Chapter – 13 Major Mechanical Codes for Refrigeration Systems

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Pressure Vessel Code ASME:

All the pressure vessels including the heat exchangers are to be designed in accordance with the ASME Pressure Vessel Code Section VIII. The ASME code applies for all the pressure vessels over 6” in internal diameter and the design working pressure over 15 Psig. However, the code does not apply to a shell or portion thereof contains water or certain common brine and the volume is less than 120 gallons.

The tube side of the flooded cooler is for the cooling medium or brine which the pressure is the hydrostatic pressure plus pumping head. In this case, no impact tested welds or nickel steel is required providing that the parts subject to this pressure are designed to 2.5 times the maximum pressure to be encountered in the service. For example: If the tube side of a vessel working pressure is 60 Psig, the channel heads and water box is to be designed for 60 x 2.5 = 150 Psig. It is suggested to check with the manufacturer for each case for these requirements.

All the pressure vessels for refrigeration applications are to be designed, constructed, inspected and stamped in accordance with the ASME code where it applies.

Alternation or modification for pressure vessels that have been inspected and stamped by ASME is not allowed and is in violation of the code unless proper arrangement is made from code authorities is obtained.

ASME Code Requirement for Low Temperature Application:

Special steel and impact test requirement for low temperature is because the metal becomes brittle at the low temperature. The normal guide line of ASME for low temperature application is -20℉. Under ASME code, carbon steel can be used for operating temperature above -20℉, A-516 Carbon Steel normalized may be used for temperature between -20℉ to -50℉; 3-1/2% Nickel steel is for temperature between -50℉ to -150℉ and 304 Stainless steel may be used for temperature between -150℉ to -325℉. Also impact testing of welds and materials are required for temperature below -20℉.

However, the character of refrigerant is that temperature is a function of the pressure;

the pressure is low when the temperature is low and the operating pressure is higher only when the operating temperature is higher. Therefore, under ASME section UCS-66(c)(2), the ASME code permits within practical pressure limits, carbon steel is allowed for low temperature application. That means no impact test and no nickel steel or other special steel is required for operating temperature below -20℉ if the operating pressure below -20℉ never exceeds 0.4 times of the DWP at -20℉.

An example is for a refrigeration system using R-717 (Ammonia) as the refrigerant. The low side DWP is 225 Psig, the pressure limit allowing using carbon steel for low side evaporator under UCS-66(c)(2) is 225 x 0.4 = 90 Psig. The ET for the evaporator is -40℉ which the operating pressure is 8.7” Hg. 8.7” Hg is below 0 Psig and is below than 90 Psig allowed under ASME UCS-66(c)(2) . Therefore, impact tested welds or special shell material will not be required for code conformance. However, carbon steel should not be used below -150℉; nor 3-1/2% nickel steel below -200℉.

The case of R-1270 (Propylene) refrigerant: The low side DWP is 225 Psig, the pressure limit allowing using carbon steel for low side evaporator under UCS-66(c)(2) is 225 x 0.4 = 90 Psig. The ET for the evaporator is -40℉ which the operating pressure is 5.91 Psig. The operating pressure of 5.91 Psig is below than 90 Psig allowed under ASME UCS-66(c)(2); therefore, impact tested welds and special shell material are not required for code conformance to ASME.

No impact tested welds or nickel steel is required for tubes side of brine cooler provided that parts subjected to the pressure are designed to 2.5 times the maximum pressure of the service encountered.

Some users might insist to use low temperature material such as A516 or Nickel Steel for the fabrication of the heat exchanger, the cost extra for the using of these material is significant.

TEMA Code for Shell-and-Tube Heat Exchanger:

TEMA (Tubular Exchanger Manufacturers Association) Standard might be sometimes specified for the heat exchanger by the users of hydrocarbon processing or chemical industries.

The TEMA specification is not a replacement of ASME, but it is an additional to ASME. If TEMA is required, the inspection of TEMA is actually to be carried out by ASME inspector and the certification is also to be done by ASME.

Figure 13-1 shows the TEMA heat exchanger nomenclature for the constructions of shell-and-tube heat exchangers. The first column of the chart is the front end stationary head types; the second column is the shell types and the third column is for the rear end head types. Selecting one description from each column, it shall be the basic construction requirements of the heat exchanger design. For example, the heat exchanger of AEL designates: “A”- represents the front end head with removal cover; “E”- represents one pass shell and “L”-Represents the rear end channel fixed tube sheet stationary head with removal cover.

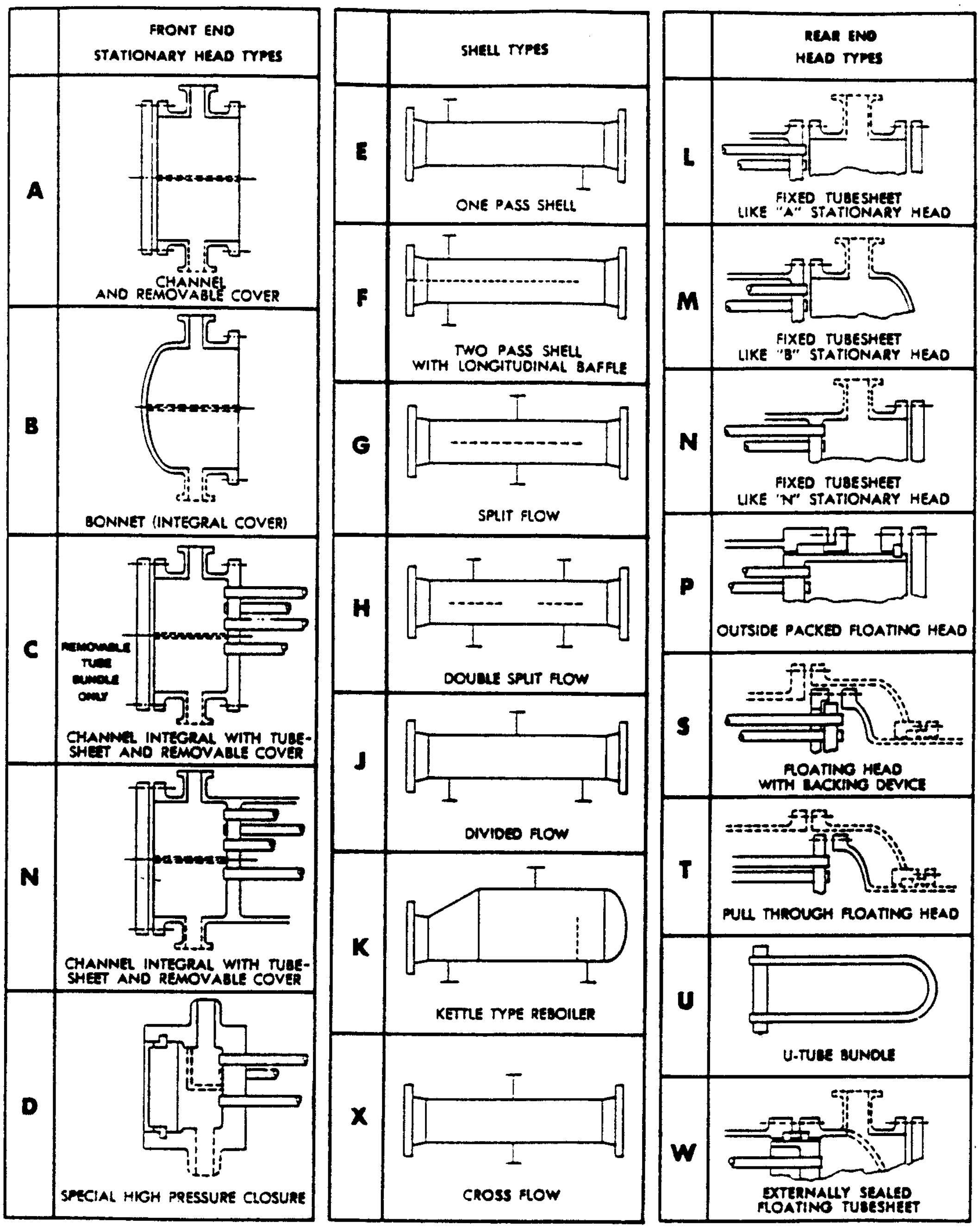

Figure 13-1 TEMA Heat Exchanger Nomenclature

The TEMA specification covers three classifications as the following:

TEMA-C: For the general moderate requirements of commercial general process application.

TEMA-B: For the service requirement of chemical process application.

TEMA-R: For the general severe service requirements of petroleum and related processing application.

If the heat exchanger is to be designed and constructed in accordance with the TEMA specification, the class of TEMA design such as either “C” or “B” or “R” must be indicated.

The major differences of the heat exchanger design between TEMA and ASME are the front and rear end head type construction, hydrostatic test, corrosion allowance minimum tube pitch, minimum tube supports, minimum shell thickness and etc. The heat exchanger of TEMA design is larger than ASME for the same heat load requirement.

The major differences between TEMA-C, TEMA-B and TEMA-R are that the shell thickness of TEMA-B is less severe than TEMA-R; TEMA-C is less severe than TEMA-B and etc.

Direct expansion shell-and-tube heat exchanger is not under the classification of TEMA. Therefore, exception must be taken to the head design.

Mechanical Refrigeration Safety Code:

Safety Code for Mechanical Refrigeration ANSI/ASHRAE 15 is the primary safety reference for mechanical refrigeration systems. It covers the safety requirements for the design, construction, installation, testing and inspection.

ANSI/IIAR-2 governs the standards for the equipment, design and installation of ammonia mechanical refrigeration systems.

Refrigeration Piping Codes:

Pressure piping code of ASME/ANSI Standard B31.5 covers the design requirements of the refrigerant piping, valves and fittings for the refrigeration system.

B31.5 effects shell connections in some area where no cast iron, wrought iron or carbon steel be used for pipe fittings below -100°F; also a 2% increase over the actual design working pressure should be added for each degree below 0°F.

B31.3 is the Pressure Piping, Petroleum Refinery Piping Code. This code is compatible with B31.5 the design and material requirements except for operating temperatures below -20℉, where the B31.1 becomes involved with requirements for impact tested materials.