Take the TEMA test

TEMA stands for Tubular Exchanger Manufacturers Association Specifying that workhorse of the process industries, the shell and tube heat exchanger, is usually a straightforward exercise in these days of computer-aided design packages, but you do need to ask the right questions. David Knightbridge offers a brief guide to that common query: 'which type of TEMA exchanger?'

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The advent of modern computer programmes has enabled many of us to thermally rate heat exchangers quickly and accurately. But how do we decide which design of heat exchanger for a given application will satisfy the operating conditions, all the mechanical/thermal criteria, and give a cost-effective solution?

Many customers have asked what forms the basis of a heat exchanger design for their particular enquiry. I well recall in my earlier years as a junior applications engineer, my mentor of the time showing me how to make a selection, saying that the enquiry we were looking at 'was leading him by the nose' to a certain type of heat exchanger design. His experience gained over the years enabled him to do this, but what was the thought process that went into selecting the right type of heat exchanger? In some cases there can be more than one solution.

Obviously it is not possible to cover all aspects of design or all available TEMA types of heat exchanger in just a few short lines, but the table and diagrams overleaf show some of the more commonly used types of TEMA heat exchangers.

All the types shown in the table can be designed in accordance with TEMA B, C and R codes. The table is intended as a general guide only and does not purport to cover all aspects of design. Full technical advice can be given by a heat exchanger applications engineer.

Another question that is often asked is 'what is the difference between the three types of TEMA B, C and R codes?' To answer that in detail would require a full

Which type of TEMA Heat Exchanger?

Typical TEMA type heat exchanger	Description of TEMA type heat exchanger	Removable tube bundle	Tubes can be cleaned internally by rodding	Non-hazardous liquids & gases below 40barg		Non-hazardous liquids & gases above 40barg	Hazardous liquids and gases	No gaskets in contact with process side	Ability to resist thermal shock
				Below 190 °C	Above 190 °C				
AEW BEW	Externally sealed Floating tube sheet	Yes	Yes	Yes	No	No	No	No	No
AEP BEP	Outside packed floating head	Yes	Yes	Yes	Yes	Yes[2]	No	No	No
AEL BEM	Fixed tube sheet	No	Yes	Yes[1]	Yes[1]	Yes	Yes	Yes[3]	No
NEN	Fixed tubesheet, channel integral with tubesheet	No	Yes	Yes[1]	Yes[1]	Yes	Yes	Yes[3]	No
AEU BEU	U tube	Yes	No	Yes	Yes	Yes	Yes	Yes[4]	Yes
AET BET	Pull-through floating head	Yes	Yes	Yes	Yes	Yes	Yes	No	Yes
AES BET	Floating head with backing device	Yes	Yes	Yes	Yes	Yes	Yes	No	Yes

Notes: **1.** Expansion bellows may be required. **2.** Tube side only. **3.** Shell side only. **4.** Shell side only if tube bundle welded into shell and therefore not removable.

review of TEMA standards, but the following guide lines may be useful:

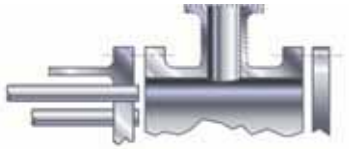
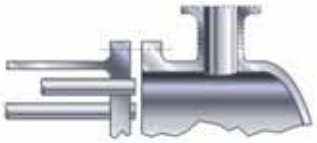
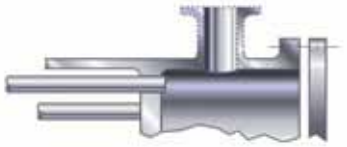
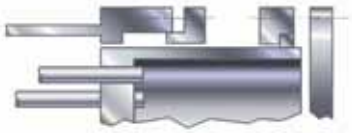
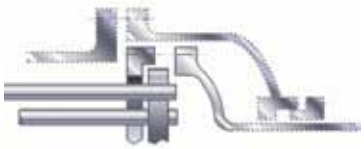
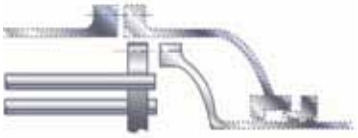
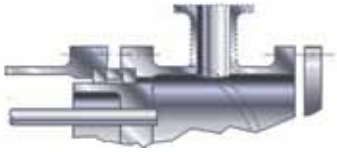
- TEMA B — generally for chemical process services, more stringent than TEMA C, but not as stringent as R;
- TEMA C — for generally moderate commercial and process application requirements. Probably the most commonly used in our industry;
- TEMA R — the highest integrity design.

Front end stationary head types	
A - Channel and removable cover	
B - Bonnet (integral cover)	
N - Channel integral with tube-sheet and removable cover	
Shell types	
E - One pass shell	

The standard-setting TEMA team

TEMA, the Tubular Exchanger Manufacturers Association, is a US trade association of leading manufacturers of shell and tube heat exchangers, which has pioneered the research and development of heat exchangers since its foundation in 1939. TEMA standards and software are now accepted worldwide as the authoritative source on shell and tube mechanical design. Ten editions of TEMA standards have been published over the years, each one updating the industry on the latest developments in technology. The standards have been developed with input from the likes of the API (American Petroleum Institute) and ASME (the American Society of Mechnical Engineers), both standard-setting organisations in their own right. TEMA has also developed engineering software products which complement the TEMA standards in the areas of flexible shell elements (expansion joints) analysis, flow induced vibration analysis and fixed tubesheet design and analysis. The software programs feature a materials databank of 38 materials of construction.

The decision as to which class of TEMA to use does not lie with the heat exchanger manufacturer, but with the design authority responsible for that part of the project. The manufacturer must then consider all the thermal and mechanical requirements of the requested design code when making the selection.

Rear end head types	
L - Fixed tubesheet like "A" stationary head	
M - Fixed tubesheet like "B" stationary head	
N - Fixed tubesheet like "N" stationary head	
P - Outside packed floating head	
S - Floating head with backing device	
T - Pull through floating head	
U - U-tube bundle	
W - Externally sealed floating tubesheet	

The typical TEMA type heat exchangers listed in the table can be visualised from the diagrams shown here (right and left). From the three-letter coding for each type of exchanger (AEW, BEW, AEP and so on, as listed in the table) a picture can be built up of the final shell and tube assembly of front- end stationary head, shell type, and rear-end head