CH402 Chemical Engineering Process Design

Class Notes L8

Heat Exchanger Types and Costs

Today's agenda

General designs and design steps.

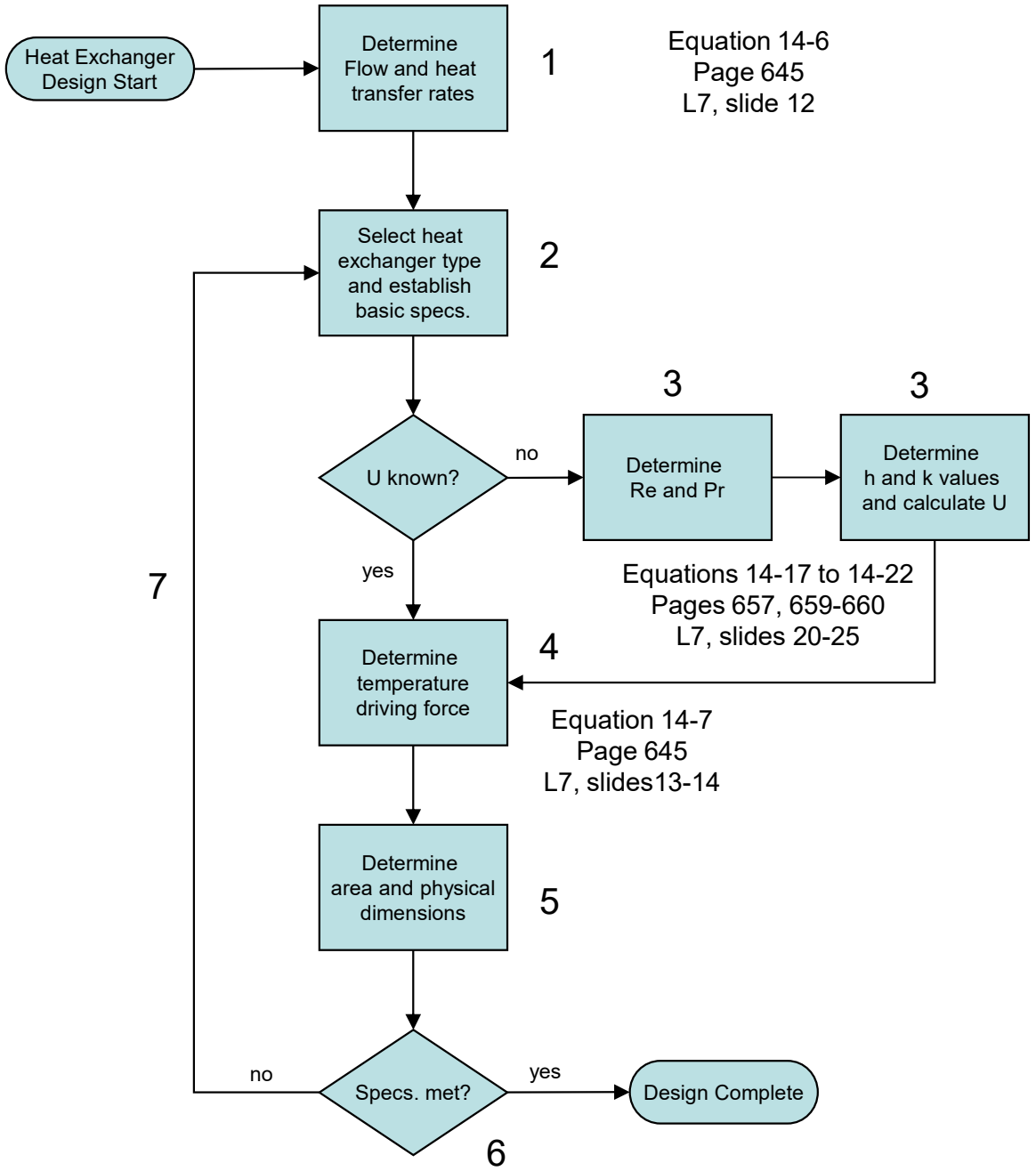
TEMA standards.

Cost correlations and CHEMCAD costing.

Problem 14-9

Steps in Heat Exchanger Design

Implemented in the "3-step method"



1. Determine the flow rates and heat transfer rates necessary to meet the given conditions.
2. Select the type of heat exchanger to be used and establish basic specifications.
3. Evaluate the overall heat transfer coefficient.
4. Evaluate the temperature driving force.
5. Determine the required heat transfer area.
6. Analyze dimensions, pressure drops, capital and operating costs.
7. If Step 6 reveals unsatisfactory performance, go to Step 2 and repeat.

Types of Heat Exchangers

- Double-pipe (p. 670)
- Shell-and-tube (pp. 670-672)
- Reboilers
- Scraped-surface (p. 672)
- Welded-plate (pp. 672-673)
- Spiral (pp. 673-674)
- Compact (pp. 674-675)
- Air-cooled (p. 675)
- Condensers (pp. 675-676)
- Evaporators (p. 676)

Selection Criteria

Type	Max. P, MPa	T, °C	Area, m^2	velocity, shell/tube, m/s	fluid limitations	key features
Double-Pipe	30 (shell) 140 (tube)	-100 to 600	.25-20	liq., 2-3/2-3 gas, 10-20/10-20	materials of construction	modular, small scale
Multiple Pipe	same	same	10-200	same	same	same
Shell-and-Tube	same	-200 to 600+	3-1000	liq., 1-3/2-3 gas, 5-10/10-20	same	adaptable
Scraped-wall	~0.11	up to 200	2-20	liq., 1-2/1-2	liquids solidifying	for viscous, crystallization
Gasketed Plate	0.1-2.5	-25-175	1-2500	liq., 1-2/1-2 gas, 5-10/5-10	gasket material; avoid gases	modular, minimal $/$m^2$
Welded Plate	3	>400	1-2500	liq., 1-2/1-2 gas, 5-10/5-10	materials of construction; fouling	Δp between fluids < 3 MPa
Spiral Plate	2	up to 300	10-200	liq., 1-2/1-2 gas, 5-10/5-10	materials of construction	viscous, corrosive liq.
Spiral Tube	50	350	1-50	liq., 2-3/2-3 gas, 5-10/5-10	materials of construction	adaptable
Compact	3-10	-270 to 800	10-30,000	gas, 2-5/2-5	materials of construction; no corrosives	large area/vol; very small ΔT

Table 14-6, page 677 and Table 14-7, page 678.

Cost correlations

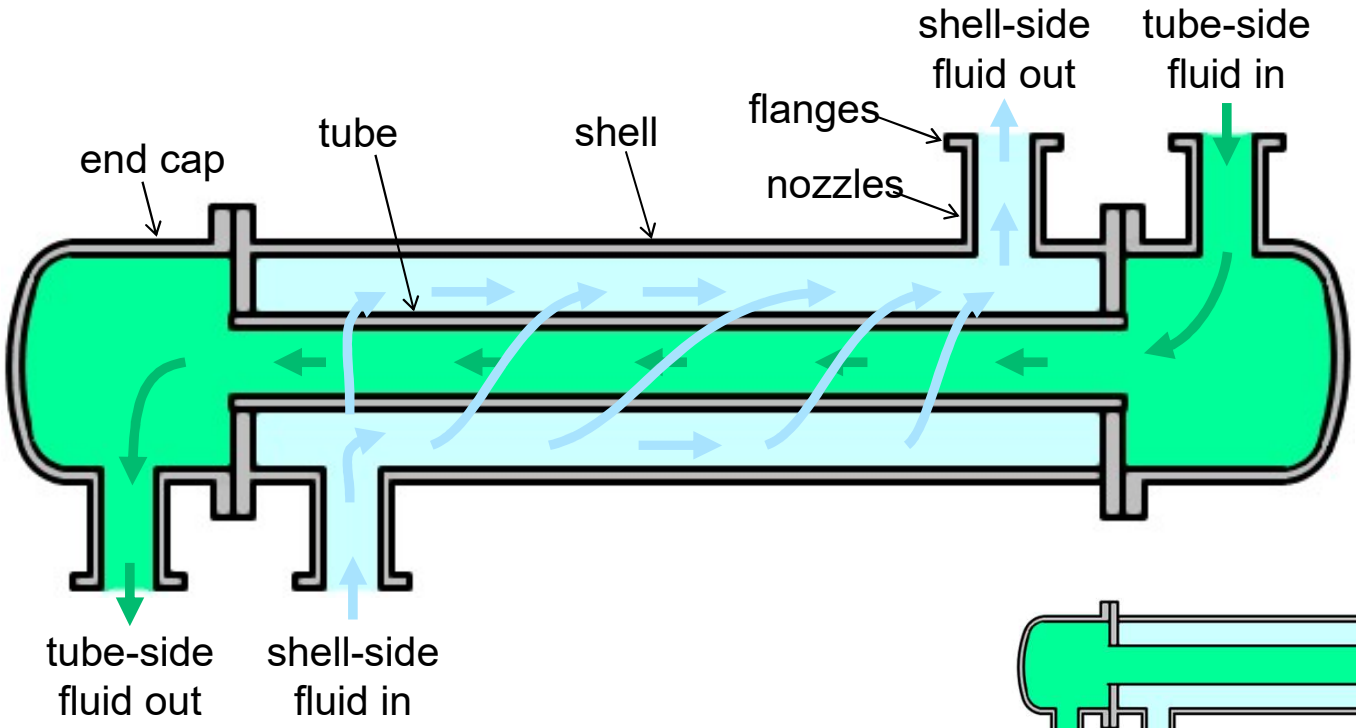
Figures and Tables from PTW

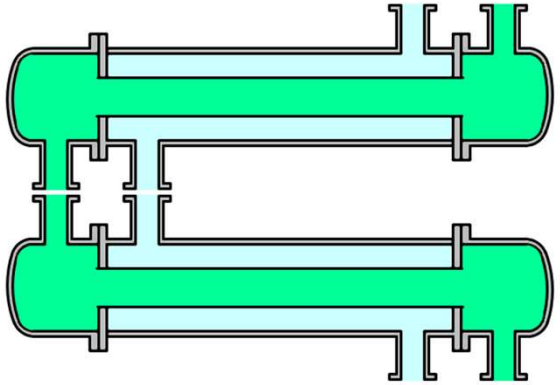
- Textbook figures

Pricing of:	Table	page
Double-pipe		
Double-pipe	14-15	680
Multiple double-pipe	14-16	681
Shell-and-tube		
U-tube	14-17	681
Fixed	14-18	682
Floating	14-19	682
Finned-tube floating	14-20	683
Effect of tube diameter	14-21	683
Effect of tube length	14-22	684
Effect of pressure	14-23	684
Effect of materials	Table 14-8, Fig. 14-24	685
Gasketed and welded plate	14-25	686
Scraped wall and spiral	14-26	686
Spiral and flat plate	14-27	687
Air-cooled	14-28	687
Condensers	14-29 to 14-31	688-89
Evaporators	14-32 to 14-34	689-90

- CHEMCAD

Double-pipe

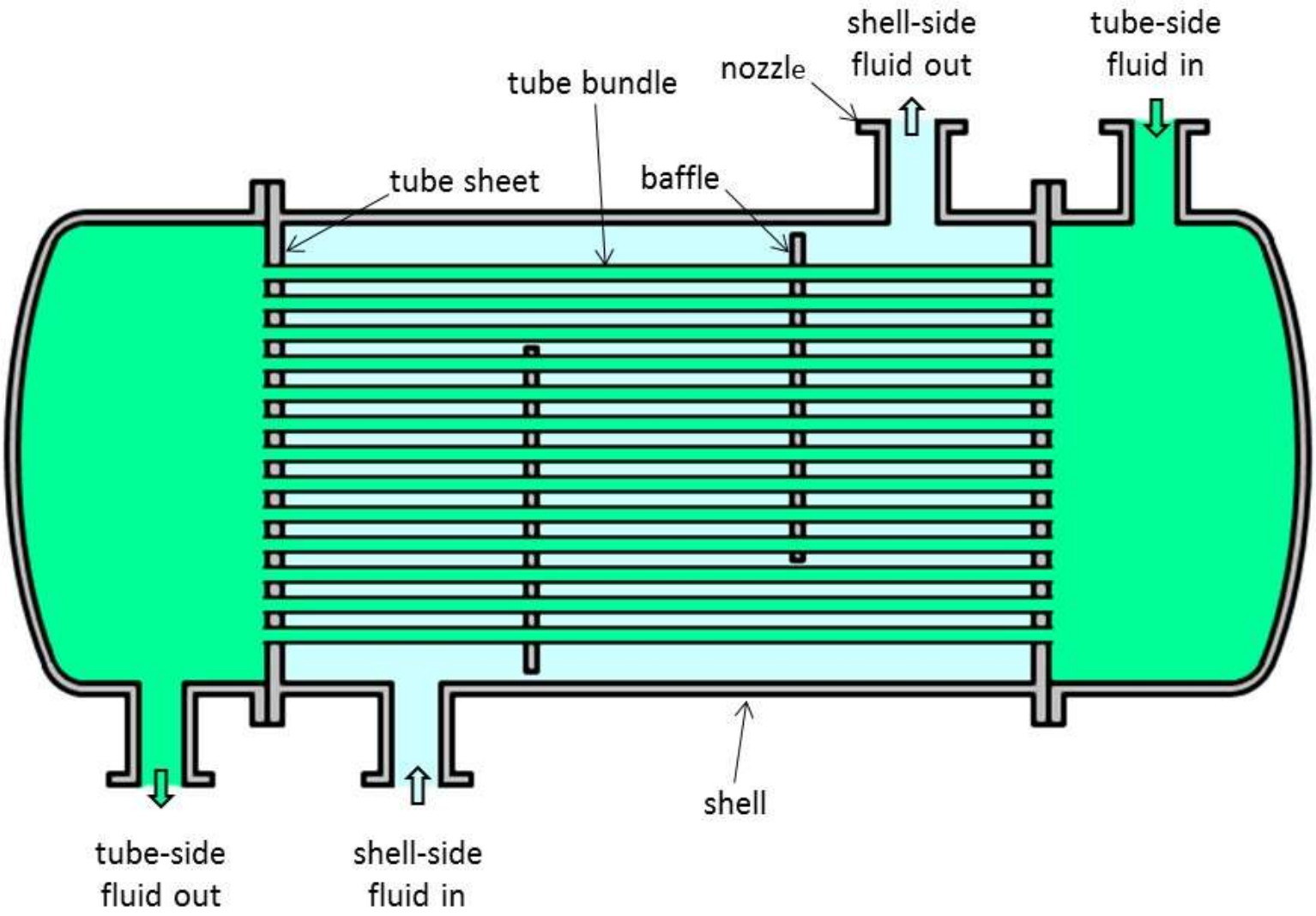




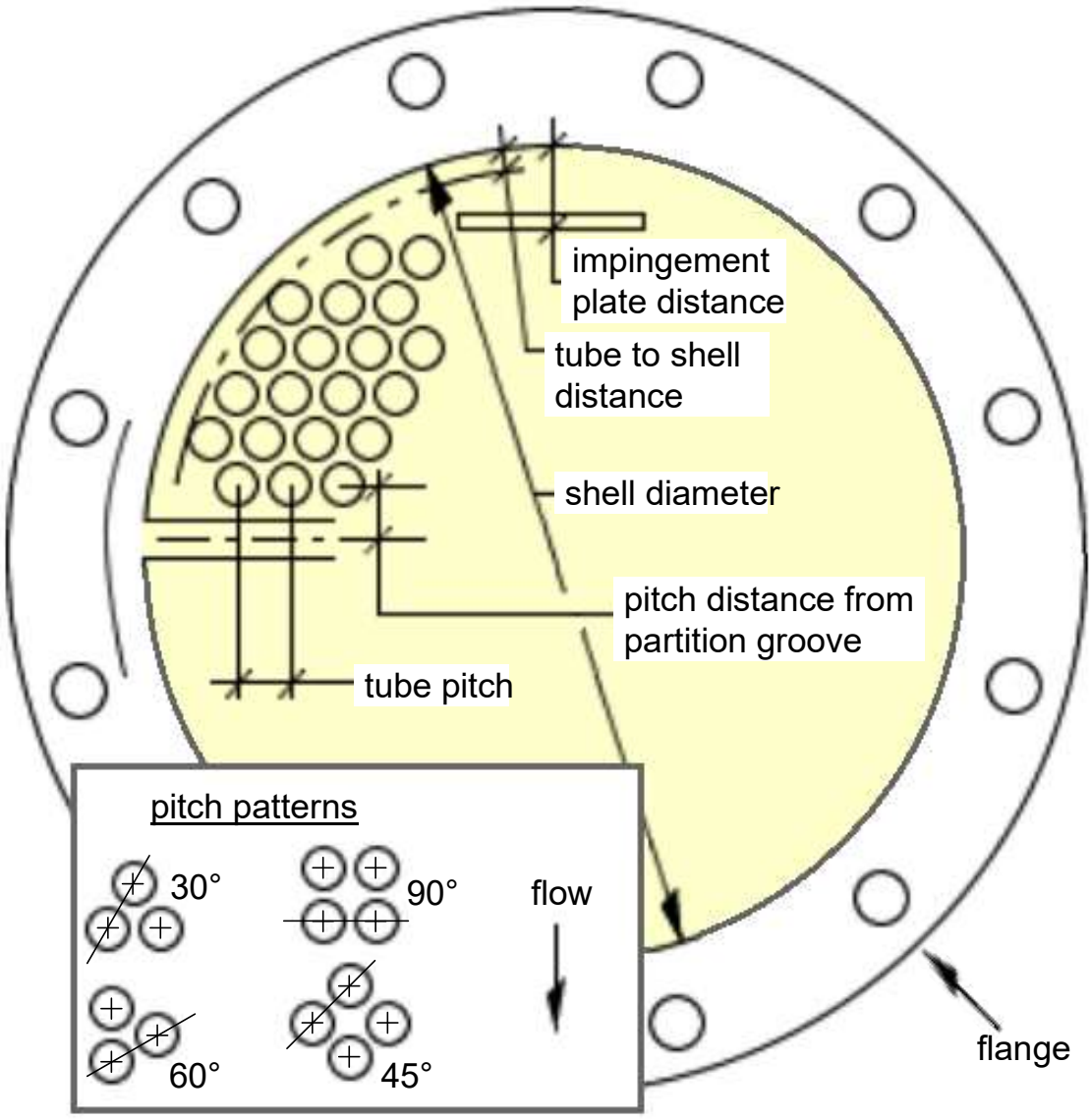
Simplest design – “tube inside a tube.”
Highly modular (U-tubes).

Works well when heat transfer rates are small.
Fins may be needed (inside or outside tube).
Easy to clean.

Shell and tube – general design



Shell and tube – tube sheet layout



Tubular Exchanger Manufacturers Association, Inc.

CHEMCAD design provides “TEMA Sheets”

The Tubular Exchanger Manufacturers Association, Inc. (TEMA) is trade association of leading manufacturers of shell and tube heat exchangers, who have pioneered the research and development of heat exchangers for over sixty years.

The TEMA Standards and software have achieved worldwide acceptance as the authority on shell and tube heat exchanger mechanical design.

TEMA is a progressive organization with an eye towards the future. Members are market-aware and actively involved, meeting several times a year to discuss current trends in design and manufacturing. The internal organization includes various subdivisions committed to solving technical problems and improving equipment performance. This cooperative technical effort creates an extensive network for problem-solving, adding value from design to fabrication.

Whether having a heat exchanger designed, fabricated or repaired, you can count on TEMA members to provide the most current, efficient design and manufacturing solutions. TEMA is a way of thinking--members are not only researching the latest technology, they're creating it.

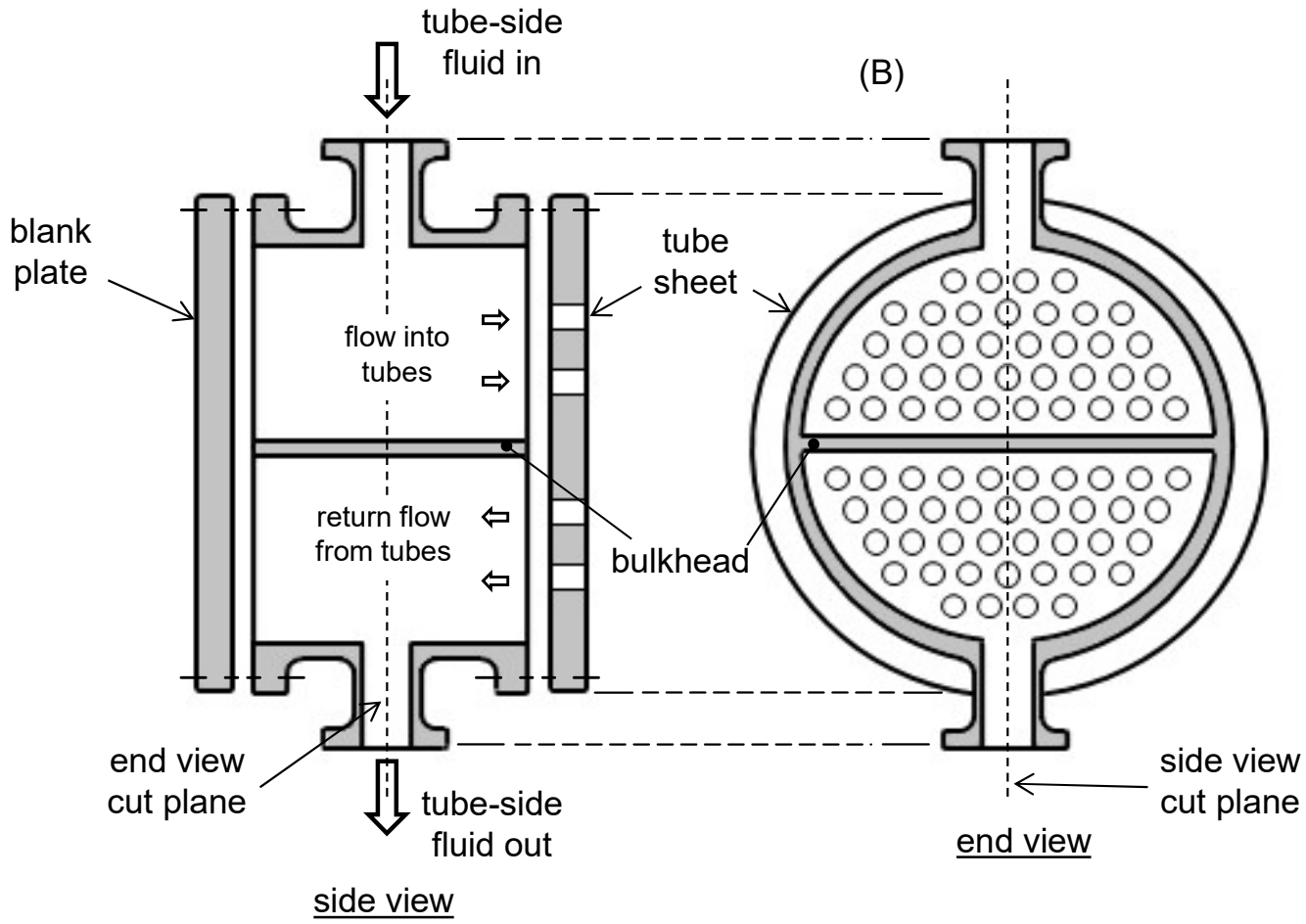
For over half a century our main goal has been to continually find innovated approaches to heat exchanger applications. As a result, TEMA members have a unique ability to understand and anticipate the technical and practical needs of today's market.

Using TEMA members as a resource today ensures a reliable partners for years to come.

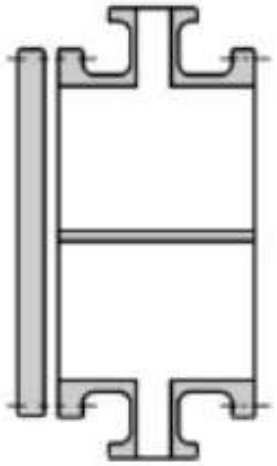
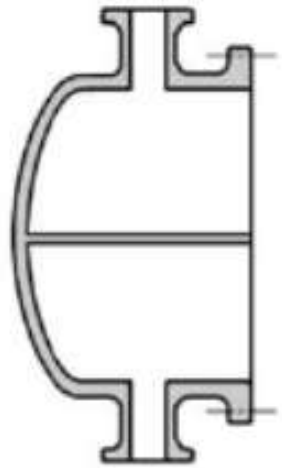
TEMA Name Plate

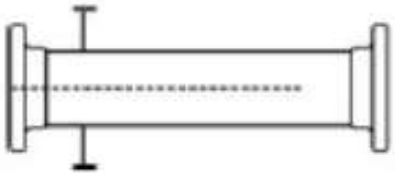
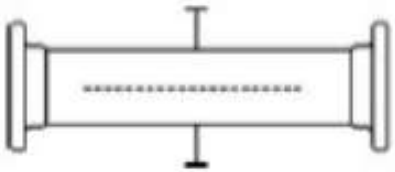
For quality assurance, one need only look for the TEMA Plate attached to the heat exchanger. When you deal with a TEMA manufacturer, you enter into a partnership with an organization dedicated to furnishing a product of the highest technical standards.

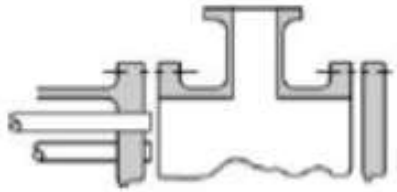
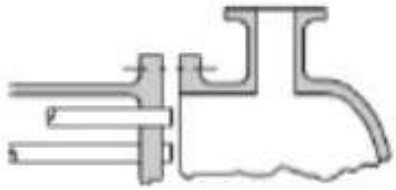
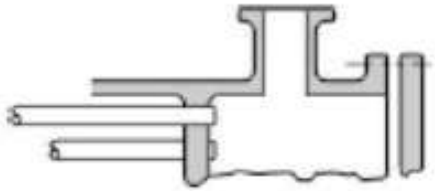
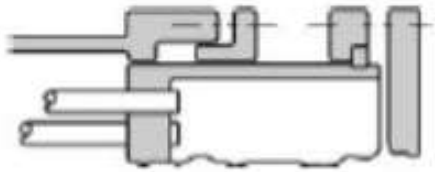
Shell-and-tube – TEMA type A front end details.



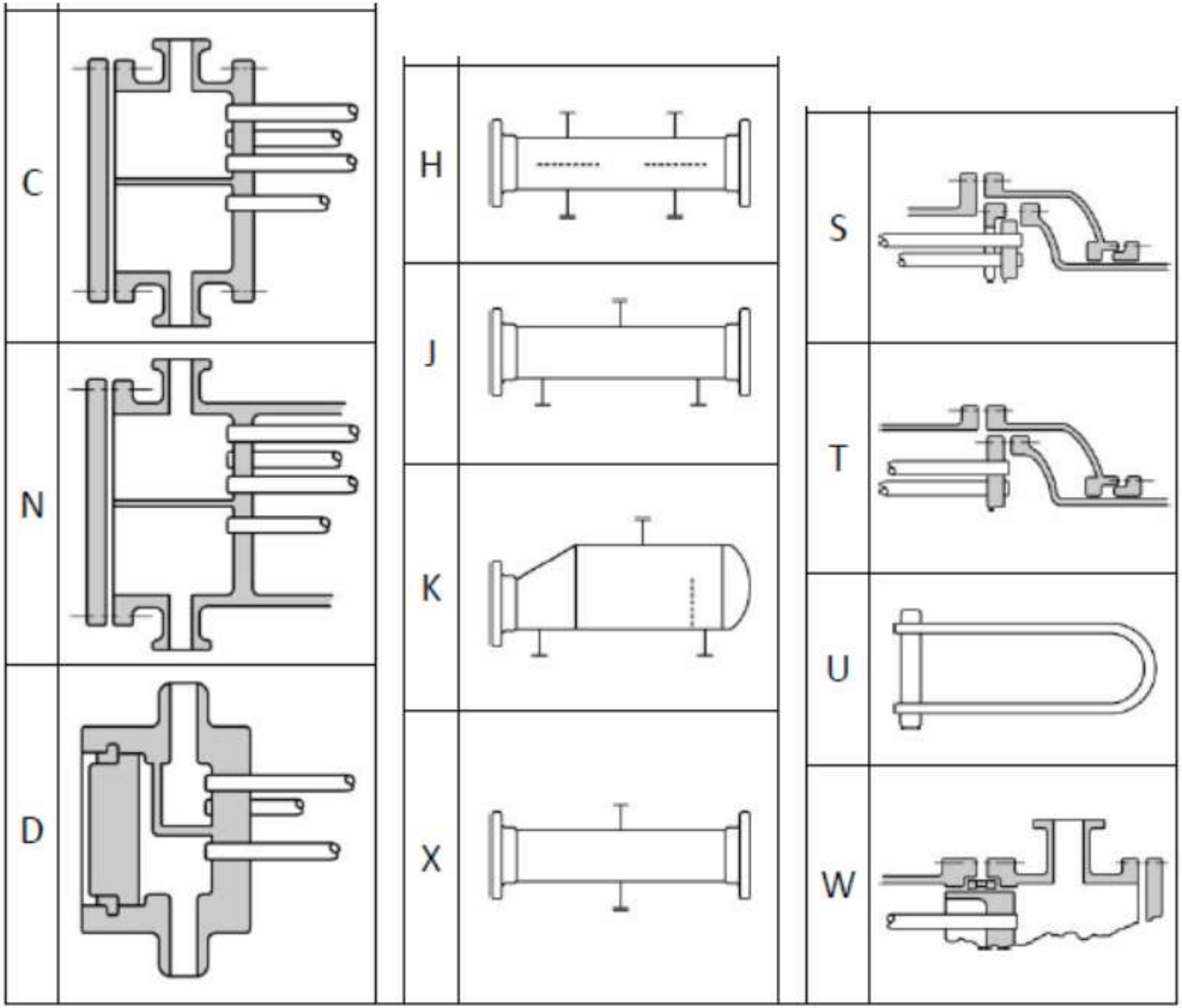
Shell and tube – TEMA codes

	Front End Stationary Head Types
A	
B	

	Shell Types
E	
F	
G	

	Rear End Head Types
L	
M	
N	
P	

Shell and tube – TEMA codes – continued



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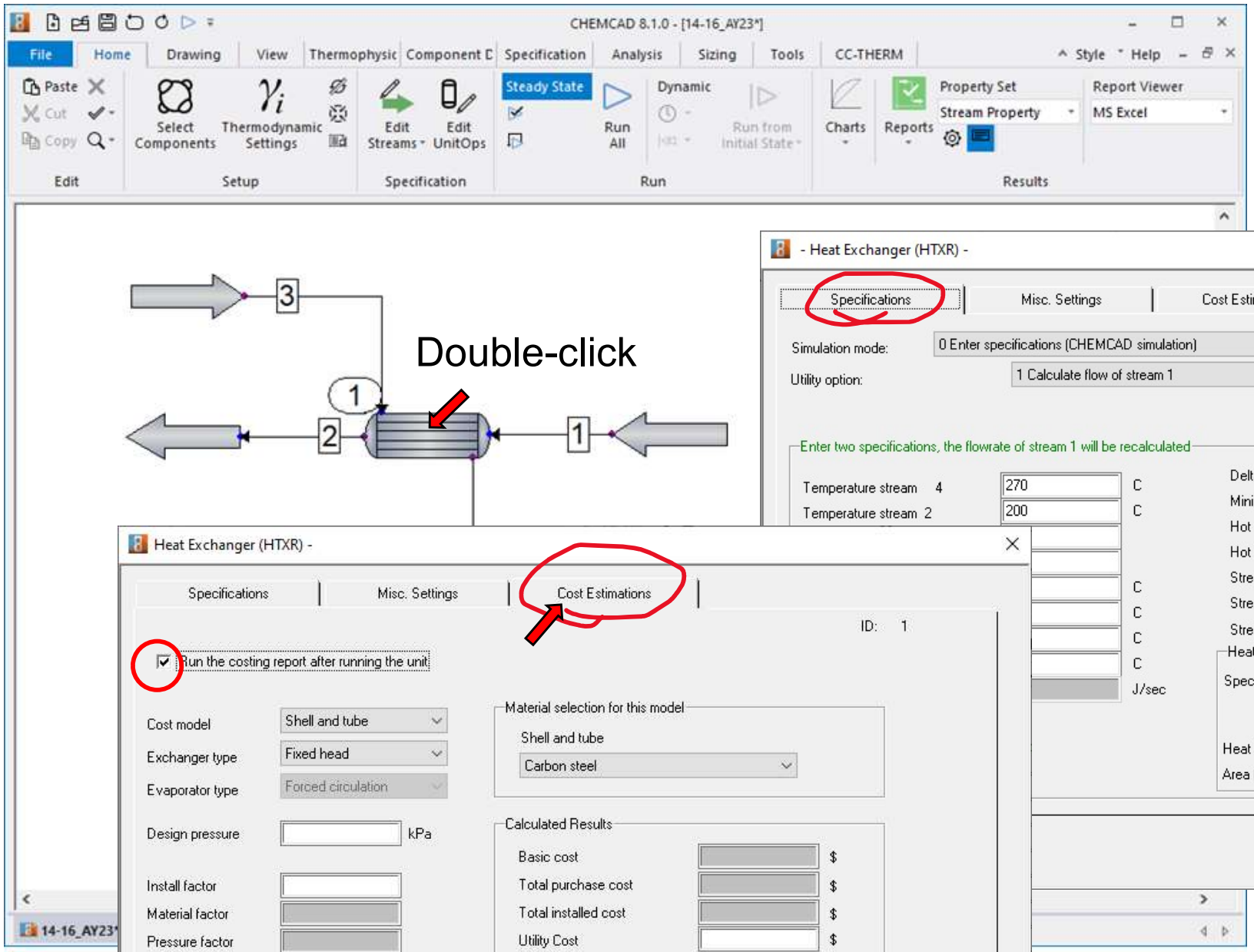

CHEMCAD costing

Questions?