Selecting TEMA Type Heat Exchangers

Tubular Exchange Manufacturers Association

TEMA is a set of standards developed by leading heat exchanger manufacturers that define the heat exchanger style and the machining and assembly tolerances to be employed in the manufacturing of a given unit. TEMA stands for Tubular Exchanger Manufacturers Association. An advantage of TEMA standards is that end customers recognize that the specifications set forth comprise industry standards that directly relate to recognized quality practices for manufacturing. Vendors who build to TEMA standards can be competitively compared because tolerances and construction methods should be very similar for a given design.

The general descriptions of the three major TEMA classes are:

TEMA C - General Service

TEMA B - Chemical Service

TEMA R - Refinery Service

TEMA R is the most restrictive and TEMA C is the least stringent. TEMA B and TEMA R are very similar in scope. TEMA R includes the requirement for confined joints where recesses must be machined in the flanges and tubesheets. A spiral wound gasket with a ring construction also meets this TEMA R requirement. TEMA R also requires a greater minimum thickness for some components.

This section has the purpose of defining the major TEMA constructions and identifies the advantages, limitations and applications suitable for each type.

TEMA designations refer to the front head design, the shell design and the rear head design. For example, a TEMA type BEM has a type B front head, a type E shell and a type M rear head design.

There are conditions such as with high vapor flows, high pressure and temperature crossing where a combination of special TEMA features is advantageous. For example, K type shells allow for proper vapor disengagement for reboilers and J and H type shells accommodate high vapor flow.

Straight Tube, Fixed Tubesheet, Type BEM, AEM, NEN, Etc. - This TEMA type is the simplest design and is constructed without packed or gasketed joints on the shell side. The tubesheet is welded to the shell and the heads are bolted to the tubesheet. On the NEN heat exchanger, the shell and the head is welded to the tubesheet. Typically, a cover plate design is provided to facilitate tube cleaning. This TEMA category, especially the NEN, it is the lowest cost TEMA design per square foot of heat transfer surface.

Advantages

- Less costly than removable bundle designs
- Provides maximum amount of surface for a given shell and tube diameter
- Provides for single and multiple tube passes to assure proper velocity
- May be interchangeable with other manufacturers of the same TEMA type

Limitations

- Shell side can be cleaned only by chemical methods
- No provision to allow for differential thermal expansion, must use an expansion joint

Applications

- Oil Coolers, Liquid to Liquid, Vapor condensers, reboilers, gas coolers
- Generally, more viscous and warmer fluids flow through the shell
- Corrosive or high fouling fluids should flow inside the tubes

Removable Bundle, Externally Sealed Floating Tubesheet, Type OP, AEW, BEW This design allows for the removal, inspection and cleaning of the shell circuit and shell interior. Special floating tubesheet prevents intermixing of fluids. In most cases, straight tube design is more economical than U-tube designs.

Advantages

- Floating tubesheet allows for differential thermal expansion between the
- Shell and the tube bundle.
- Shell circuit can be inspected and steam or mechanically cleaned
- The tube bundle can be repaired or replaced without disturbing shell pipe
- Less costly than TEMA type BEP or BES which has internal floating head
- Maximum surface for a given shell diameter for removable bundle design
- Tubes can be cleaned in AEW models without removing piping.

Limitations

- Fluids in both the shell and tube circuits must be non-volatile, non-toxic
- Tube side passes limited to single or two pass design
- All tubes are attached to two tubesheets. Tubes cannot expand independently
- so that large thermal shock applications should be avoided
- Packing materials produce limits on design pressure and temperature

Applications

- Intercoolers and aftercoolers, air inside the tubes
- Coolers with water inside the tubes
- Jacket water coolers or other high differential temperature duty
- Place hot side fluid through the shell with entry nearest the front end

Removable Bundle, Outside Packed Head, Type BEP, AEP, Etc - This design allows for the easy removal, inspection and cleaning of the shell circuit and shell interior without removing the floating head cover. Special floating tubesheet prevents intermixing of fluids. In most cases, straight tube removable design is more costly than U-tube designs.

Advantages

- Floating tubesheet allows for differential thermal expansion between the shell and the tube bundle.
- Shell circuit can be inspected and steam cleaned. If the tube bundle has a square tube pitch, tubes can be mechanically cleaned by passing a brush between rows of tubes.
- The tube bundle can be repaired or replaced without disturbing shell piping
- On AEP design, tubes can be serviced without disturbing tubeside piping
- Less costly than TEMA type BES or BET designs
- Only shell fluids are exposed to packing. Toxic or volatile fluids can be cooled in the tubeside circuit
- Provides large bundle entrance area, reducing the need for entrance domes for proper fluid distribution

Limitations

- Shell fluids limited to non volatile, non toxic materials
- Packing limits shell side design temperature and pressure
- All tubes are attached to two tubesheets. Tubes cannot expand independently so that large thermal shock applications should be avoided
- Less surface per given shell and tube diameter than AEW or BEW

Applications

- Flammable or toxic liquids in the tube circuit
- Good for high fouling liquids in the tube circuit

Removable Bundle, Internal Split Ring Floating Head, Type AES, BES, Etc. - Ideal for applications requiring frequent tube bundle removal for inspection and cleaning. Uses straight-tube design suitable for large differential temperatures between the shell and tube fluids. More forgiving to thermal shock than AEW or BEW designs. Suitable for cooling volatile or toxic fluids.

Advantages

- Floating head design allows for differential thermal expansion between the shell and the tube bundle.
- Shell circuit can be inspected and steam cleaned. If it has a square tube layout, tubes can be mechanically cleaned
- Higher surface per given shell and tube diameter than “pull-through” designs such as AET, BET, etc.
- Provides multi-pass tube circuit arrangement.

Limitations

- Shell cover, split ring and floating head cover must be removed to remove the tube bundle, results in higher maintenance cost than pull-through
- More costly per square foot of surface than fixed tube sheet or U-tube designs

Applications

- Chemical processing applications for toxic fluids
- Special intercoolers and aftercoolers
- General industrial applications

Removable Bundle, Pull-Through Floating Head, Type AET, BET, etc. - Ideal for applications requiring frequent tube bundle removal for inspection and cleaning as the floating head is bolted directly to the floating tubesheet. This prevents having to remove the floating head in order to pull the tube bundle.

Advantages

- Floating head design allows for differential thermal expansion between the shell and the tube bundle.
- Shell circuit can be inspected and steam or mechanically cleaned
- Provides large bundle entrance area for proper fluid distribution
- Provides multi-pass tube circuit arrangement.
- Suitable for toxic or volatile fluid cooling

Limitations

- For a given set of conditions, this TEMA style is the most expensive design
- Less surface per given shell and tube diameter than other removable designs

Applications

- Chemical processing applications for toxic fluids
- Hydrocarbon fluid condensers
- General industrial applications requiring frequent cleaning

Removable Bundle, U-Tube, Type BEU, AEU, Etc. - Especially suitable for severe performance requirements with maximum thermal expansion capability. Because each tube can expand and contract independently, this design is suitable for larger thermal shock applications. While the AEM and AEW are the least expensive, U-tube bundles are an economical TEMA design.

Advantages

- U-tube design allows for differential thermal expansion between the shell and the tube bundle as well as for individual tubes.
- Shell circuit can be inspected and steam or mechanically cleaned
- Less costly than floating head or packed floating head designs
- Provides multi-pass tube circuit arrangement.
- Capable of withstanding thermal shock applications.
- Bundle can be removed from one end for cleaning or replacement
- Limitations
- Because of u-bend, tubes can be cleaned only by chemical means
- Because of U-tube nesting, individual tubes are difficult to replace
- No single tube pass or true countercurrent flow is possible
- Tube wall thickness at the U-bend is thinner than at straight portion of
- tubes
- Draining of tube circuit is difficult when mounted with the vertical position
- With the head side up.

Applications

- Oil, chemical and water heating applications
- Excellent in steam to liquid applications