AP Government GATE Online Classes

Heat Transfer

Day-8 (02.06.2020)

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Heat Exchangers


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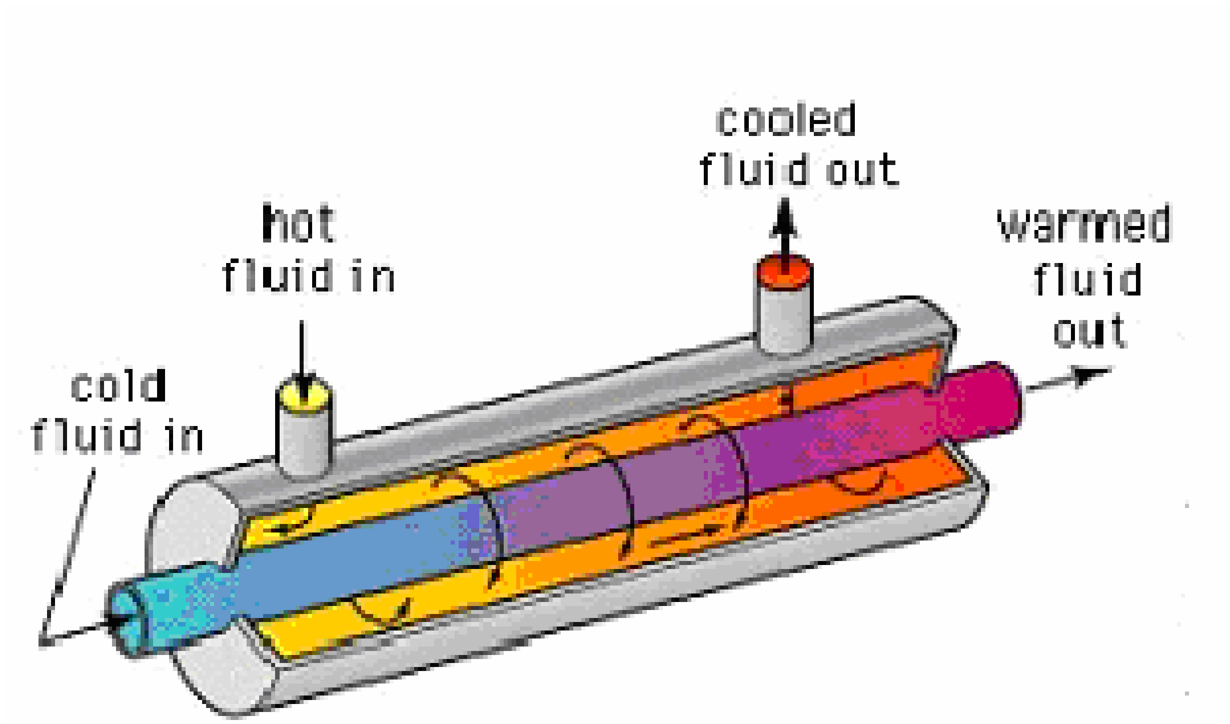
C
B

WHAT IS A HEAT EXCHANGER?



Introduction to Heat Exchanger

- A heat exchanger can be defined as any device that transfers heat from one fluid to another or from or to a fluid and the environment.

They are specifically designed for the *efficient transfer of heat* from one fluid to another fluid over a solid surface.

WHAT ARE HEAT EXCHANGERS USED FOR?

- ✓ They have the function to transfer heat as efficiently as possible. Heat exchangers are widely used in :

i. refrigeration

ii. air conditioning

iii. space heating

iv. electricity generation

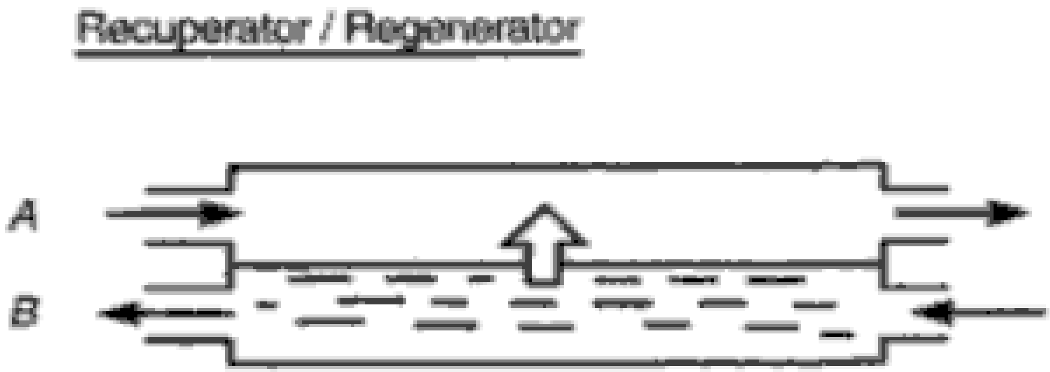
v. chemical processing

CLASSIFICATION OF HEAT EXCHANGERS

- Heat exchangers may be classified according to the following main criteria:

- **Recuperators**
- **Regenerators**
- **Direct Contact apparatus**

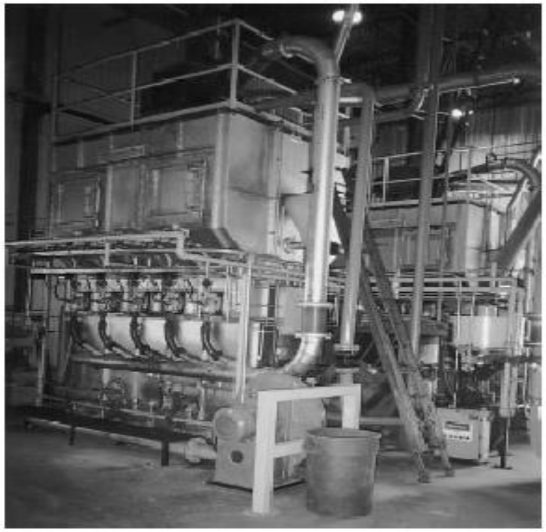
RECUPERATORS

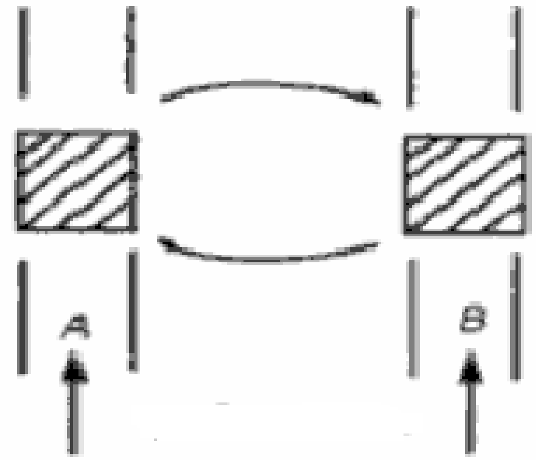


(a) Recuperator

- The conventional heat exchangers with heat transfer between two fluids.
- Hot steam A recovers some of the heat from stream B.

REGENERATORS

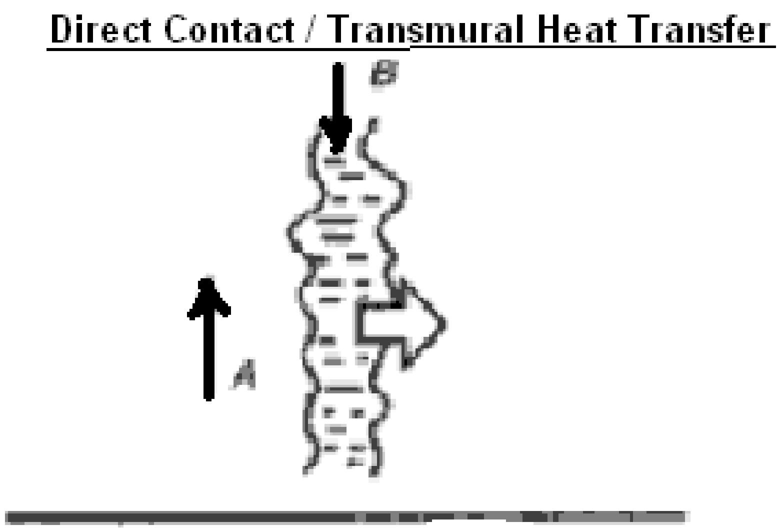




Regenerator

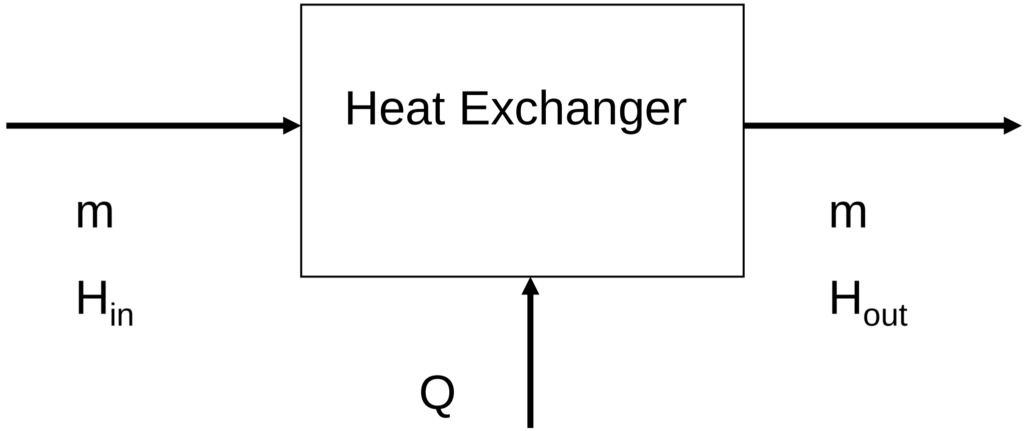
- Storage type heat exchangers.
  The same flow passage (matrix) is alternately occupied by one of the two fluids.
- Thermal energy is not transfered through the wall.

Direct contact type heat exchangers:



*Direct contact heat transfer
Heat transfer across interface between fluids

- Heat transfer between the cold and hot fluids through a direct contact between these fluids.
- ***Examples:*** Spray and tray condensers,cooling towers



Considering the heat exchanger given in the figure the continuous, steady-state heat duty is given by,

$Q = m\,(H_{out} - H_{in})$

where

Q is the heat duty (rate of heat transfer)

m is the flow rate of the stream (mass or molar)

H_{in} is the enthalpy of the stream entering (per unit mass or mole)

H_{out} is the enthalpy of the stream leaving (per unit mass or mole)

- Heat is transferred to or from process streams using other process streams or “heat transfer media”. In a heat exchanger design, every effort is made to exchange heat between process streams and thereby minimize the use of heat transfer media (referred to as utilities).
- Heat transfer media are classified as *“coolants (heat sinks)”* when heat is transferred to them from process streams, and as *“heat sources”* when heat is transferred from them to process streams.

- The transport equation for heat exchange is expressed as;

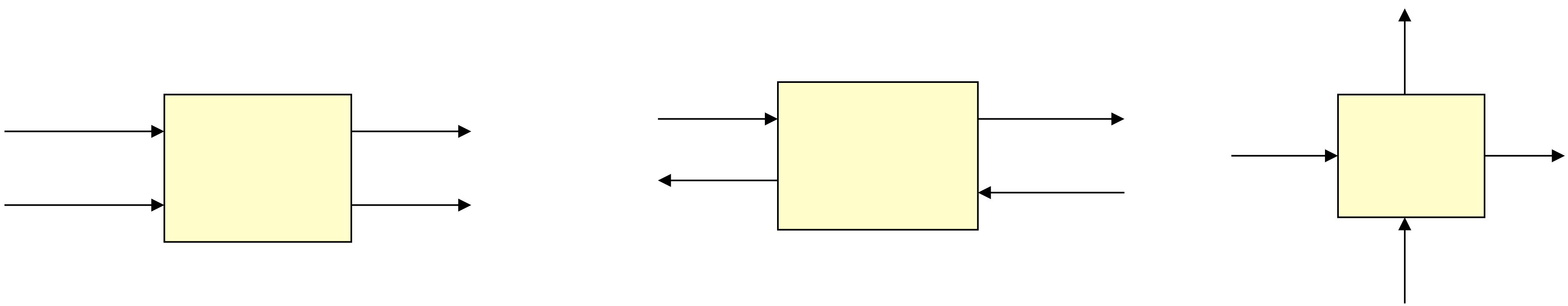
$$Q=UA\Delta T_m$$

Where,

U is the overall heat transfer coefficient

A is the area for heat transfer

ΔT_m is the mean temperature driving force for heat transfer



co current flow   countercurrent flow   cross flow

Heat Exchangers - Types

Different heat transfer applications require different types of hardware and different configurations of heat transfer equipment

Heat exchangers come in many different types:

1. **Double pipe**
2. **Spiral**
3. **Finned**
4. **plate type**
5. **Shell and tube (most common in chemical process industries)**

Equipment Function

Chiller: Cools a fluid to a temperature below that obtainable if water only were used as a coolant. It uses a refrigerant such as ammonia or Freon.

Condenser: Condenses a vapor or mixture of vapors, either alone or in the presence of a noncondensable gas.

Partial condenser Condenses vapors at a point high enough to provide a temperature difference sufficient to preheat a cold stream of process fluid. This saves heat and eliminates the need for providing a separate preheater (using flame or steam).

Final condenser Condenses the vapors to a final storage temperature of approximately 37.8°C (100°F). It uses water cooling, which means that the transferred heat is lost to the process.

Cooler Cools liquids or gases by means of water.

Exchanger Performs a double function: (1) heats a cold fluid by (2) using a hot fluid which it cools. None of the transferred heat is lost.

Heater Imparts sensible heat to a liquid or a gas by means of condensing steam or Dowtherm.

Reboiler Connected to the bottom of a fractionating tower, it provides the reboil heat necessary for distillation. The heating medium may be either steam or a hot-process fluid.

Steam generator Generates steam for use elsewhere in the plant by using the available high-level heat in tar or a heavy oil.

Superheater Heats a vapor above the saturation temperature.

Vaporizer A heater which vaporizes part of the liquid.

Waste-heat boiler Produces steam; similar to steam generator, except that the heating medium is a hot gas or liquid produced in a chemical reaction. heat-exchanger applications

BASIC CRITERIAS FOR THE SELECTION OF HEAT EXCHANGERS

- ✓ Process specifications
- ✓ Service conditions of the plant environment, resistance to corrosion by the process
- ✓ Maintenance, permission to cleaning and replacement of components
- ✓ Cost- Effectiveness
- ✓ Site requirements, lifting, servicing,capabilities

Design Constraints

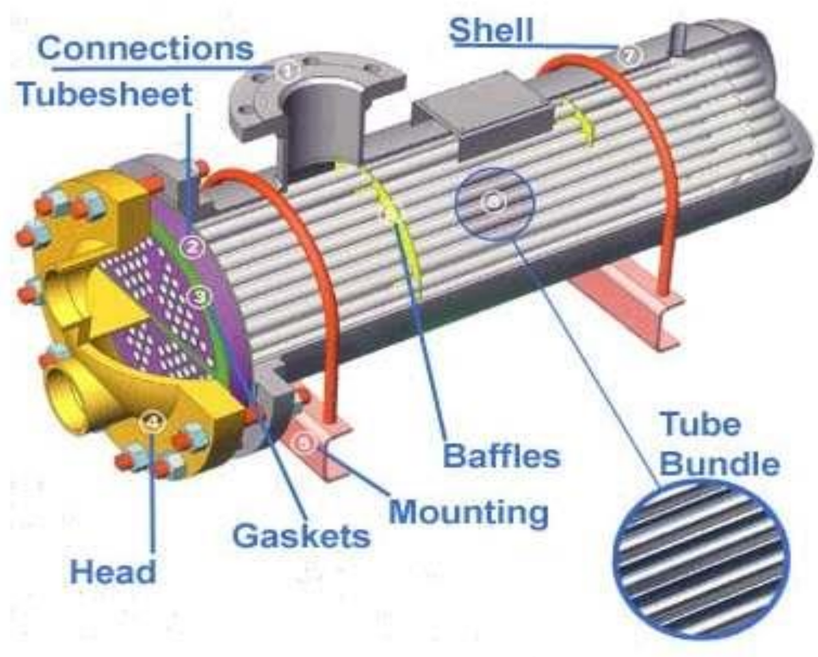
- **Cost – wish to have an exchanger that costs the least.**
- **Efficiency – wish to have an exchanger that operates most efficiently, with minimum loss of energy in the transfer, and minimum drop in pressure of the fluids.**
- **Space – wish to have an exchanger that is small.**
- **Materials – want an exchanger built from materials that are compatible with the process streams and don't cost a lot.**
- **Maintenance – want an exchanger that can be easily cleaned.**
- **Ease of construction.**

TUBULAR HEAT EXCHANGERS

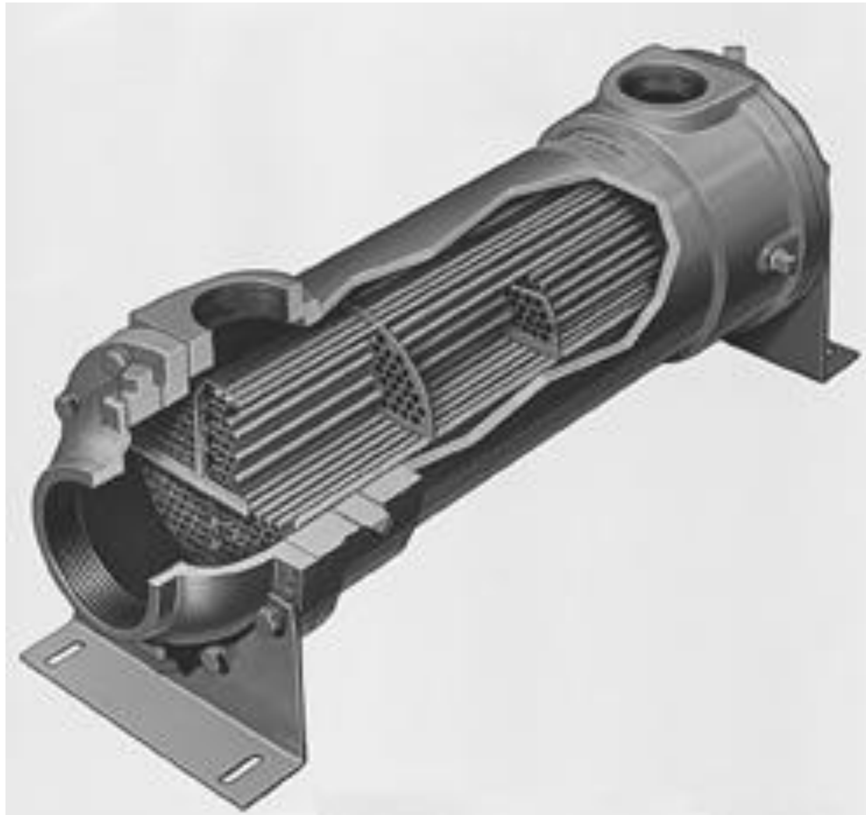
- **SHELL AND TUBE**
- **DOUBLE-PIPE**

Shell and tube heat exchanger

- Main Parts
- 1.Tubes
- 2.Shell
- 3.Baffles
- 4.Tube Sheets
- 5.Head
- 6.Tube Bundle



- Consist of two main things as it's name implies Shell & Tubes
- The shell is a large vassel with a number of tubes inside it .



- The principle of operation is simple enough: Two fluids of different temperatures are brought into close contact but they are not mixing with each other.
- One fluid runs through the tubes, and another fluid flows over the tubes (through the shell) to transfer heat between the two fluids.

Why shell-and-tube?

STHE accounted for 85% of new exchangers supplied to oil-refining, chemical, petrochemical and power companies.

Why?

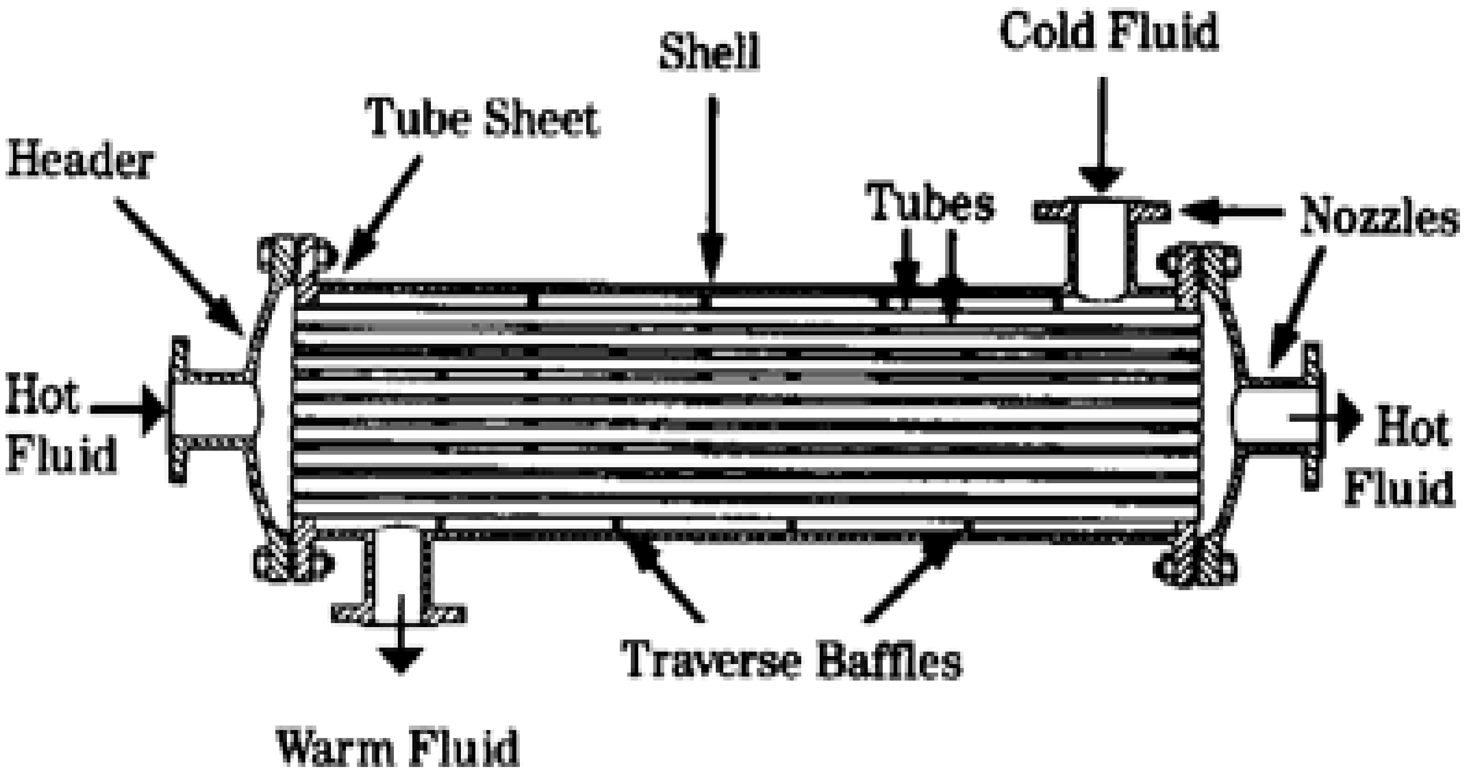
- Can be designed for almost any duty with a very wide range of temperatures and pressures
- Can be built in many materials
- Many suppliers
- Repair can be by non-specialists
- Design methods and mechanical codes have been established from many years of experience

Scope of shell-and-tube

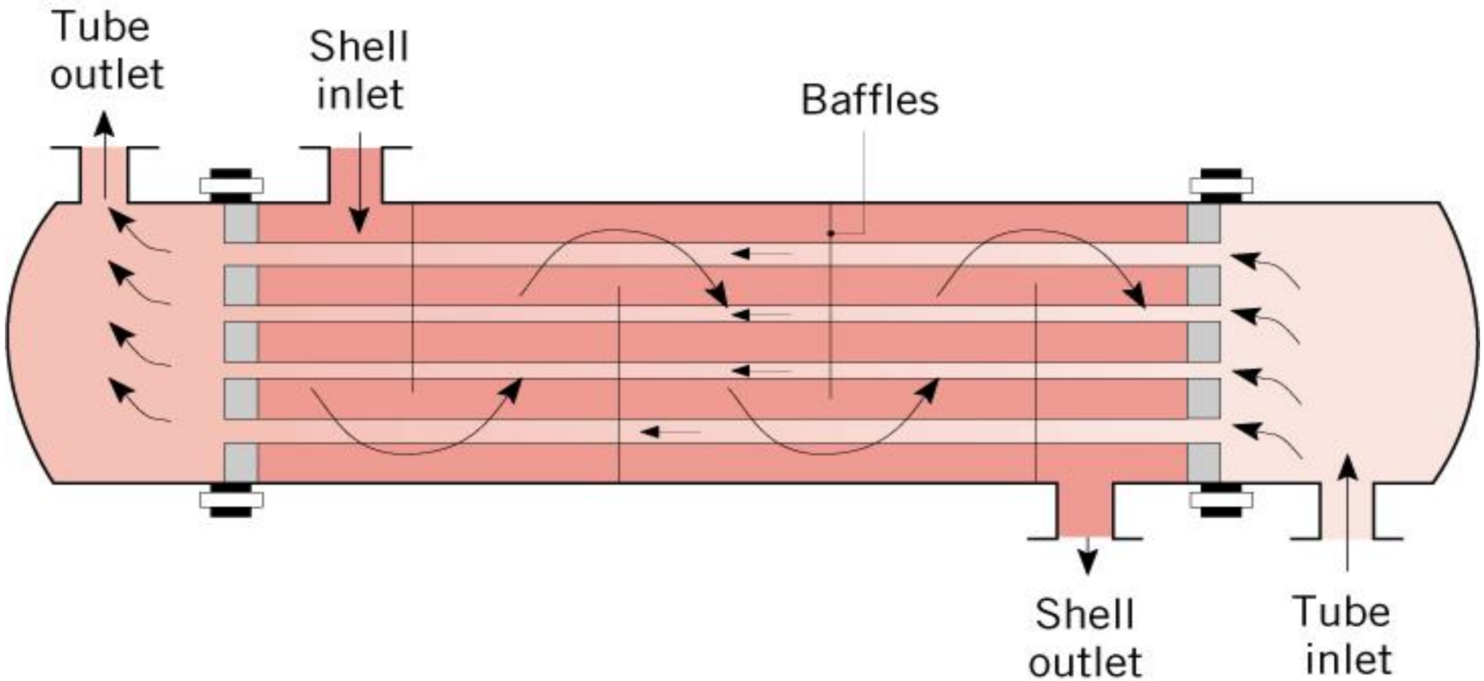
- Maximum pressure
  - Shell 300 bar (4500 psia)
  - Tube 1400 bar (20000 psia)
- Temperature range
  - Maximum 600^{o}C (1100^{o}F) or even 650^{o}C
  - Minimum -100^{o}C (-150^{o}F)
- Fluids
  - Subject to materials
  - Available in a wide range of materials
- Size per unit 100 - 10000 ft^2 (10 - 1000 m^2)

Can be extended with special designs/materials

SHELL AND TUBE HEAT EXCHANGERS



- Shell-and-Tube Heat Exchangers



One Shell Pass and One Tube Pass

SHELL AND TUBE HEAT EXCHANGERS

•are the most commonly used heat exchangers in oil refineries and other large chemical processes.

•are used when a process requires large amounts of fluid to be heated or cooled.

• provide transfer of heat efficiently.

•use baffles on the shell-side fluid to accomplished mixing or turbulence.

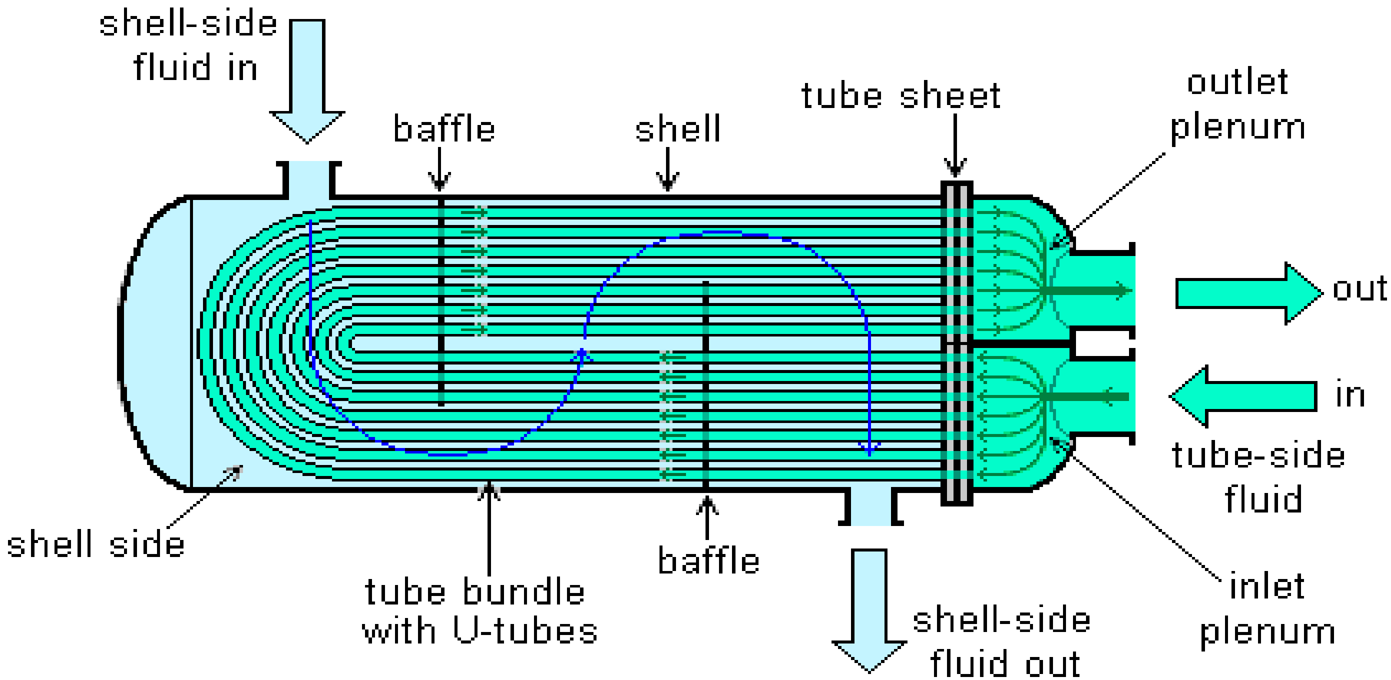
SHELL AND TUBE HEAT EXCHANGERS

- U - TUBE HEAT EXCHANGERS
- FIXED TUBE HEAT EXCHANGERS
- FLOATING HEAD HEAT EXCHANGERS

U - TUBE HEAT EXCHANGERS

heat exchanger systems consisting of straight length tubes bent into a U-shape surrounded by a shell.

U-tube heat exchanger



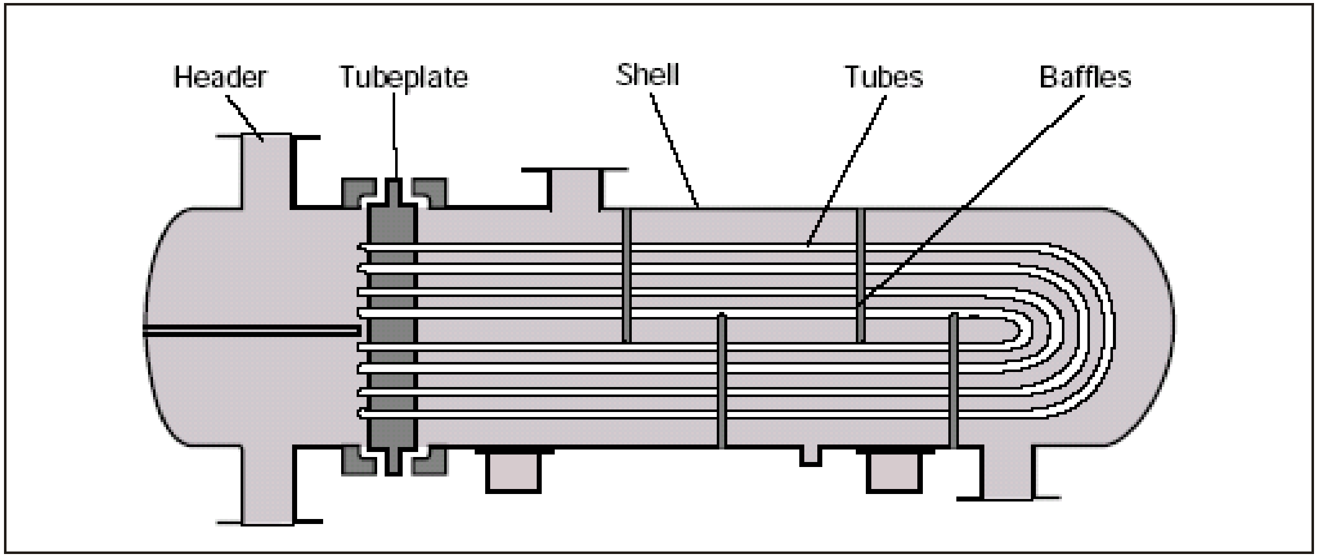
U - TUBE HEAT EXCHANGERS

- Both initial and maintenance costs are reduced by reducing the number of joints.

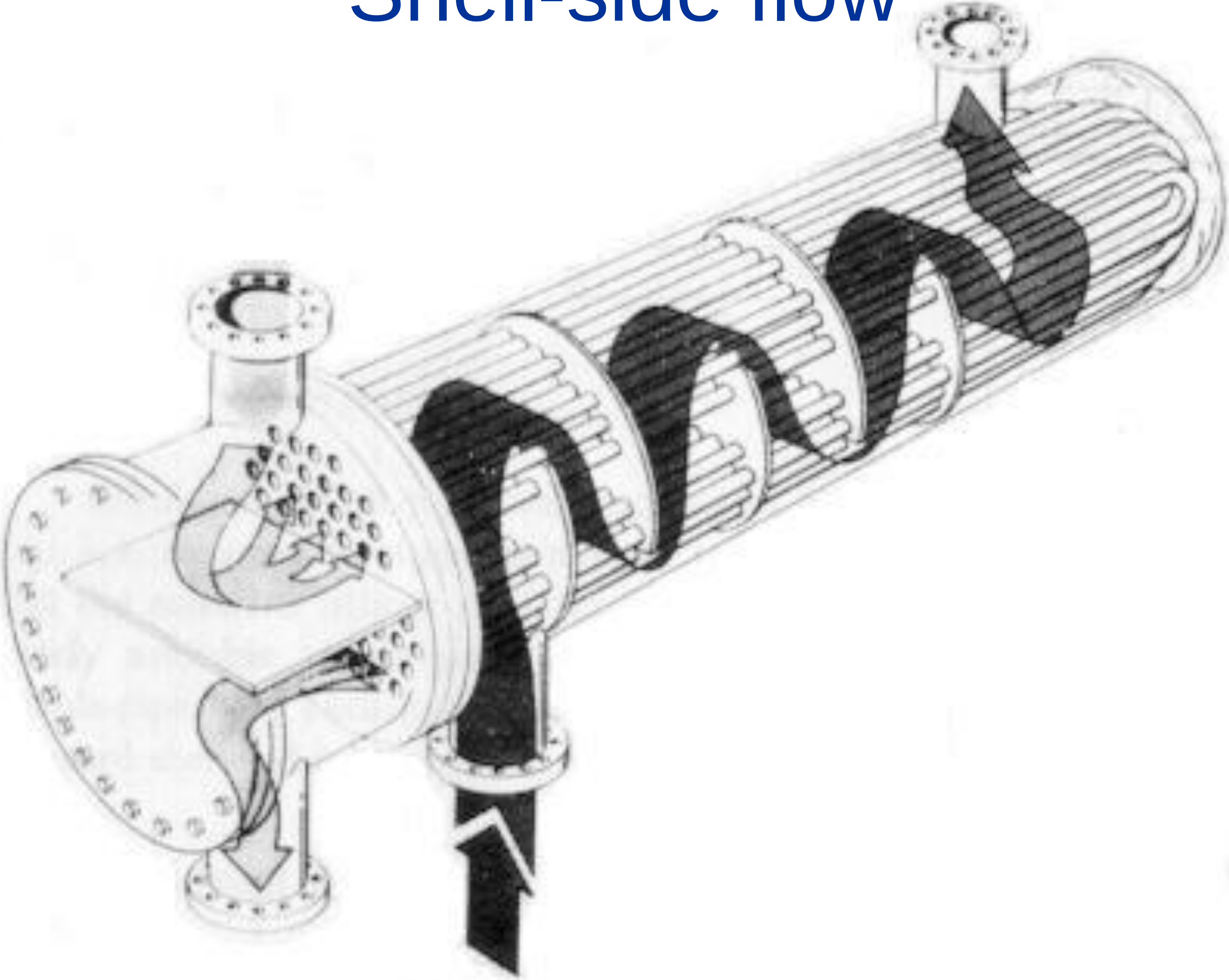
- They have drawbacks like inability to replace individual tubes except in the outer row and inability to clean around the bend.

U - TUBE HEAT EXCHANGERS

- Examples : reboilers, evaporators and Kettle type.
- They have enlarged shell sections for vapor-liquid separation.

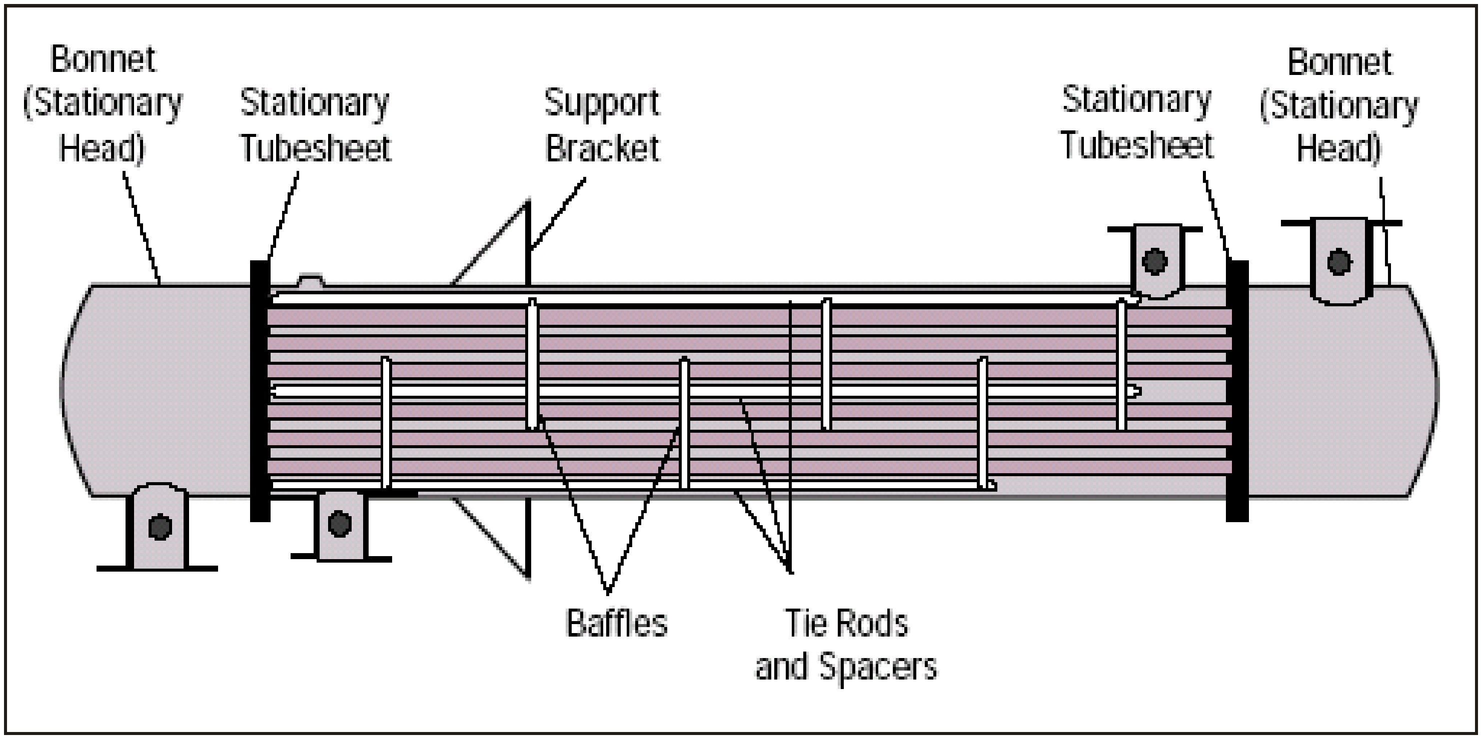


Shell-side flow



FIXED TUBE HEAT EXCHANGERS

have straight tubes that are secured at both ends to tube sheets welded to the shell.

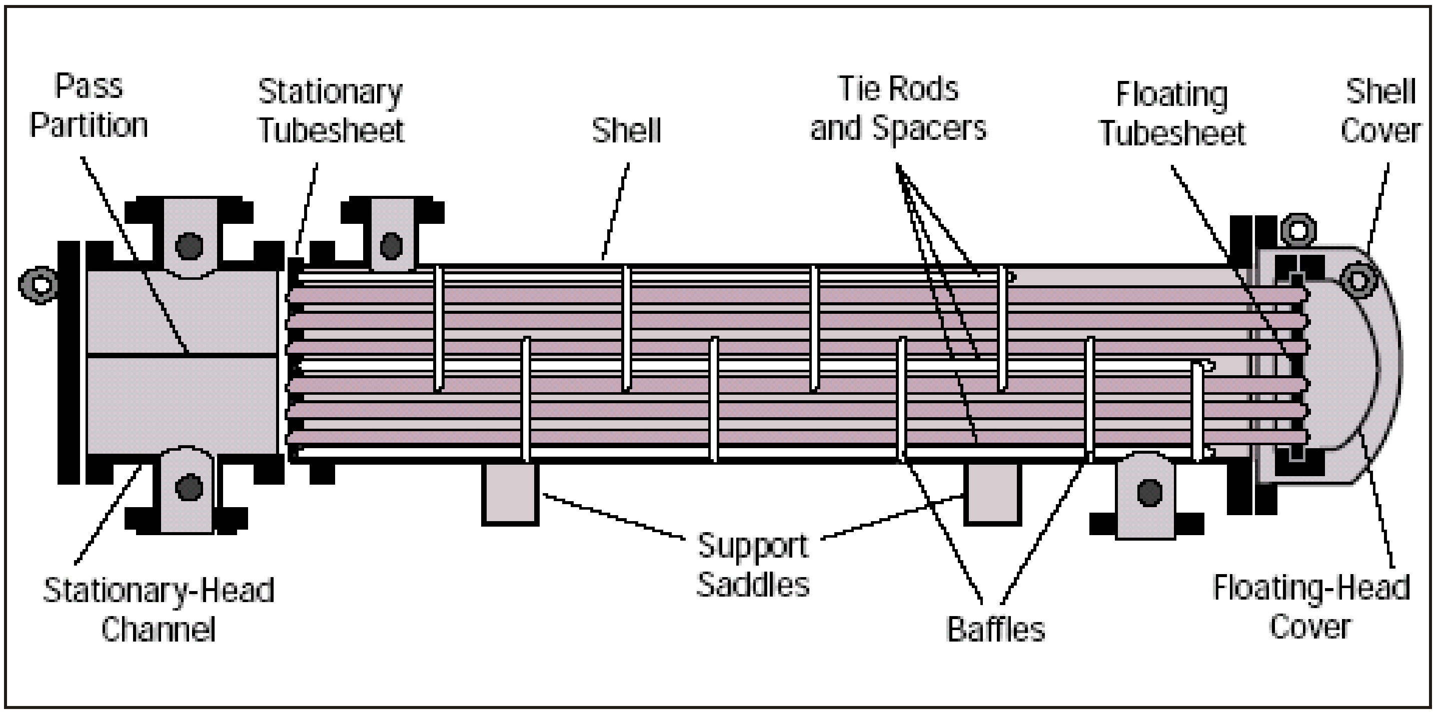


FIXED TUBE HEAT EXCHANGERS

- They are the most economical type design.
- They have very popular version as the heads can be removed to clean the inside of the tubes.
- Cleaning the outside surface of the tubes is impossible as these are inside the fixed part.
- Chemical cleaning can be used.

FLOATING HEAD HEAT EXCHANGER

one tube is free to float within the shell and the other is fixed relative to the shell.



FLOATING HEAD HEAT EXCHANGERS

- A floating head is excellent for applications where the difference in temperature between the hot and cold fluid causes unacceptable stresses in the axial direction of the shell and tubes.
- The floating head can move, so it provides the possibility to expand in the axial direction.
- Design allows for bundle to be removed for inspection, cleaning or maintenance.

FLOATING HEAD HEAT EXCHANGERS

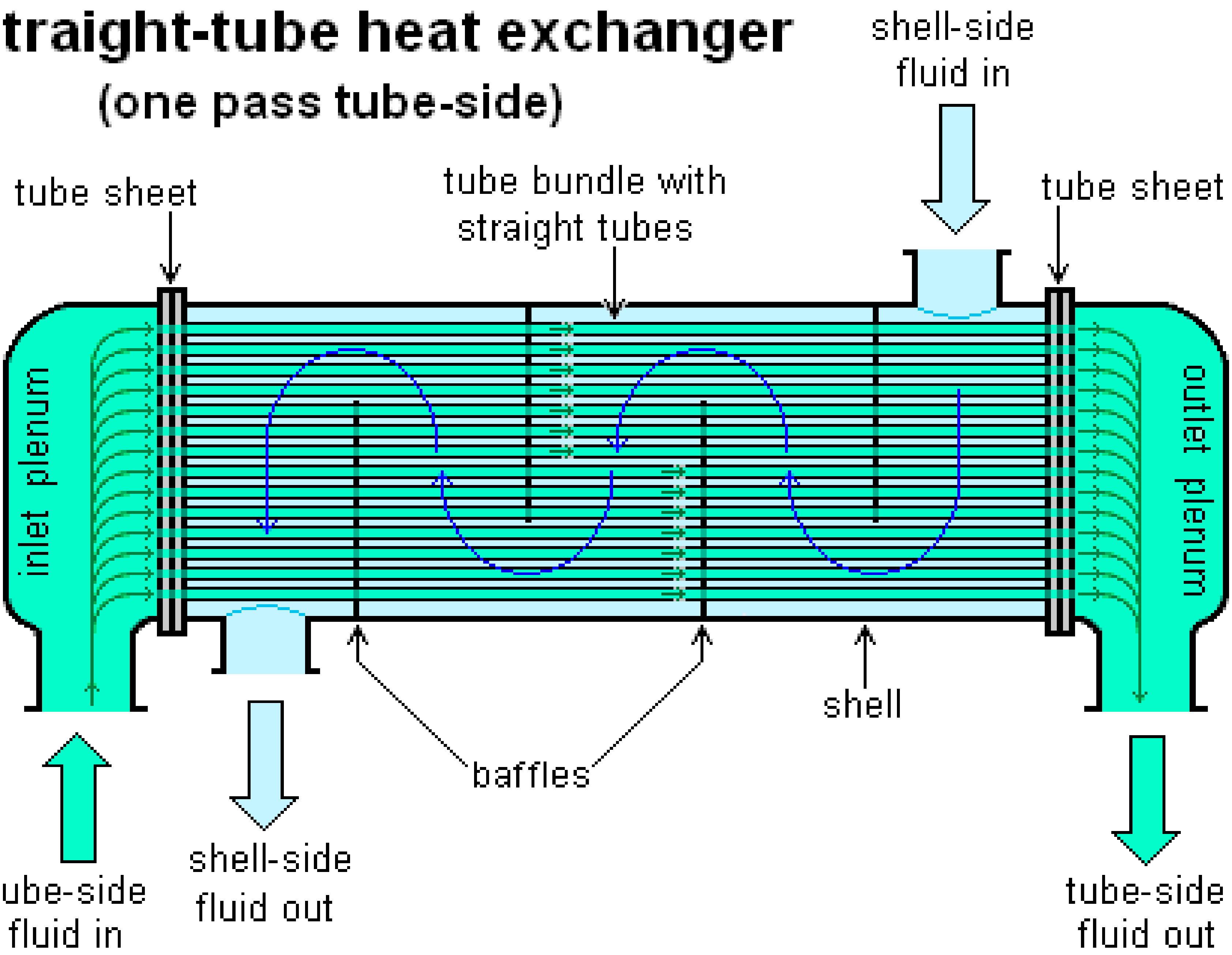
- Examples : kettle boilers which have dirty heating medium.
- They have the most highest construction cost of all exchanger types.

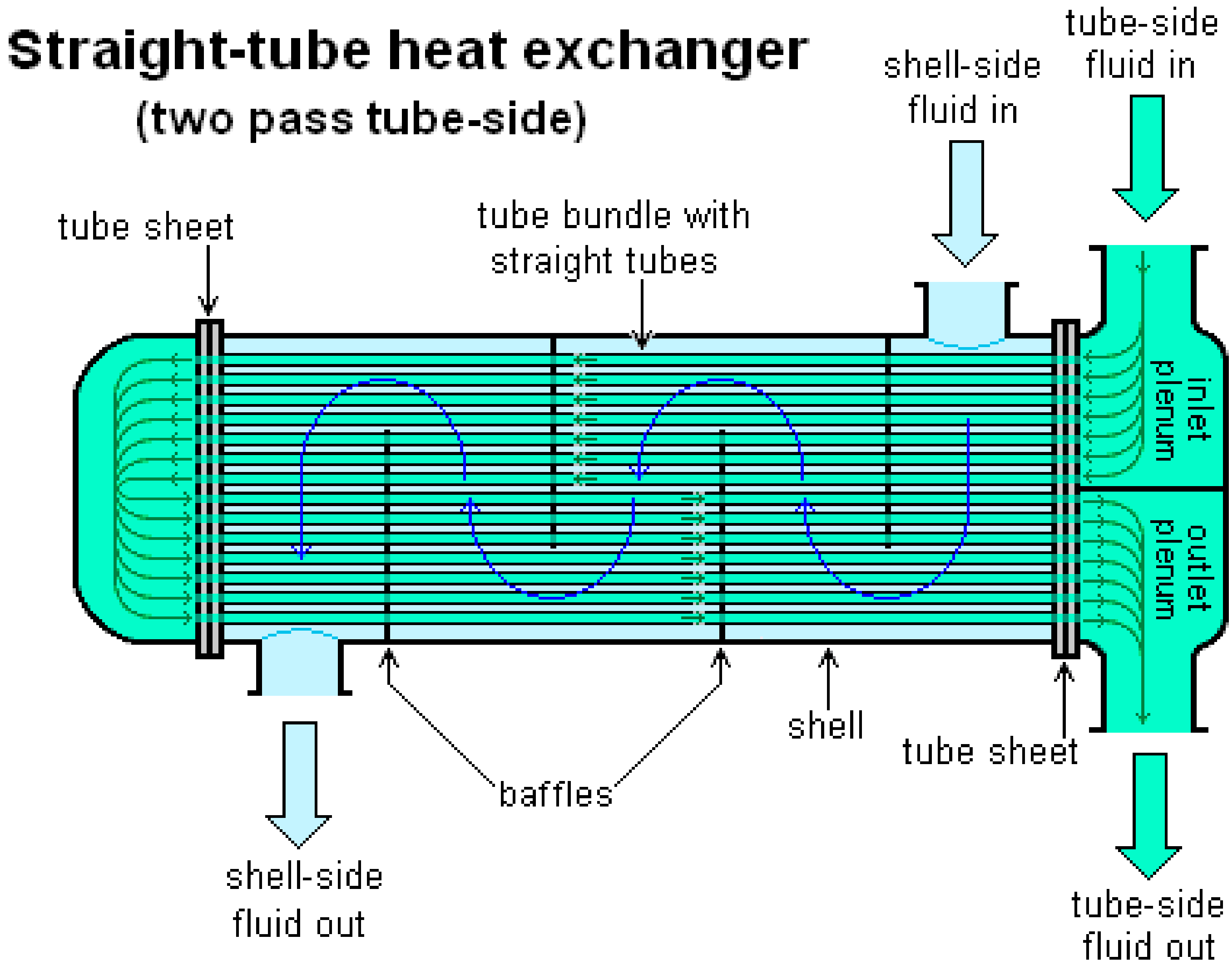
SHELL AND TUBE HEAT EXCHANGERS

- SINGLE-PASS 1-1 EXCHANGER
- 1-2 PARALLEL-COUNTER FLOW EX.
- 2-4 EXCHANGER.

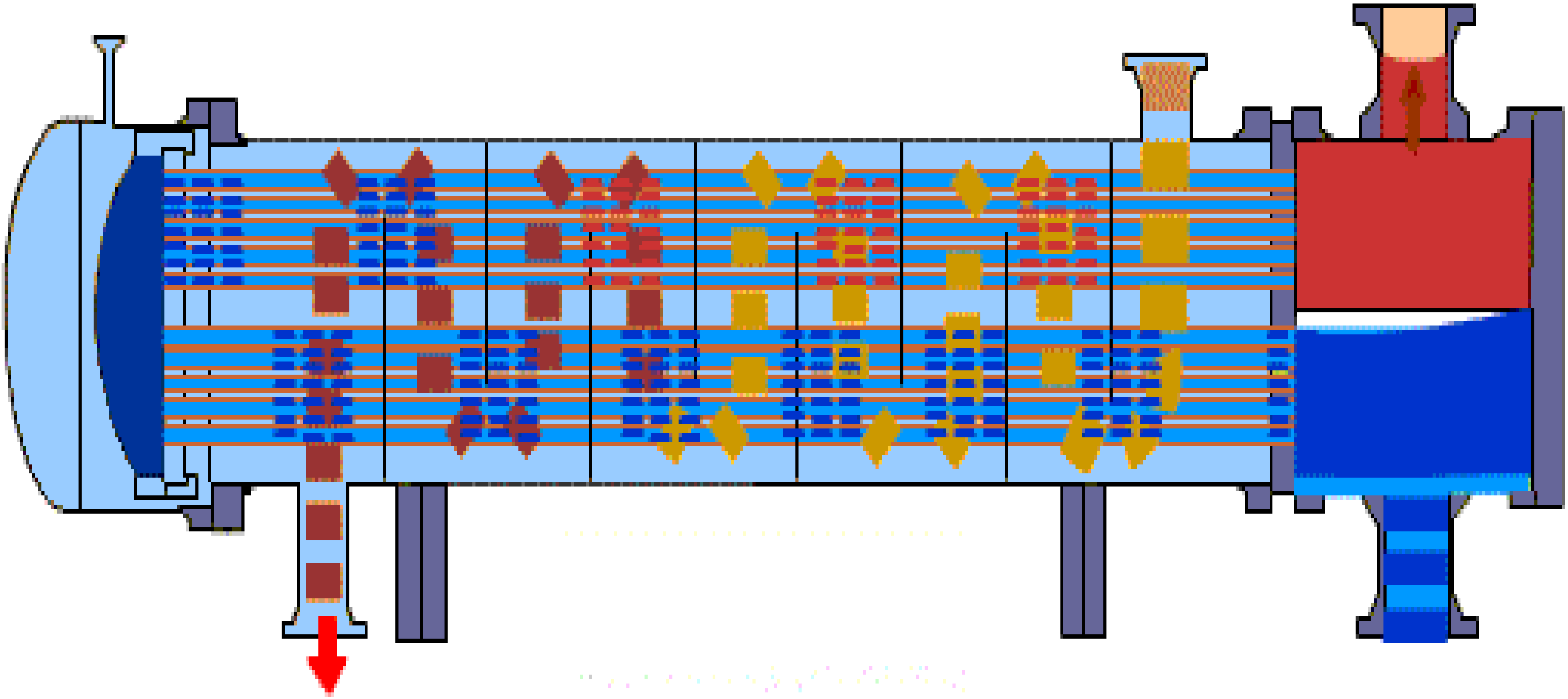
Straight-tube heat exchanger

(one pass tube-side)

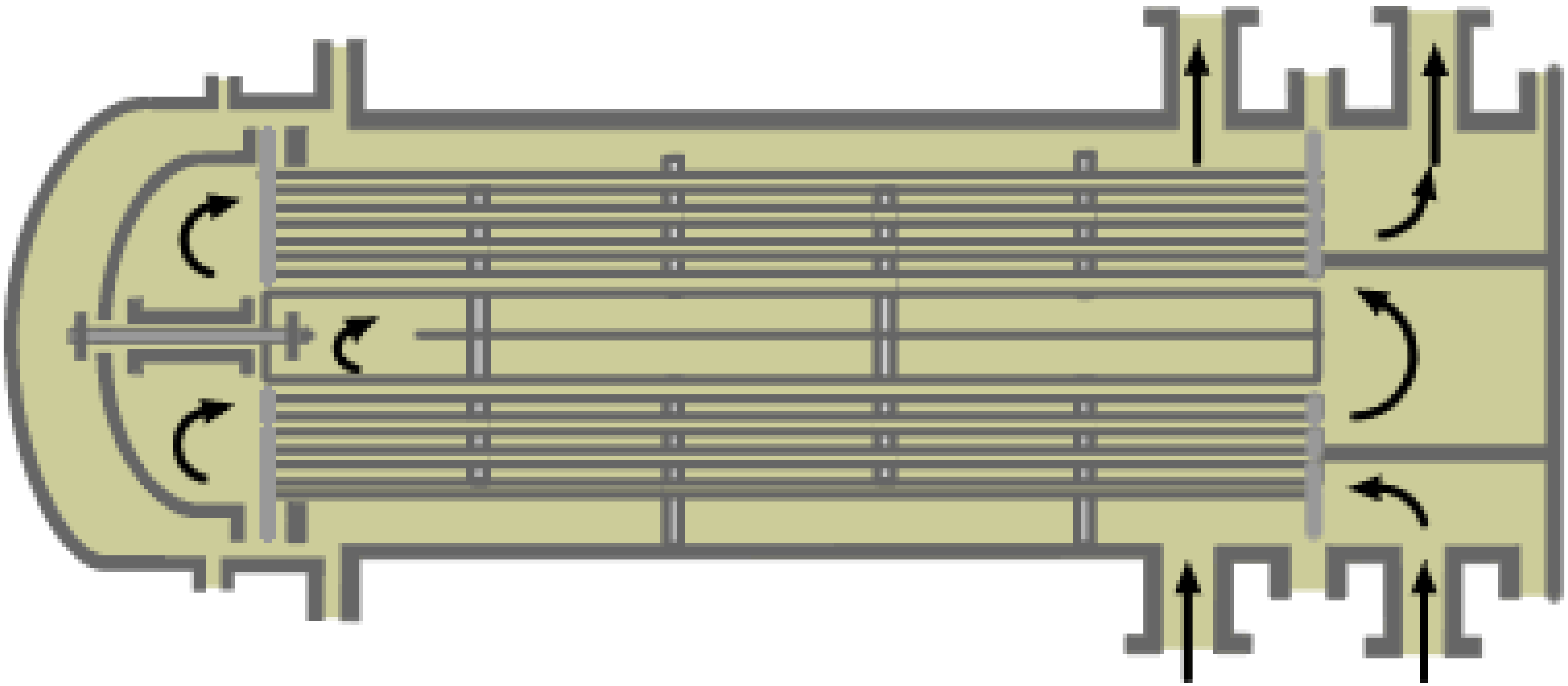



Straight-tube heat exchanger
(two pass tube-side)
shell-side
fluid in
tube-side
fluid in
tube sheet
tube bundle with
straight tubes
inlet
plenum
outlet
plenum
shell-side
fluid out
baffles
shell
tube sheet
tube-side
fluid out

1-2 shell and tube Heat Ex.

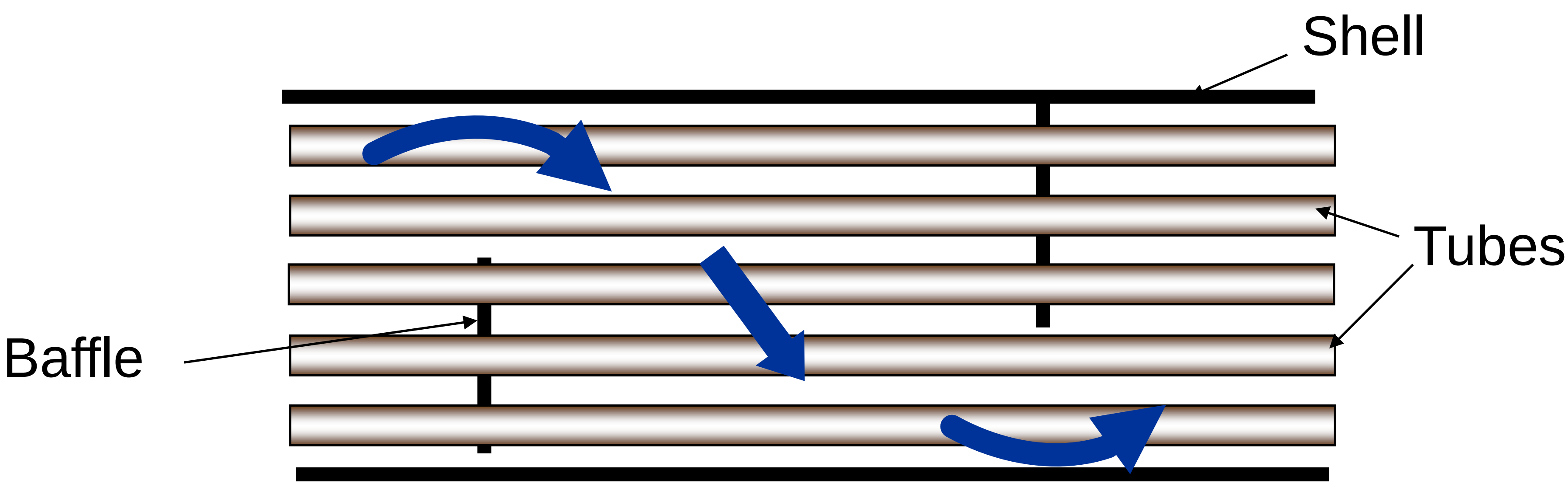


2-4 shell and tube Heat Ex.



Construction

- Bundle of tubes in large cylindrical shell
- **tube** : strong, thermally conductive, corrosion resistant, high quality
- **outer shell** : durable, highly strong



Tubes and Tube Passes

- A large number of tube passes are used to increase fluid velocity and heat transfer coefficient, and to minimize fouling
- Tube wall thickness is standardized in terms of the Birmingham Wire Gauge (BWG) of the tube
- Small tube diameters for larger area/volume ratios, but limited for in-tube cleaning
- Larger tube diameters suitable for condensers and boilers
- Fins used on the outside of tubes when low heat transfer coefficient fluid is present on the shell-side
- Longer tubes → fewer tubes, fewer holes drilled, smaller shell diameter, lower cost. However limitations due to several factors result in 1/5 – 1/15 shell-diameter-to-tube-length ratio

TABLE 8.1

Dimensional Data for Commercial Tubing

OD of Tubing (in.)	BWG Gauge	Thickness (in.)	Internal Flow Area (in.^{2})	Sq. Ft. External Surface per Ft. Length	Sq. Ft. Internal Surface per Ft. Length	Weight per Ft. Length, Steel (lb.)	ID Tubing (in.)	OD/ID
1/4	22	0.028	0.0295	0.0655	0.0508	0.066	0.194	1.289
1/4	24	0.022	0.0333	0.0655	0.0539	0.054	0.206	1.214
1/4	26	0.018	0.0360	0.0655	0.0560	0.045	0.214	1.168
3/8	18	0.049	0.0603	0.0982	0.0725	0.171	0.277	1.354
3/8	20	0.035	0.0731	0.0982	0.0798	0.127	0.305	1.233
3/8	22	0.028	0.0799	0.0982	0.0835	0.104	0.319	1.176
3/8	24	0.022	0.0860	0.0982	0.0867	0.083	0.331	1.133
1/2	16	0.065	0.1075	0.1309	0.0969	0.302	0.370	1.351
1/2	18	0.049	0.1269	0.1309	0.1052	0.236	0.402	1.244
1/2	20	0.035	0.1452	0.1309	0.1126	0.174	0.430	1.163
1/2	22	0.028	0.1548	0.1309	0.1162	0.141	0.444	1.126
5/8	12	0.109	0.1301	0.1636	0.1066	0.602	0.407	1.536
5/8	13	0.095	0.1486	0.1636	0.1139	0.537	0.435	1.437
5/8	14	0.083	0.1655	0.1636	0.1202	0.479	0.459	1.362
5/8	15	0.072	0.1817	0.1636	0.1259	0.425	0.481	1.299
5/8	16	0.065	0.1924	0.1636	0.1296	0.388	0.49s	1.263
5/8	17	0.058	0.2035	0.1636	0.1333	0.350	0.509	1.228
5/8	18	0.049	0.2181	0.1636	0.1380	0.303	0.527	1.186

TABLE 8.2

Heat Exchanger and Condenser Tube Data

Nominal Pipe Size (in.)	Outside Diameter (in.)	Schedule Number or Weight	Wall Thickness (in.)	Inside Diameter (in.)	Surface Area		Cross-Sectional Area	
					Outside (ft.^{2}/ft.)	Inside (ft.^{2}/ft.)	Metal Area (in.^{2})	Flow Area (in.^{2})
		40	0.113	0.824	0.275	0.216	0.333	0.533
3/4	1.05	80	0.154	0.742	0.275	0.194	0.434	0.432
		40	0.133	1.049	0.344	0.275	0.494	0.864
1	1.315	80	0.179	0.957	0.344	0.250	0.639	0.719
		40	0.140	1.38	0.434	0.361	0.668	1.496
1-1/4	1.660	80	0.191	1.278	0.434	0.334	0.881	1.283
		40	0.145	1.61	0.497	0.421	0.799	2.036
1-1/2	1.900	80	0.200	1.50	0.497	0.393	1.068	1.767
		40	0.154	2.067	0.622	0.541	1.074	3.356
2	2.375	80	0.218	1.939	0.622	0.508	1.477	2.953
		40	0.203	2.469	0.753	0.646	1.704	4.79
2-1/2	2.875	80	0.276	2.323	0.753	0.608	2.254	4.24
		40	0.216	3.068	0.916	0.803	2.228	7.30
3	3.5	80	0.300	2.900	0.916	0.759	3.106	6.60
		40	0.226	3.548	1.047	0.929	2.680	9.89
3-1/2	4.0	80	0.318	3.364	1.047	0.881	3.678	8.89
		40	0.237	4.026	1.178	1.054	3.17	12.73
4	4.5	80	0.337	3.826	1.178	1.002	4.41	11.50

Tube Layout

- Angle between the tubes
- 30º results in greatest tube density, most common
- P_T/d_o is between 1.25 and 1.50
- Maximum number of tubes that can be accommodated within a shell under specified conditions given in Table

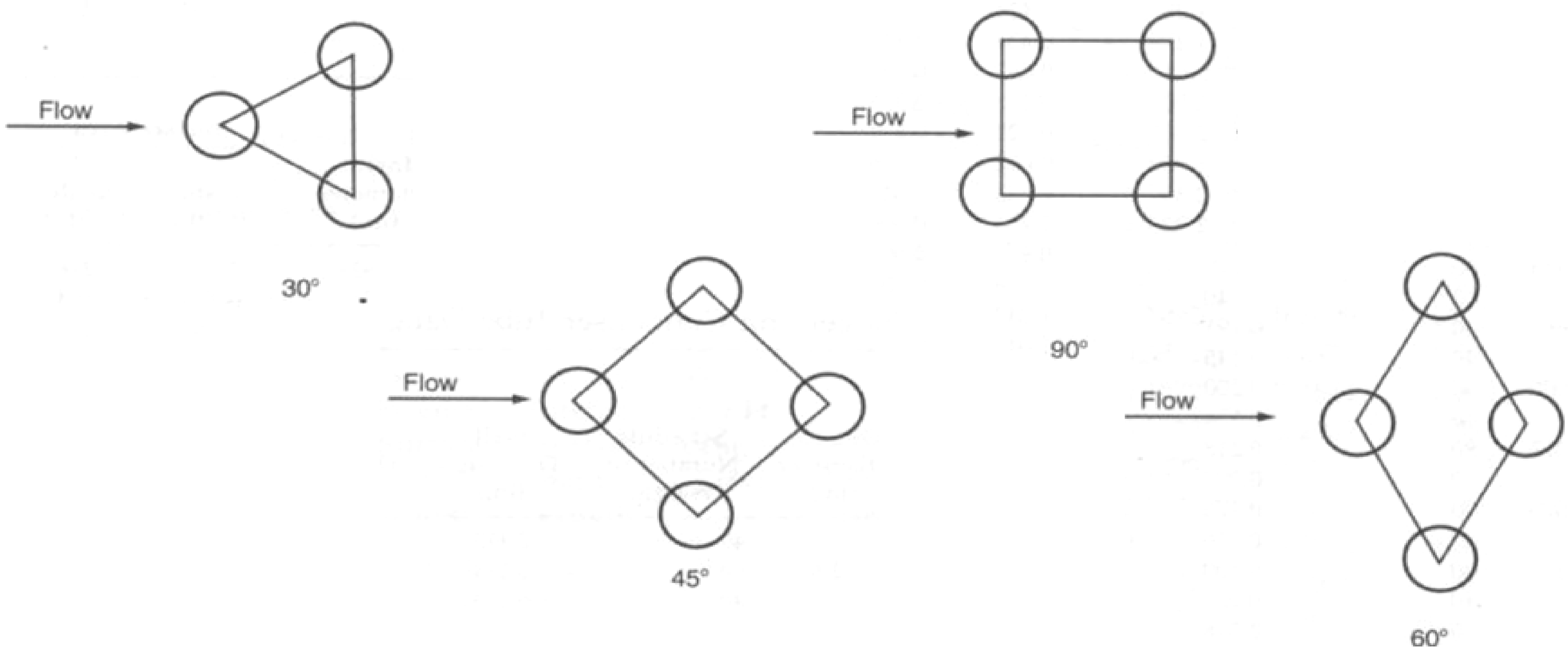


TABLE 8.3

Tube-Shell Layouts (Tube Counts)

Shell ID (in.)	1-P	2-P	4-P	6-P	8-P
3/4-in. O.D. Tubes on 1-in. Triangular Pitch					
8	37	30	24	24	
10	61	52	40	36	
12	92	82	76	74	70
13 1/4	109	106	86	82	74
15 1/4	151	138	122	118	110
17 1/4	203	196	178	172	166
19 1/4	262	250	226	216	210
21 1/4	316	302	278	272	260
23 1/4	384	376	352	342	328
25	470	452	422	394	382
27	559	534	488	474	464
29	630	604	556	538	508
31	745	728	678	666	640
33	856	830	774	760	732
35	970	938	882	864	848
37	1074	1044	1012	986	870
39	1206	1176	1128	1100	1078

Baffle Type and Geometry

Baffles support the tubes for structural rigidity, thus prevent tube vibration and sagging

They also divert the flow across the tube bundle to obtain a higher heat transfer coefficient

Baffles can be transverse or longitudinal

Transverse baffles are plate type or rod type

Plate baffles

- single and double segmental most common
- baffle spacing is critical (optimum between 0.4 and 0.6 of the shell diameter)
- triple and no-tubes-in-window segmental baffles for low pressure drop applications

Plate Baffle Types

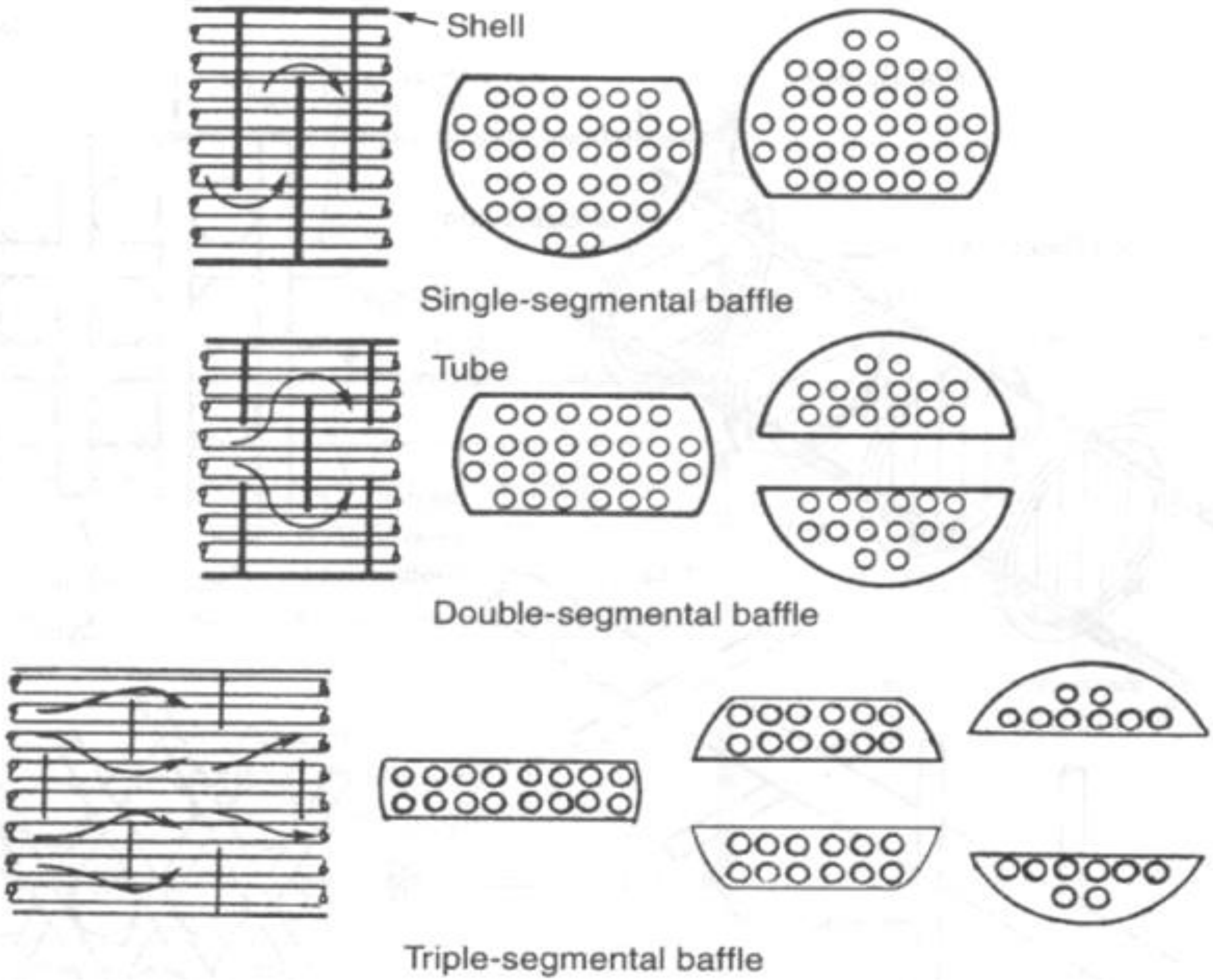
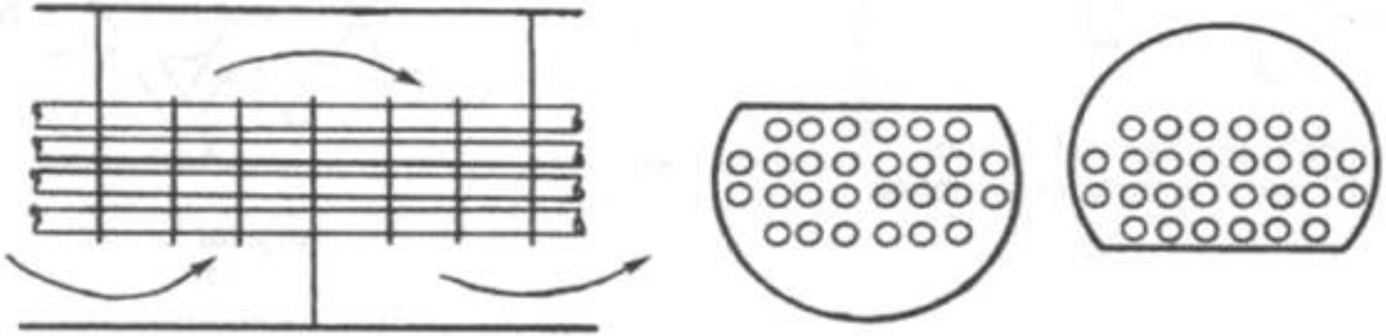
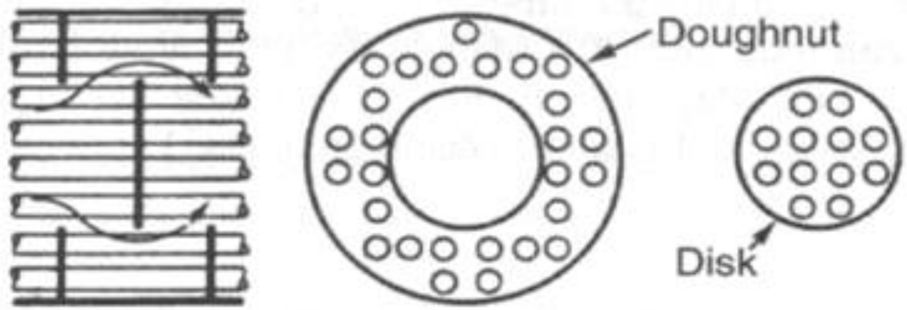


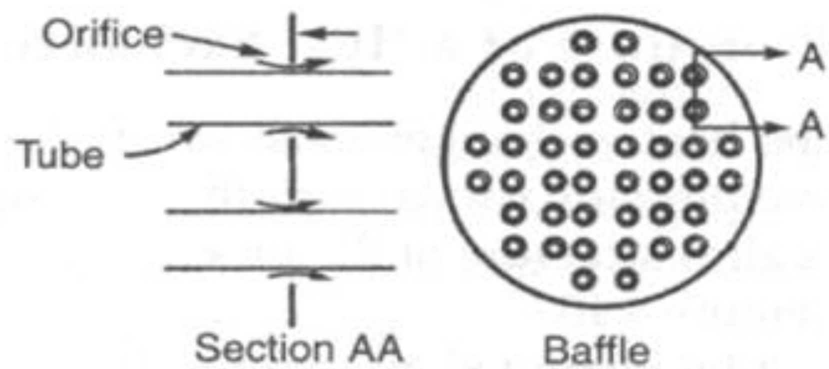
Plate Baffle Types (continued)



No-tubes-in-window segmental baffle

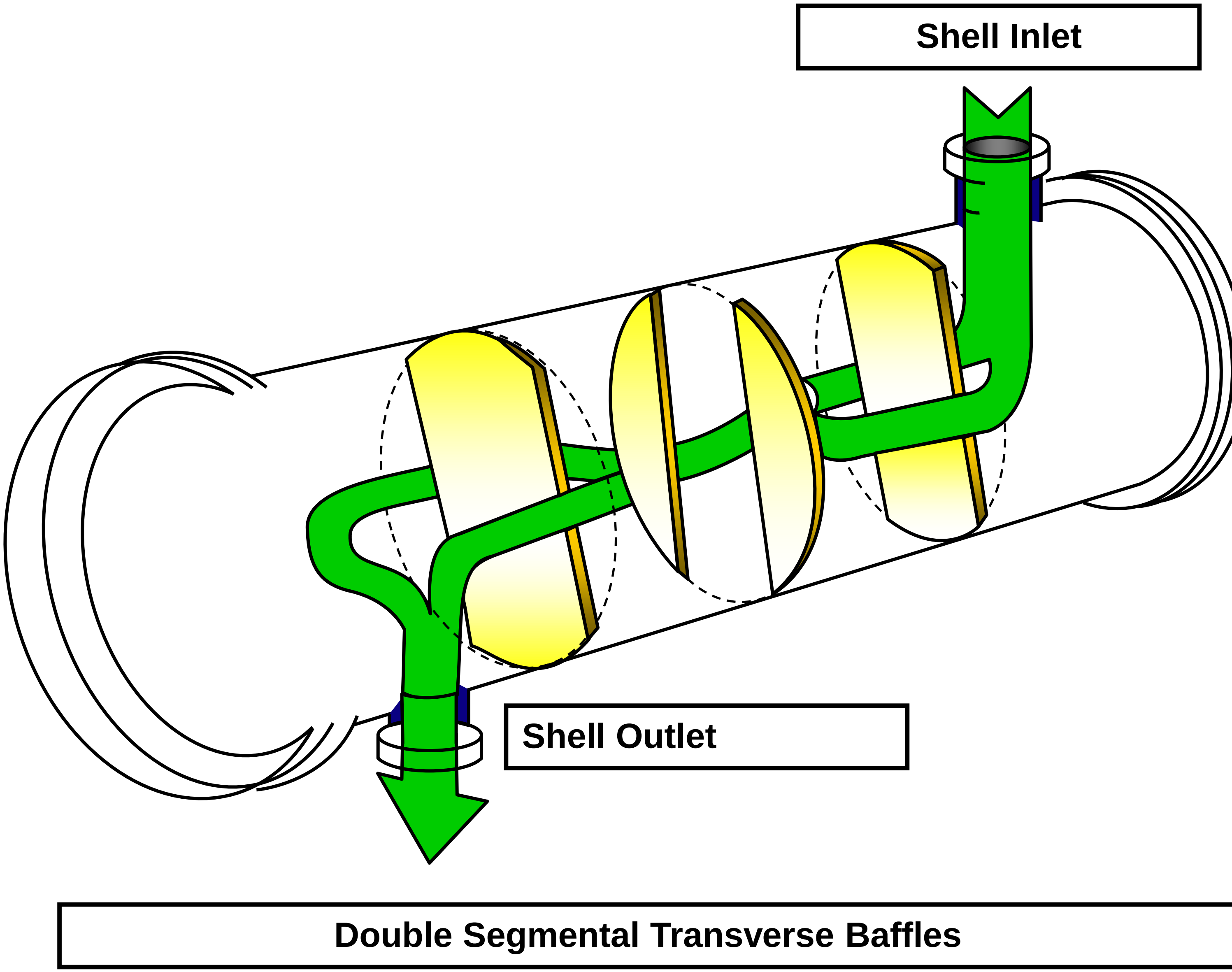


Disk and doughnut baffle

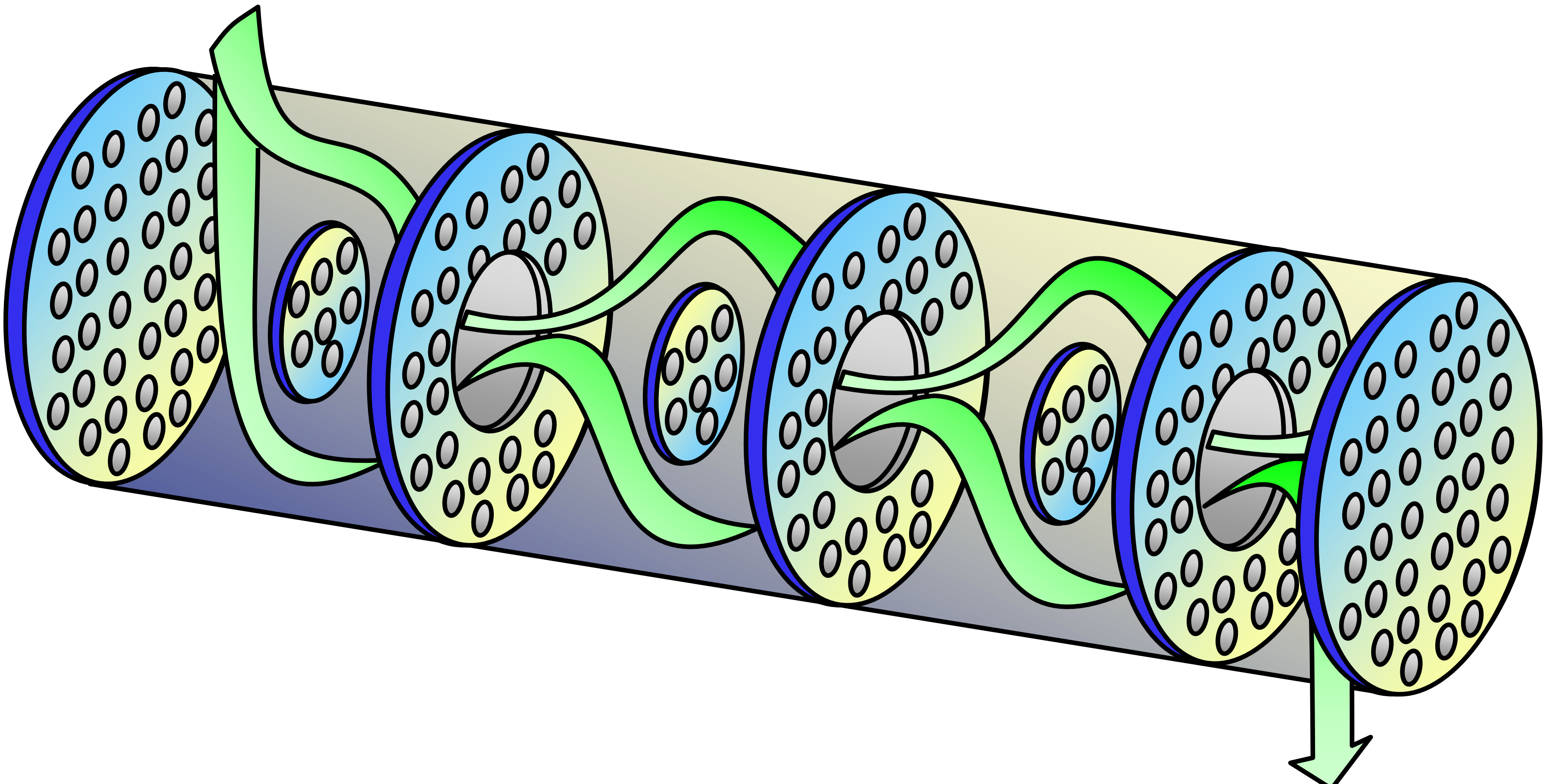


Orifice baffle

Shell and Tube Heat Exchanger



Shell and Tube Heat Exchanger



Doughnut and Disc Type Baffles

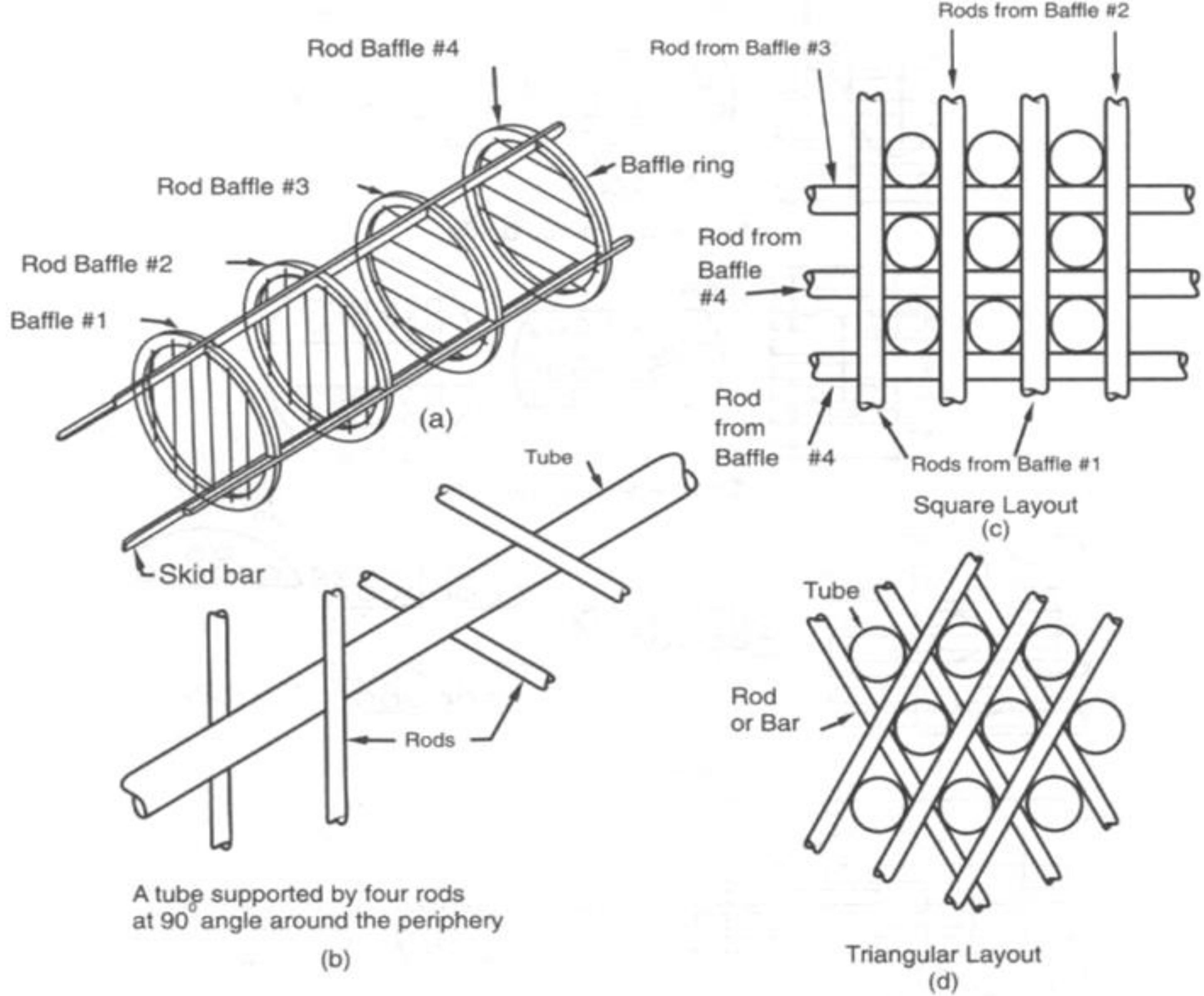
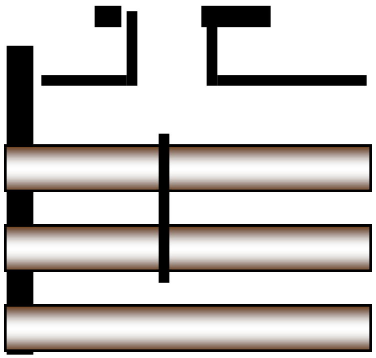
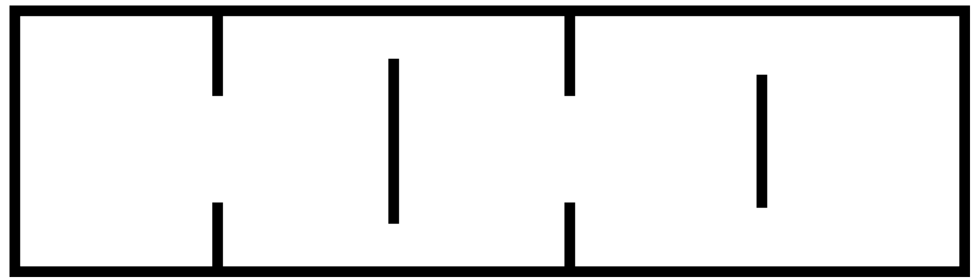


FIGURE 8.9
(a) Four rod baffles held by skid bars (no tube shown), (b) a tube supported by four rods, (c) a square layout of tubes with rods, and (d) a triangle layout of tubes with rods. (Adapted from Kakaç, S., Bergles, A. E., and Mayinger, F.. Eds. [1981] *Heat Exchangers: Thermal-Hydraulic Fundamentals and Design*, Taylor and Francis, Washington, D.C.)

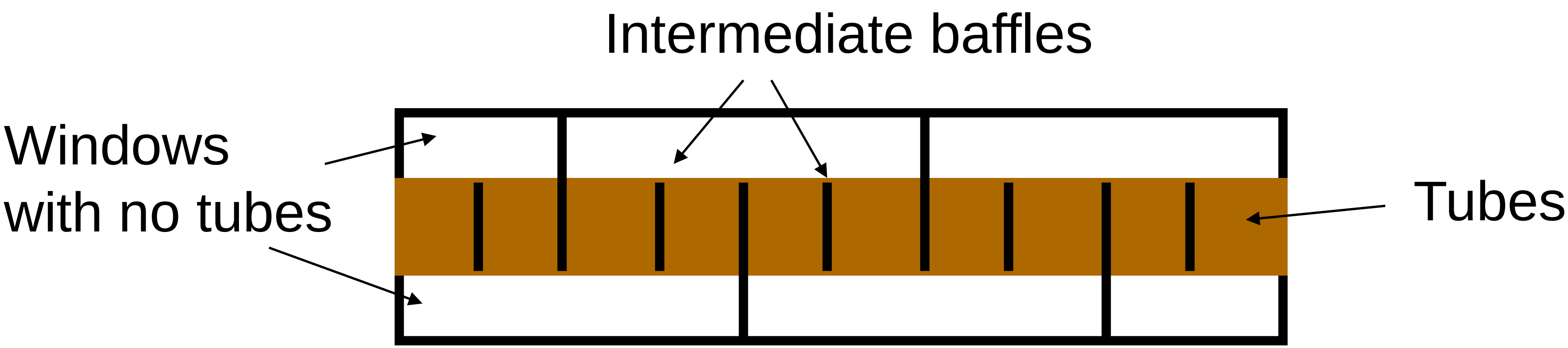
Avoiding vibration (cont.)



Inlet support baffles



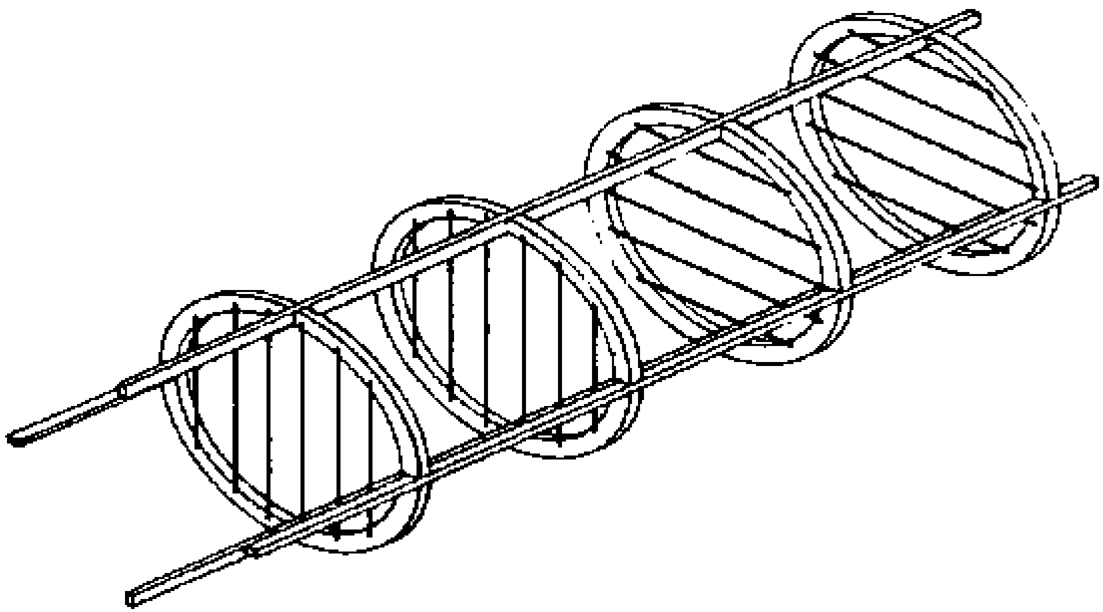
Double-segmental baffles



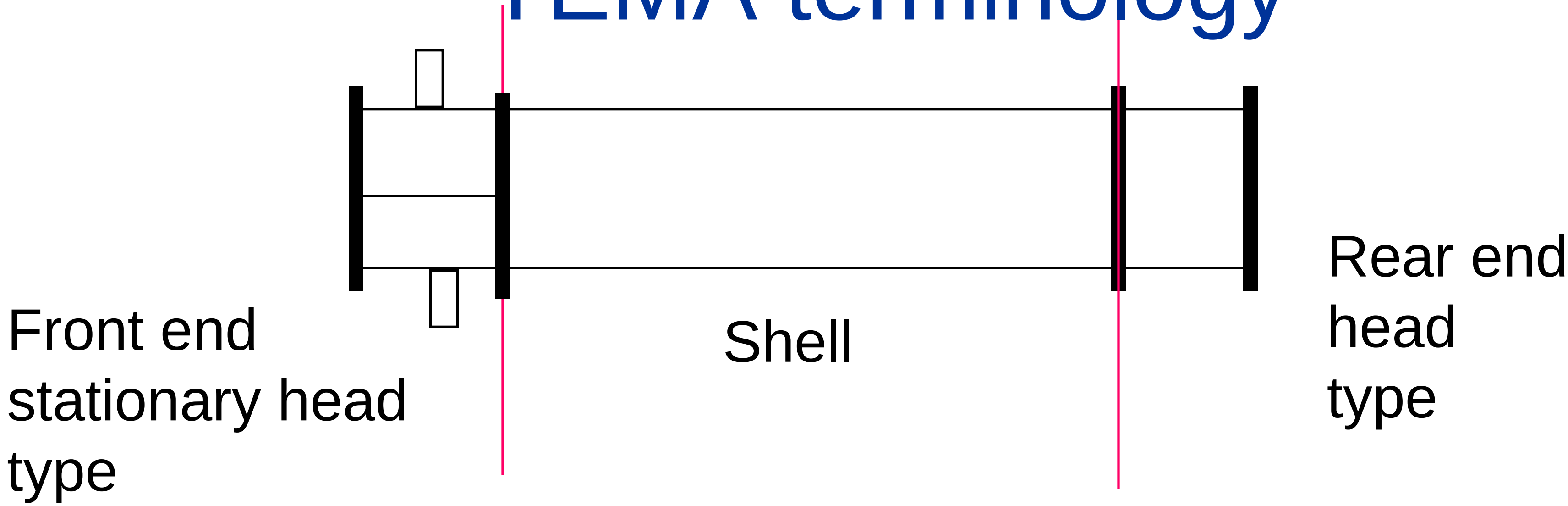
No tubes in the window - with intermediate support baffles

ROD baffles

Tend to be about 10% more expensive for the same shell diameter



TEMA terminology

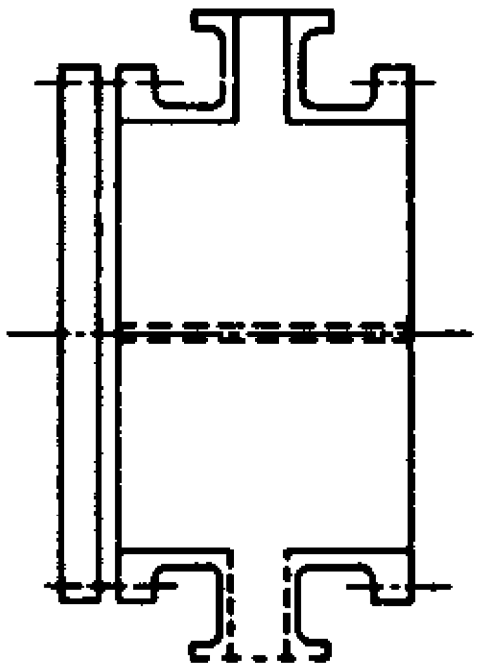


- Letters given for the front end, shell and rear end types
- Exchanger given three letter designation

Front head type

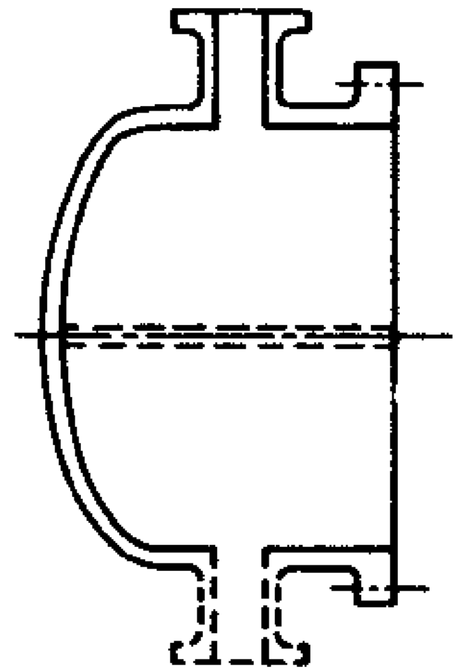
- A-type is standard for dirty tube side
- B-type for clean tube side duties. Use if possible since cheap and simple.

A



Channel and removable cover

B

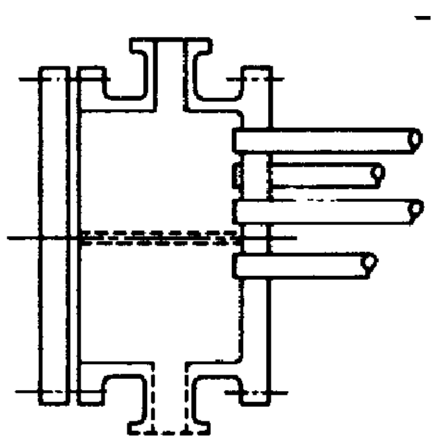


Bonnet (integral cover)

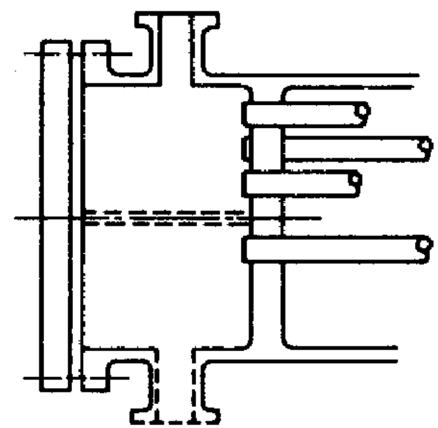
More front-end head types

- C-type with removable shell for hazardous tube-side fluids, heavy bundles or services that need frequent shell-side cleaning
- N-type for fixed for hazardous fluids on shell side
- D-type or welded to tube sheet bonnet for high pressure (over 150 bar)

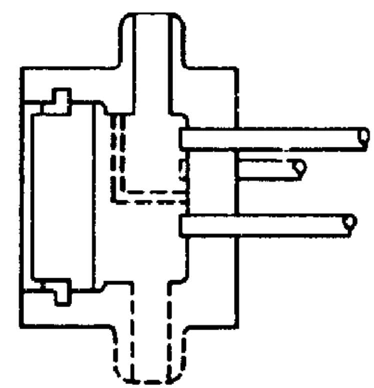
B



N



D

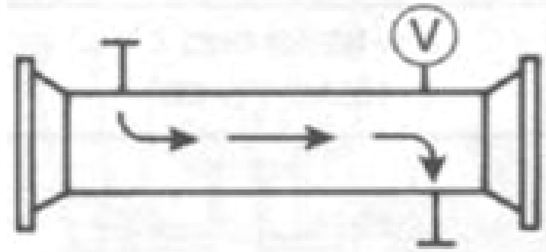


Basic Components

Shell Types

Front and rear head types and shell types are standardized by TEMA, identified by alphabetic characters

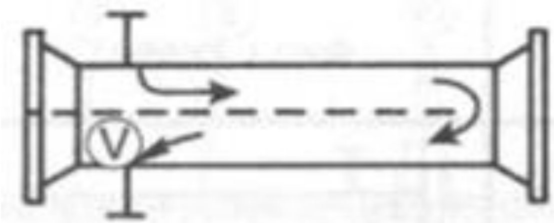
E-shell is the most common



E: One-Pass Shell

- cheap and simple configuration
- one-shell pass and one- or multiple-tube passes
- if one-tube pass, nominal counter flow is achieved
- most common for single-phase shell fluid applications

F-shell used when there are two tube passes and pure counter flow is desired



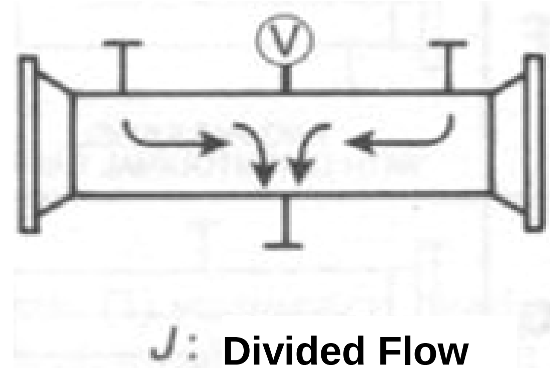
F: Two-Pass Shell with Longitude Baffle

- longitudinal baffle results in two-shell passes
- units in series, each shell pass represents one unit
- higher pressure drop than that for E-shell

Shell Types (continued)

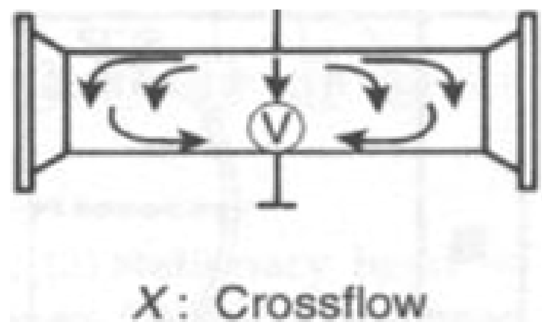
J-shell has divided flow

- for low pressure drop applications
- normally, single nozzle for shell-fluid at tube center, two nozzles near tube ends
- when used for condensing the shell fluid, two inlets for shell-side vapor and one central outlet for condensate (figure)



X-shell has cross flow

- central shell-fluid entry and exit
- no baffles are used
- very low pressure drop
- used for vacuum condensers and low-pressure gases

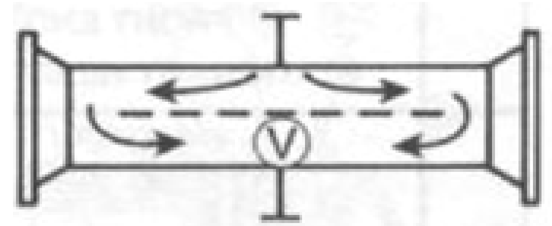


G-shell and H-shell are single- and double-split flow

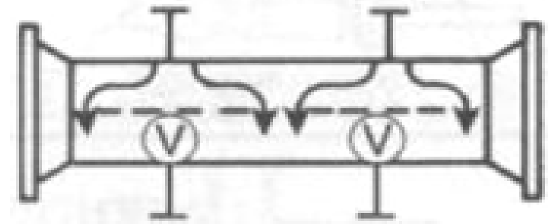
Shell Types (continued)

G-shell and H-shell are single- and double-split flow

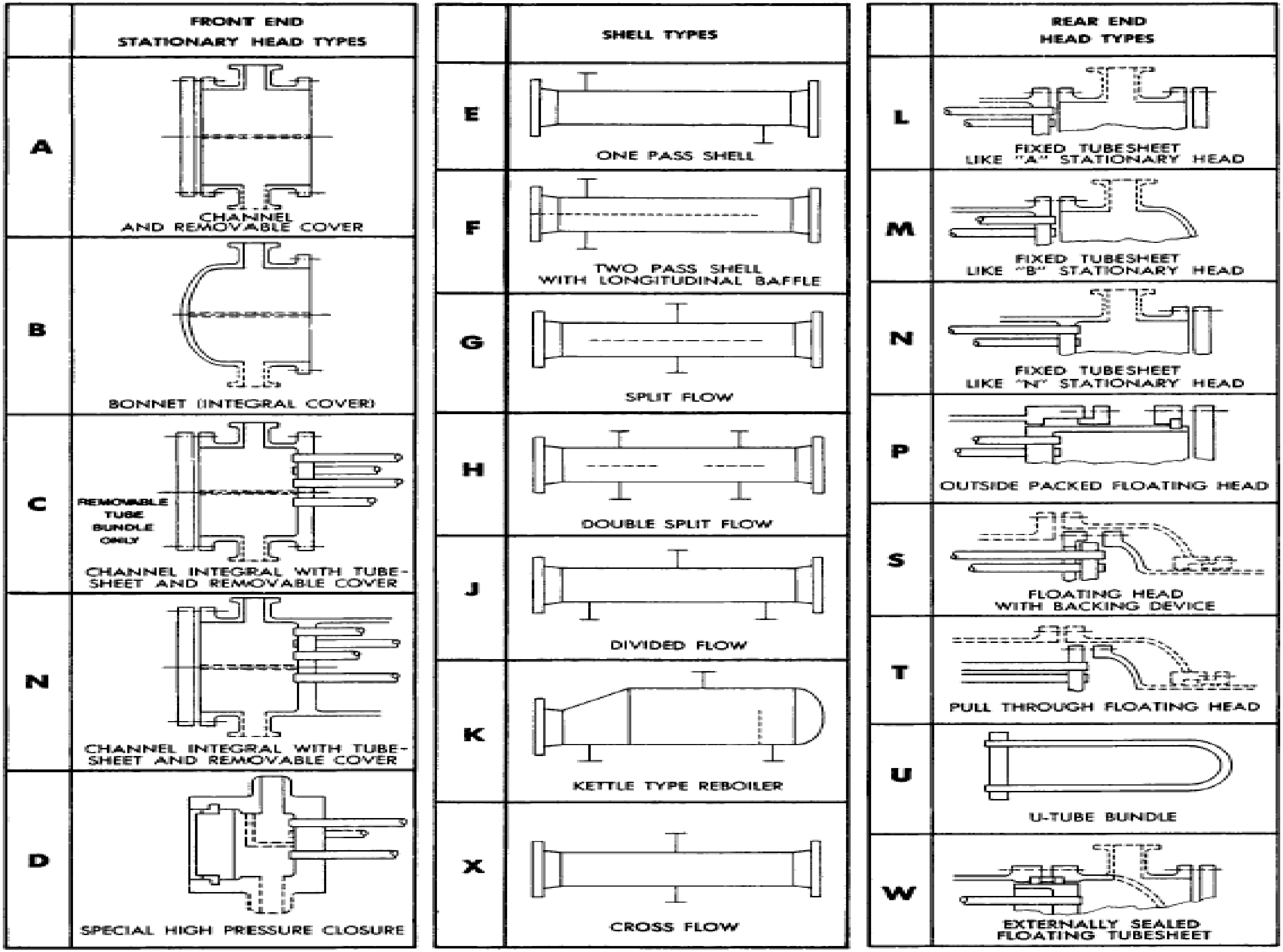
- G-shell has a horizontal baffle with ends removed, central shell-fluid entry and exit
- H-shell is similar, but with two baffles, and two nozzles at the entry and exit



G: Split Flow



H : Double Split Flow

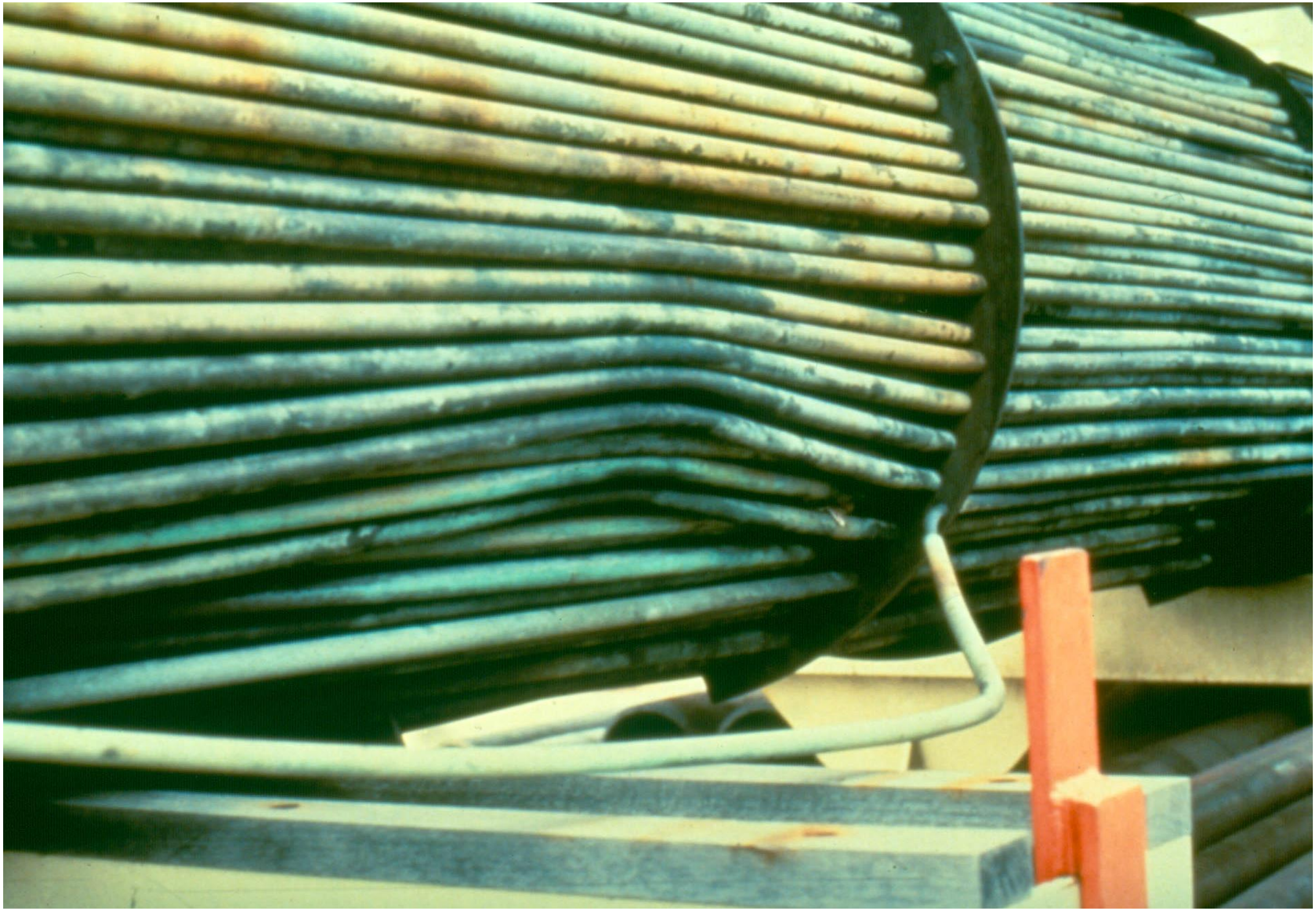

FRONT END
STATIONARY HEAD TYPES
A
CHANNEL
AND REMOVABLE COVER
B
BONNET (INTEGRAL COVER)
C
REMOVABLE
TUBE
BUNDLE
ONLY
CHANNEL INTEGRAL WITH TUBE-
SHEET AND REMOVABLE COVER
N
CHANNEL INTEGRAL WITH TUBE-
SHEET AND REMOVABLE COVER
D
SPECIAL HIGH PRESSURE CLOSURE
SHELL TYPES
E
ONE PASS SHELL
F
TWO PASS SHELL
WITH LONGITUDINAL BAFFLE
G
SPLIT FLOW
H
DOUBLE SPLIT FLOW
J
DIVIDED FLOW
K
KETTLE TYPE REBOILER
X
CROSS FLOW
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

Fouling

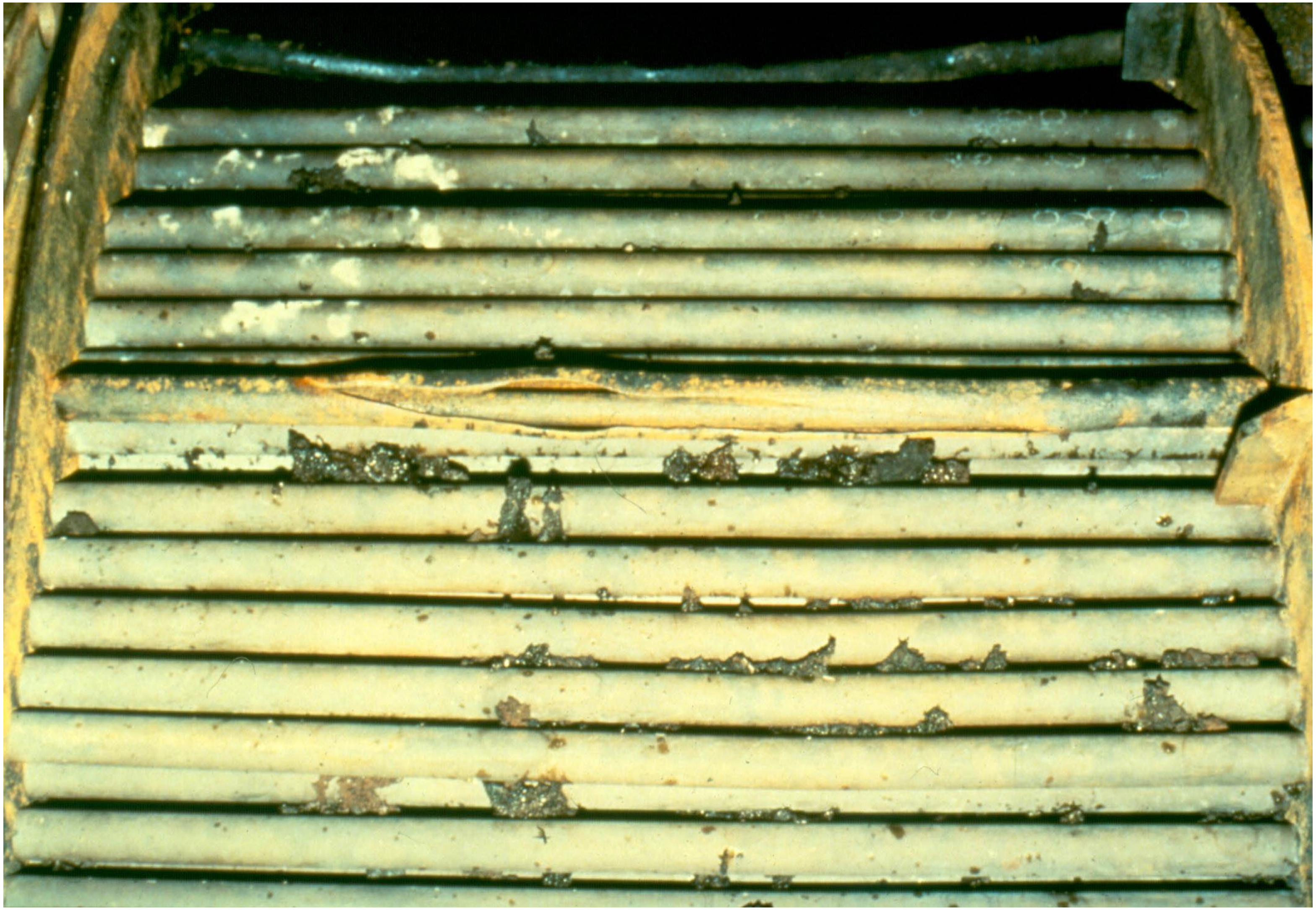
Shell and tubes can handle fouling but it can be reduced by

- keeping velocities sufficiently high to avoid deposits
- avoiding stagnant regions where dirt will collect
- avoiding hot spots where coking or scaling might occur
- avoiding cold spots where liquids might freeze or where corrosive products may condense for gases

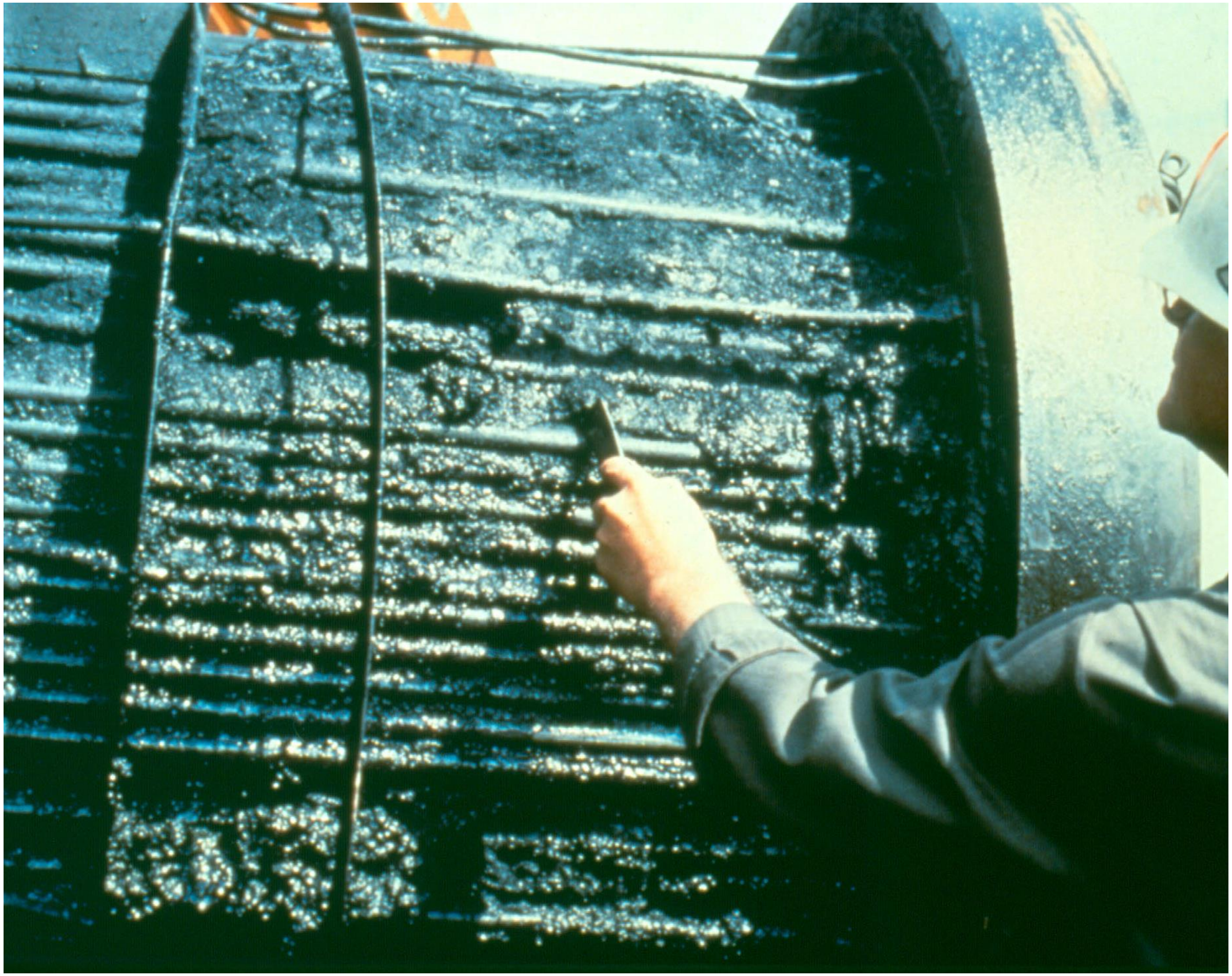
Tube Bending Shell and Tube Heat Exchanger



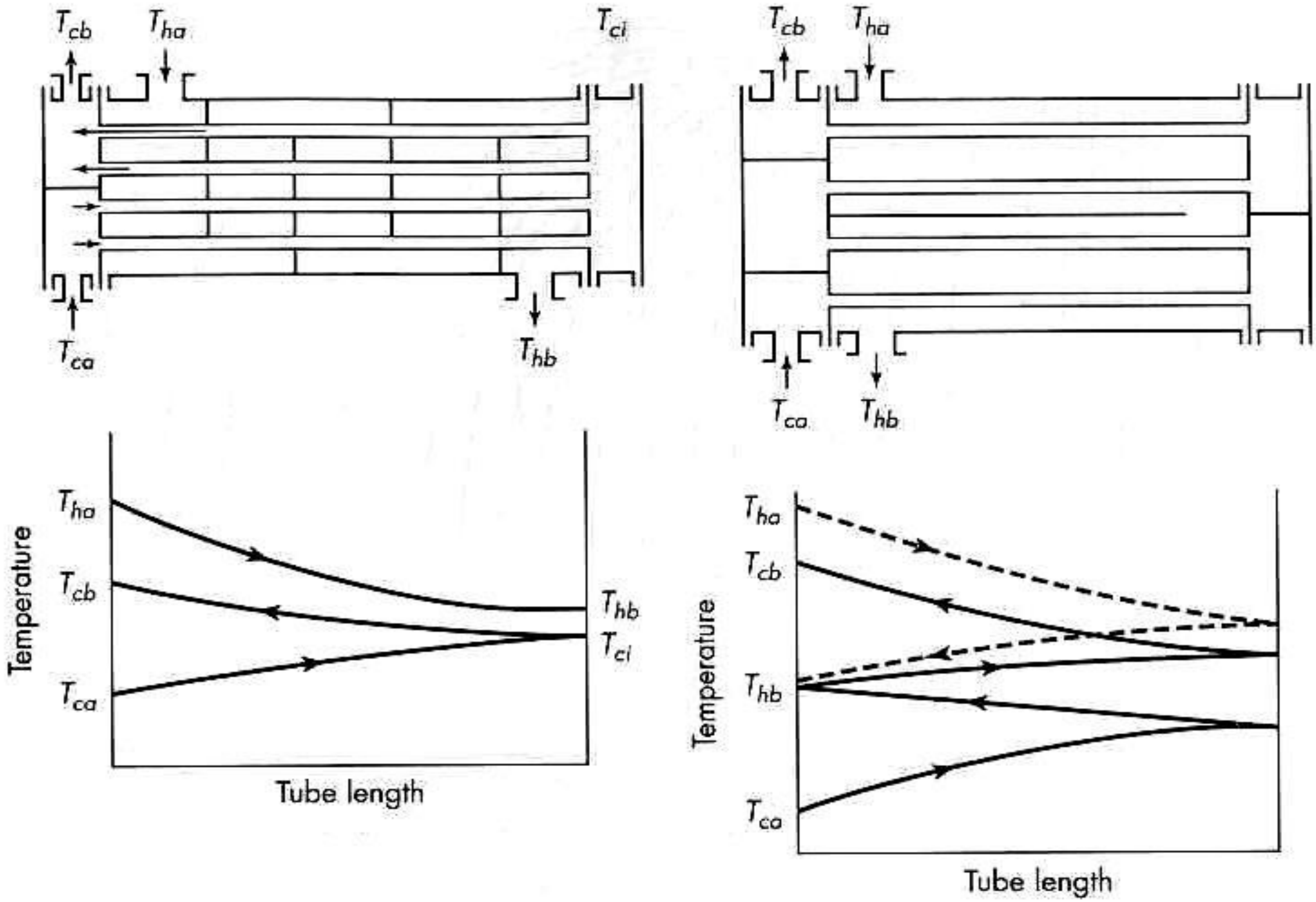
Tube Failure Shell and Tube Heat Exchanger



Fouling in Shell and Tube Heat Exchanger



Heat Exchangers - Temperatures



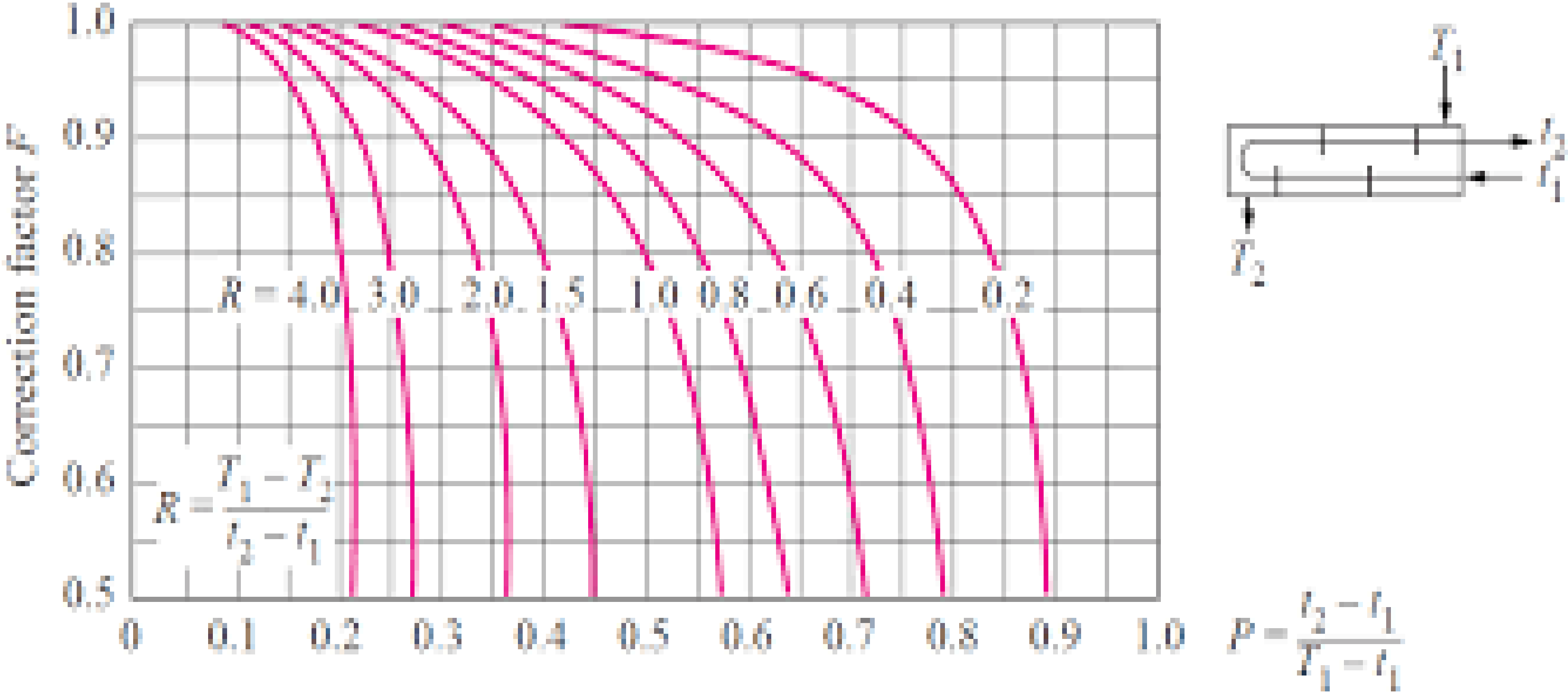
Multipass and Cross-Flow Heat Exchangers: Use of a Correction Factor

- The log mean temperature difference relation developed earlier is limited to parallel-flow and counter-flow heat exchangers only.
- To simplify the analysis of *cross-flow* and *multipass shell-and-tube* heat exchangers, it is convenient to express the log mean temperature difference relation as

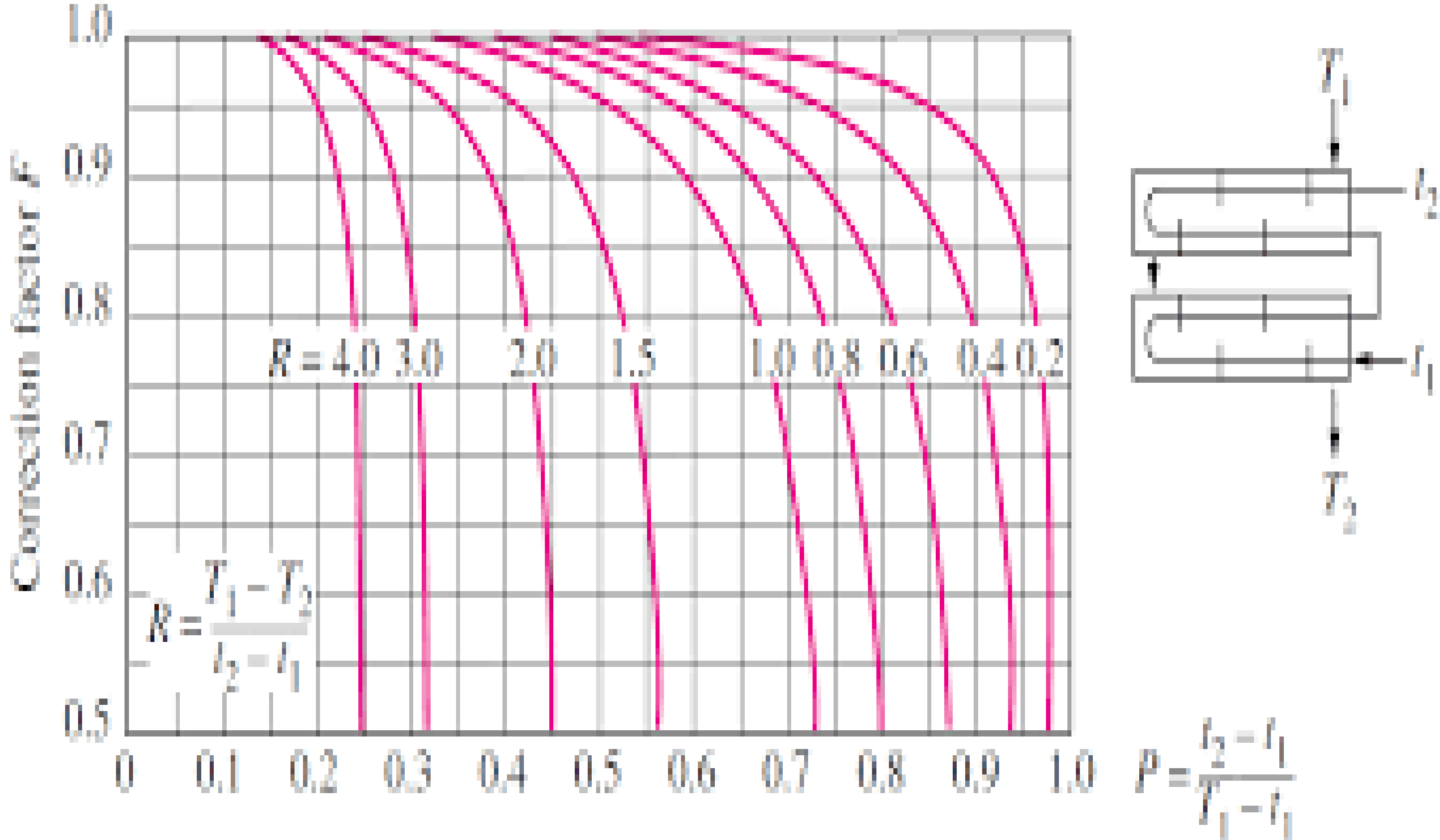
$$\Delta T_{lm} = F \Delta T_{lm,CF}$$

- ***F*** is the **correction factor**, and $\Delta T_{lm,\ CF}$ is the log mean temperature for counter-flow case.

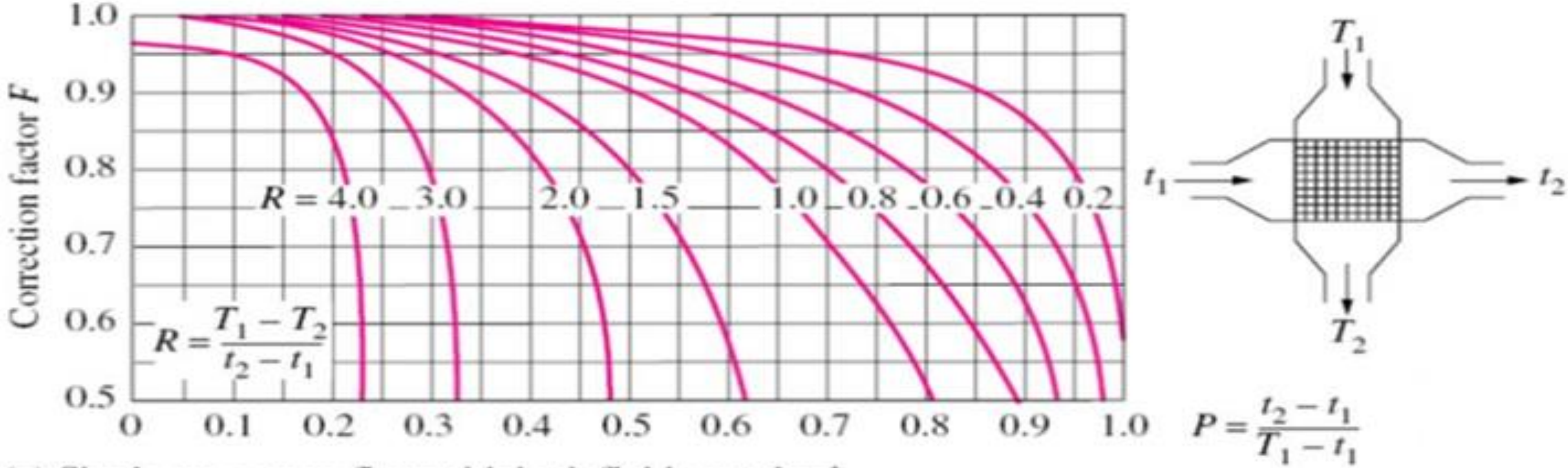
LMTD correction charts



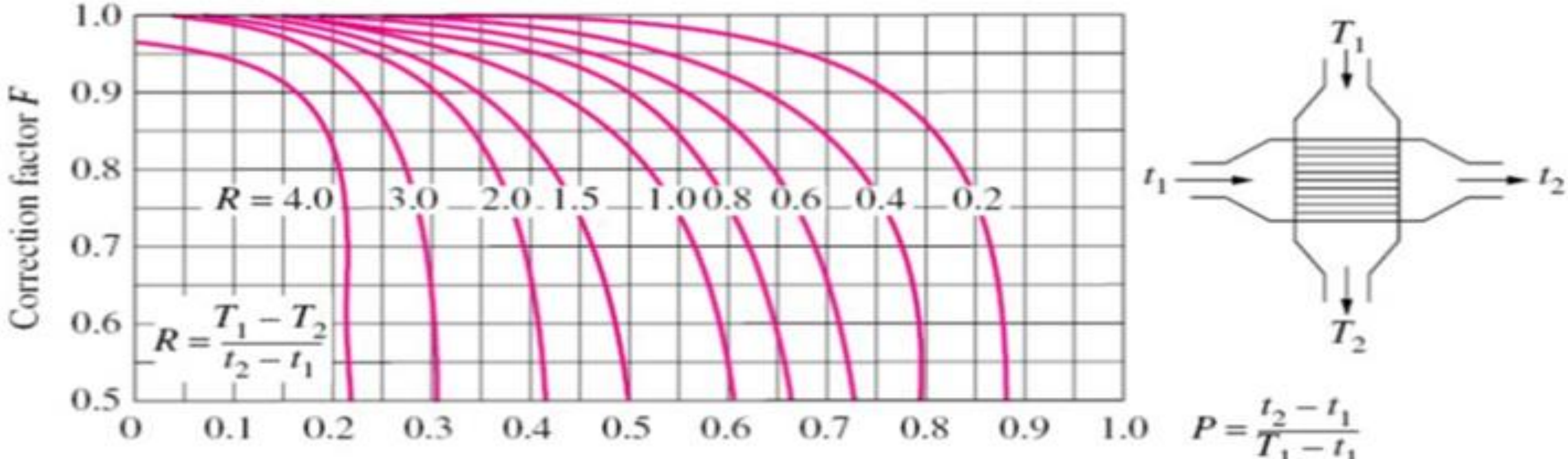
(a) One-shell pass and 2, 4, 6, etc. (any multiple of 2), tube passes



(*b*) Two-shell passes and 4, 8, 12, etc. (any multiple of 4), tube passes

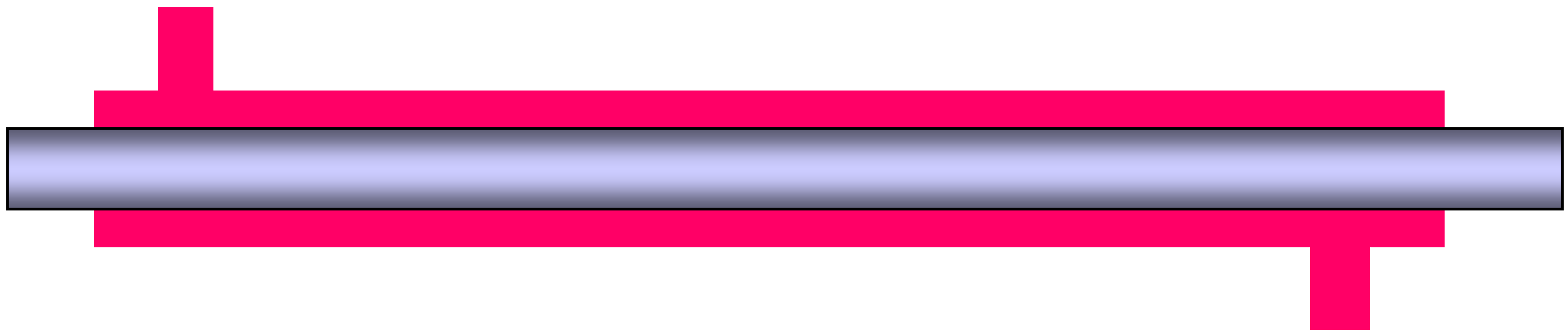


(*c*) Single-pass cross-flow with both fluids *unmixed*



(*d*) Single-pass cross-flow with one fluid *mixed* and the other *unmixed*

Double pipe heat exchanger



- Normal size

  Double-pipe heat exchangers are competitive at duties requiring 100-200 ft^2

- Built of carbon steel where possible

Advantages/disadvantages of double-pipe HE

- **Advantages**
  - Easy to obtain counter-current flow
  - Can handle high pressure
  - Modular construction
  - Easy to maintain and repair
  - Many suppliers

- **Disadvantage**
  - Become expensive for large duties (above 1MW)

Scope of double pipe HE

- **Maximum pressure**
  - 300 bar(abs) (4500 psia) on shell side
  - 1400 bar(abs) (21000 psia) on tubeside
- **Temperature range**
  - -100 to 600^{o}C (-150 to 1100^{o}F)
  - possibly wider with special materials
- **Fluid limitations**
  - Few since can be built of many metals
- **Maximum** $\varepsilon = 0.9$
- **Minimum** $\Delta T = 5$ K

Previous GATE Questions

SOLVED PROBLEMS

Q1:

Which one of the following statements about baffles in a shell and tube heat exchanger is false? Baffles

A. act as a support to the tube bundle
B. reduce the pressure drop on the shell-side
C. alter the shell-side flow pattern
D. help in increasing the shell-side heat transfer coefficient

Answer: B

Q2:

The following list of options P, Q, R and S are some of the important considerations in the design of a shell and tube heat exchanger.

P. Square pitch permits the use of more tubes in a given shell diameter.

Q. The tube side clearance should not be less than one-fourth of the tube diameter.

R. Baffle spacing is not greater than the diameter of the shell or less than onefifth of the shell diameter.

S. The pressure drop on the tube side is less than 10 psi.

Pick out the correct combination of true statements from the following

A. P, Q and R

B. Q, R and S

C. R, S and P

D. P, Q, R and S

Answer: B

Q3:

Baffles are used in heat exchangers in order to

A. increase the tube side fluid’s heat transfer coefficient
B. promote vibration in the heat exchanger
C. promote cross flow and turbulence in the shell side fluid
D. prevent shell expansion due to thermal effects

Answer: C

Q4:

A process stream of dilute aqueous solution flowing at the rate of 10 kg/s is to be heated. Steam condensate at 95°C is available for heating purpose, also at a rate of 10 kg/s. A 1-1 shell and tube heat exchanger is available. The best arrangement is

(A) counter flow with process stream on shell side

(B) counter flow with process stream on tube side

(C) parallel flow with process stream on shell side

(D) parallel flow with process stream on tube side

Answer: B

Q5:

Segmental baffles in a 2-4 shell and tube heat exchanger

A. change the flow pattern of the tube side fluid and increase the overall heat transfer coefficient
B. increase the heat transfer coefficient in the shell side and support the tubes
C. help to reduce the thermal expansion of the tubes and increase the heat transfer coefficient in the tube side
D. increase the number of passes in the shell side and increase the heat transfer coefficient in the tube side

Answer: B

Q6:

Standard pipes of different schedule numbers and standard tubes of different BWG numbers are available in the market. For a pipe / tube of a given nominal diameter, which one of the following statements is TRUE?

A. Wall thickness increases with increase in both the schedule number and the BWG number
B. Wall thickness increases with increase in the schedule number and decreases with increase in the BWG number
C. Wall thickness decreases with increase in both the schedule number and the BWG number
D. Neither the schedule number, nor the BWG number has any relation to wall thickness

Answer: B

Q7:

Indirect contact heat exchangers are preferred over direct heat exchangers because:

A. Heat transfer coefficient is high
B. There is no risk of contamination
C. There is no mist formation
D. Cost of equipment is lower

Answer: B

Q8:

For shell and tube exchanger, with increasing heat transfer area, the purchased cost per unit heat transfer area

A. Increases
B. Decreases
C. Remains constant
D. Passes through a maxima

Answer: B

Q9:

The advantage of using 1-2 shell and tube heat exchanger over a 1-1 shell and tube heat exchanger is

A. Lower tube side pressure drop
B. Lower shell side pressure drop
C. Higher tube side heat transfer coefficient
D. Higher shell side heat transfer coefficient

Answer: C

Q10:

In a heat exchanger, floating head is provided to

A. Facilitate cleaning of exchanger
B. Increase the heat transfer area
C. Relieve stresses caused by thermal expansion
D. Increase the LMTD

Answer: C