Uses

A pressure tank connected to a water well and domestic hot water system
A few pressure tanks, here used to hold propane
Pressure vessels are used in a variety of applications in both industry and the private sector. They appear in these sectors as industrial compressed air receivers and domestic hot water storage tanks. Other examples of 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, habitat of a space ship, habitat of a submarine, pneumatic reservoir, hydraulic reservoir under pressure, rail vehicle airbrake reservoir, road vehicle airbrake reservoir and storage vessels for liquified gases such as ammonia, chlorine, propane, butane, and LPG.

Types and Shapes

Spherical vessel
Cylindrical vessel with hemispherical ends
2:1 cylindrical vessel with semi-elliptical ends

Design Codes and Software

ASME Sec VIII Div-1
ASME Sec VIII Div-2
P.V.Elite-2011

MOC and Thickness

Carbon Steel: SA516Gr60, SA516Gr70, LTCS
Stainless Steel: SS304, SS316, SS304L, SS316L, SS904L
Exotic Material: SS Duplex, Super Duplex, Hestalloy C22, Inconel

Thickness Handled: 38mm in Carbon steel and 16mm in Stainless Steel
Can handle: upto 90mm in carbon steel and 45mm in Stainless Steel

A **Shell and tube heat exchanger** consists of a series of tubes. One set of these tubes contains the fluid that must be either heated or cooled. The second fluid runs over the tubes that are being heated or cooled so that it can either provide the heat or absorb the heat required. A set of tubes is called the tube bundle and can be made up of several types of tubes. Shell and tube heat exchangers are typically used for high-pressure applications (with pressures greater than 30 bar and temperatures greater than 260°C).

There are several thermal design features that are to be taken into account when designing the tubes in the shell and tube heat exchangers. These include:

Tube diameter: Using a small tube diameter makes the heat exchanger both economical and compact. However, it is more likely for the heat exchanger to foul up faster and the small size makes mechanical cleaning of the fouling difficult. To prevail over the fouling and cleaning problems, larger tube diameters can be used. Thus to determine the tube diameter, the available space, cost and the fouling nature of the fluids must be considered.

Tube thickness: The thickness of the wall of the tubes is usually determined to ensure:

- There is enough room for corrosion
- That flow-induced vibration has resistance
- Axial strength
- Availability of spare parts
- Hoop strength (to withstand internal tube pressure)
- Buckling strength (to withstand overpressure in the shell)

Tube length: heat exchangers are usually cheaper when they have a smaller shell diameter and a long tube length. Thus, typically there is an aim to make the heat exchanger as long as physically possible whilst not exceeding production capabilities.

Tube pitch: when designing the tubes, it is practical to ensure that the tube pitch (i.e., the centre-centre distance of adjoining tubes) is not less than 1.25 times the tubes' outside diameter. A larger tube pitch leads to a larger overall shell diameter which leads to a more expensive heat exchanger.

Tube Layout: refers to how tubes are positioned within the shell. There are four main types of tube layout, which are, triangular (30°), rotated triangular (60°), square (90°) and rotated square (45°). The triangular patterns are employed to give greater heat transfer as they force the fluid to flow in a more turbulent fashion around the piping. Square patterns are employed where high fouling is experienced and cleaning is more regular.

Baffle Design: baffles are used in shell and tube heat exchangers to direct fluid across the tube bundle. They run perpendicularly to the shell and hold the bundle, preventing the tubes from sagging over a long length. They can also prevent the tubes from vibrating. The most common type of baffle is the segmental baffle. Baffle spacing is of large thermodynamic concern when designing shell and tube heat exchangers. Baffles must be spaced with consideration for the conversion of pressure drop and heat transfer. For thermo economic optimization it is suggested that the baffles be spaced no closer than 20% of the shell’s inner diameter. Having baffles spaced too closely causes a greater pressure drop because of flow redirection. Consequently having the baffles spaced too far apart means that there may be cooler spots in the corners between baffles. It is also important to ensure the baffles are spaced close enough that the tubes do not sag. The other main type of baffle is the disc and donut baffle which consists of two concentric baffles, the outer wider baffle looks like a donut, whilst the inner baffle is shaped as a disk. This type of baffle forces the fluid to pass around each side of the disk then through the donut baffle generating a different type of fluid flow.

MOC and Thickness

Carbon Steel: SA516Gr60, SA516Gr70, LTCS
Stainless Steel: SS304, SS316, SS304L, SS316L, SS904L

Tubesheet Thickness in CS can be handled upto 100mm and for SS upto 80mm
Heat exchangers upto 3000 tubes can be handled