

Shell And Tubes Heat Exchanger

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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

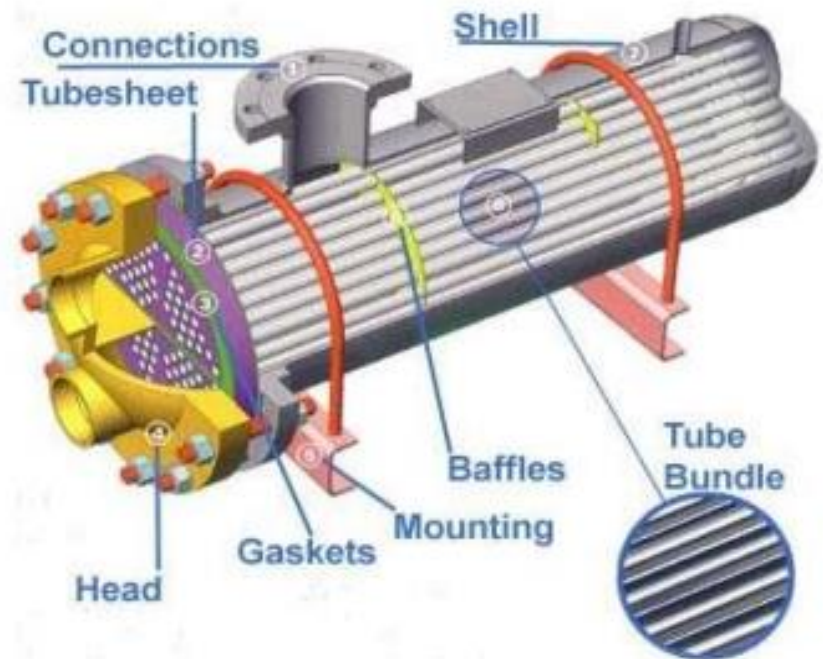
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graph TD; A[TUBULAR HEAT EXCHANGERS] --- B[SHELL AND TUBE]; A --- C[DOUBLE-PIPE]
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**SHELL AND
TUBE**

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 .



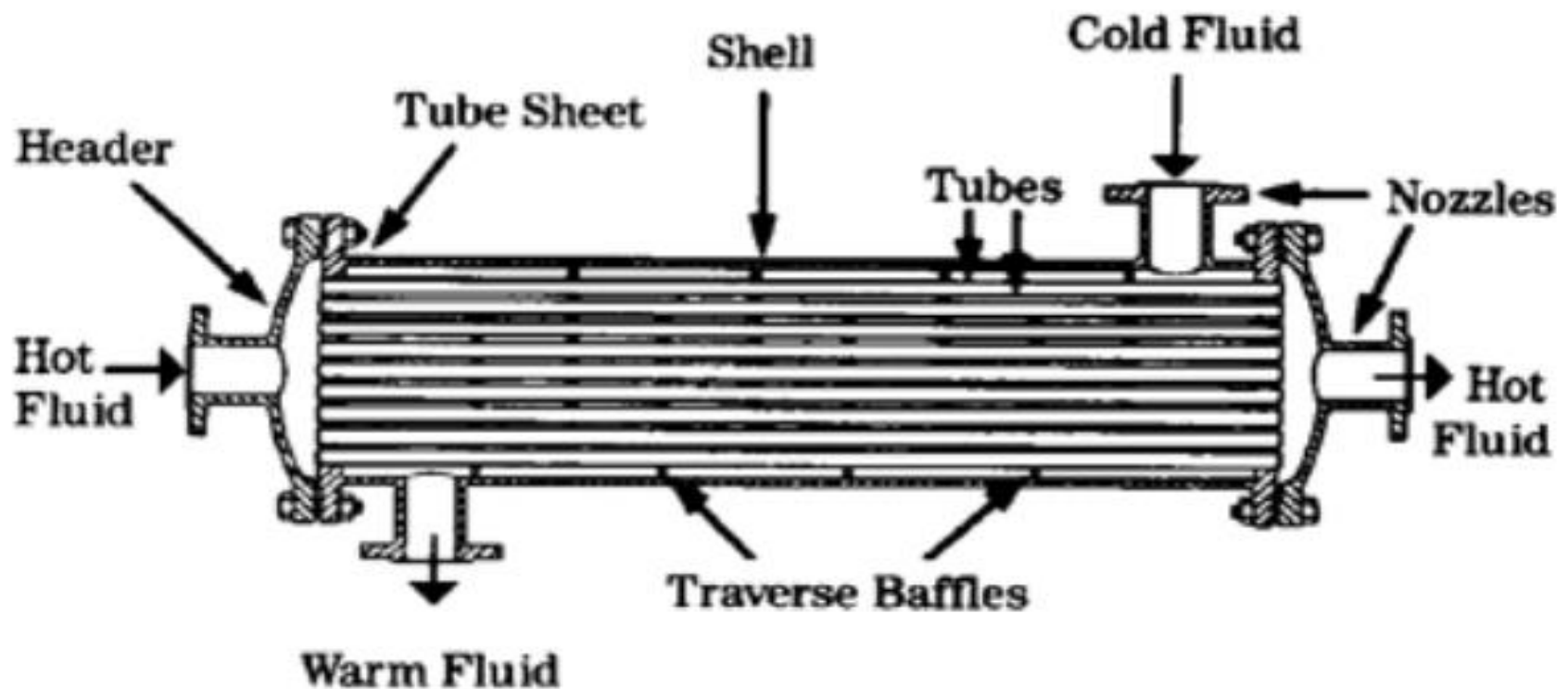
Why shell-and-tube?

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

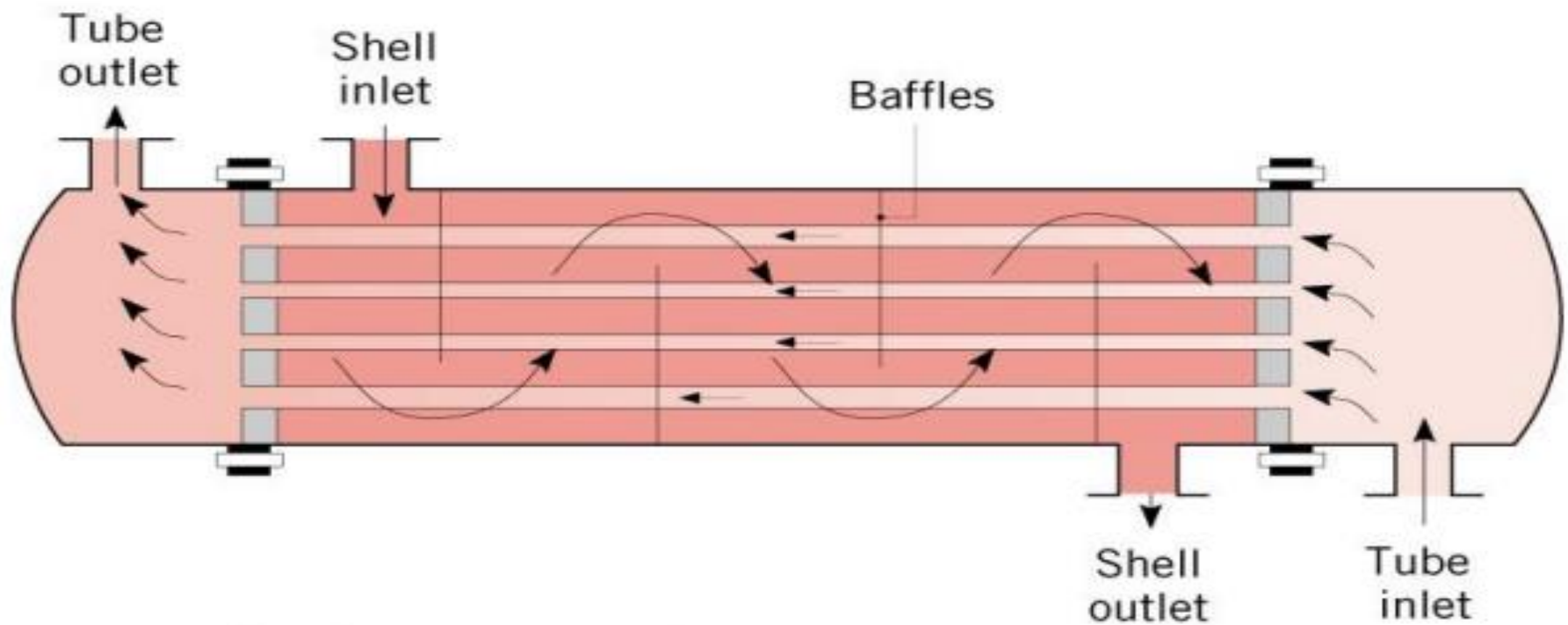
Why?

- 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

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 accomplish mixing or turbulence.

SHELL AND TUBE HEAT EXCHANGERS

U - TUBE HEAT EXCHANGERS

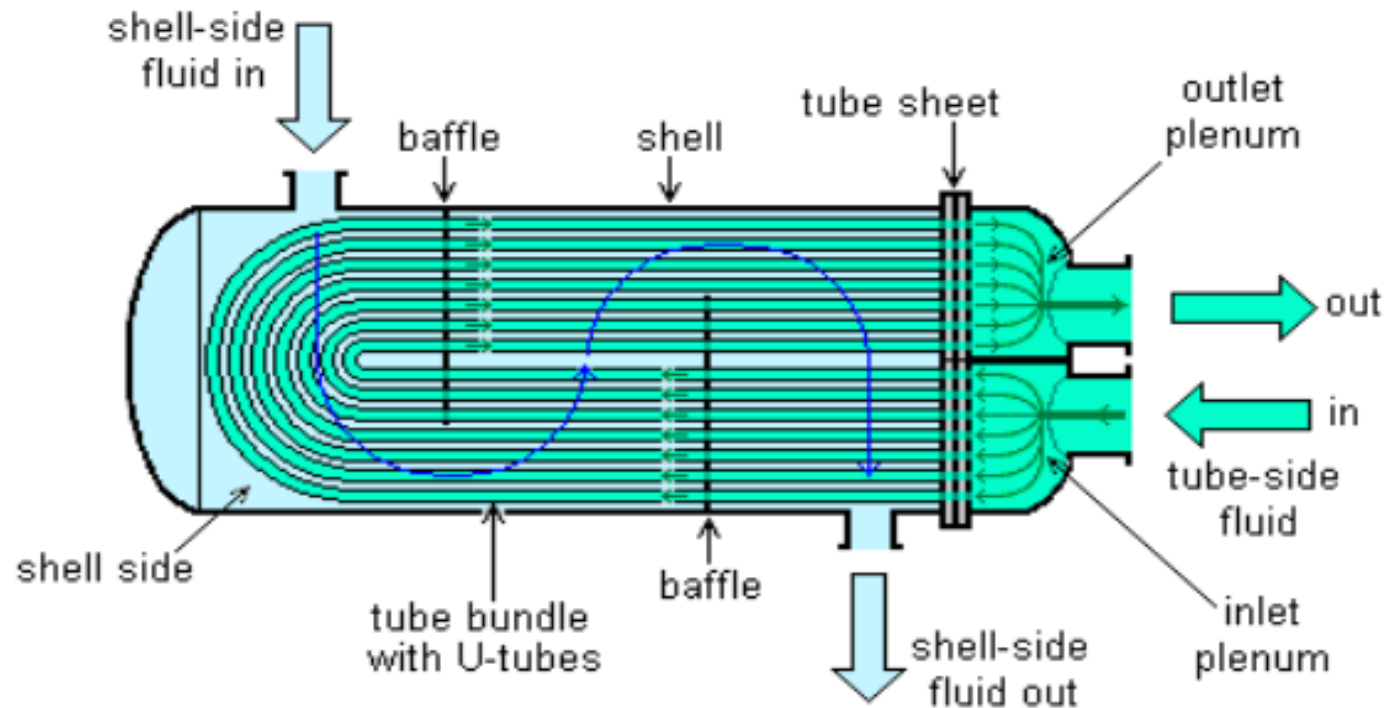
FIXED TUBE HEAT EXCHANGERS

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



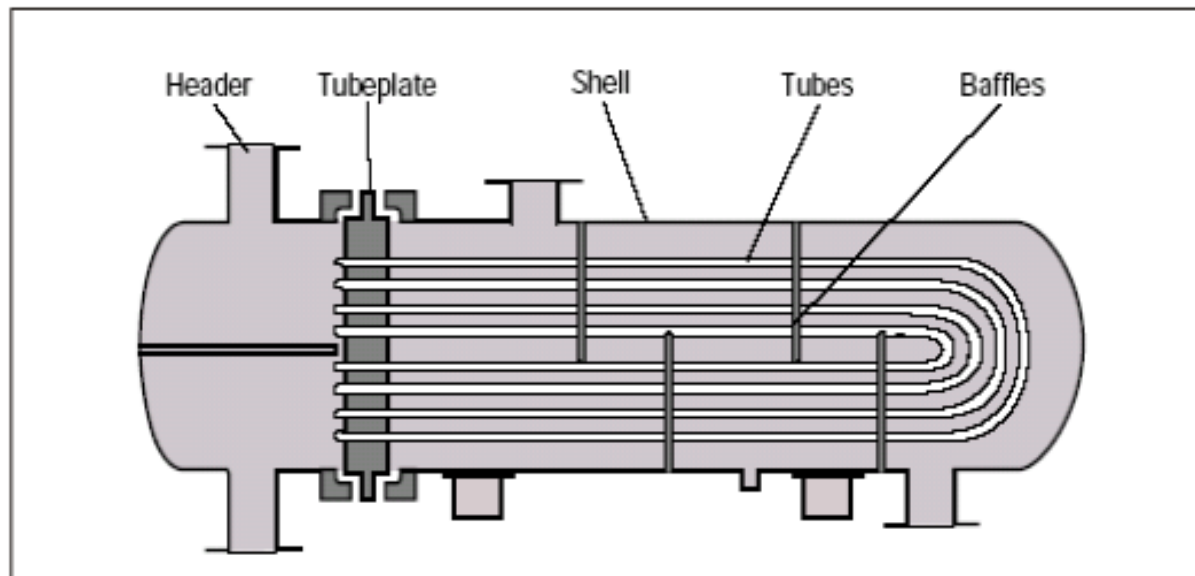
U - TUBE HEAT EXCHANGERS

- 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

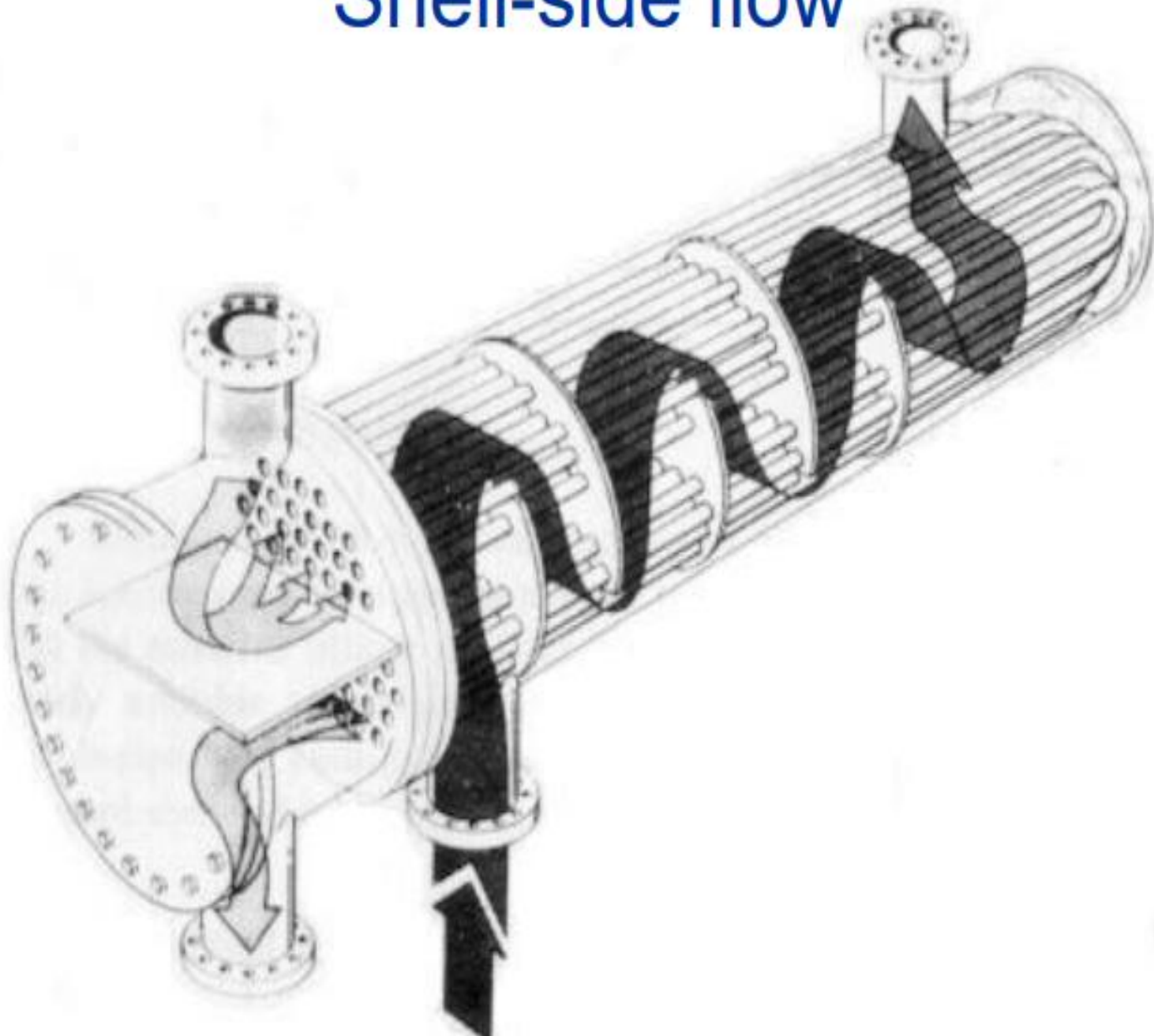
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- Examples : reboilers, evaporators and Kettle type.
- They have enlarged shell sections for vapor-liquid separation.



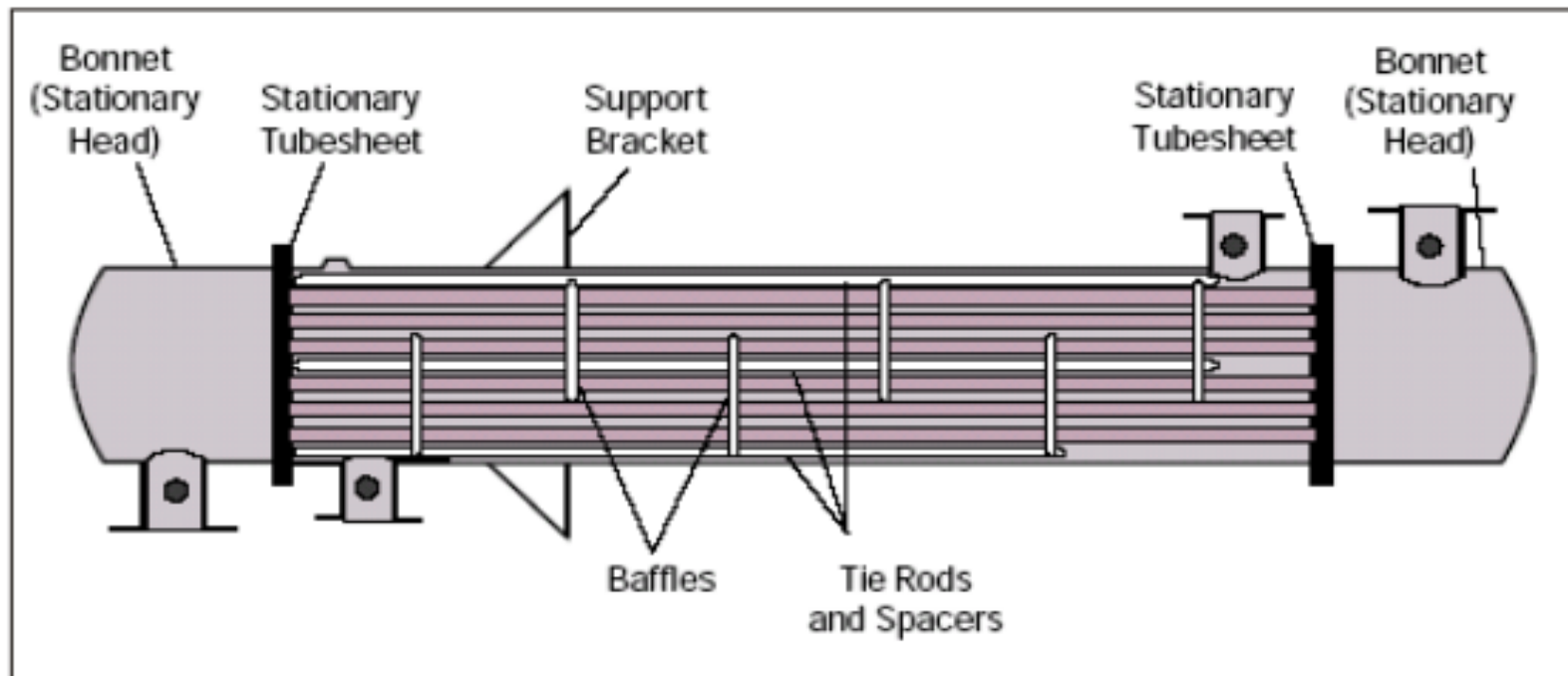
Shell-side flow

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FIXED TUBE HEAT EXCHANGERS

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

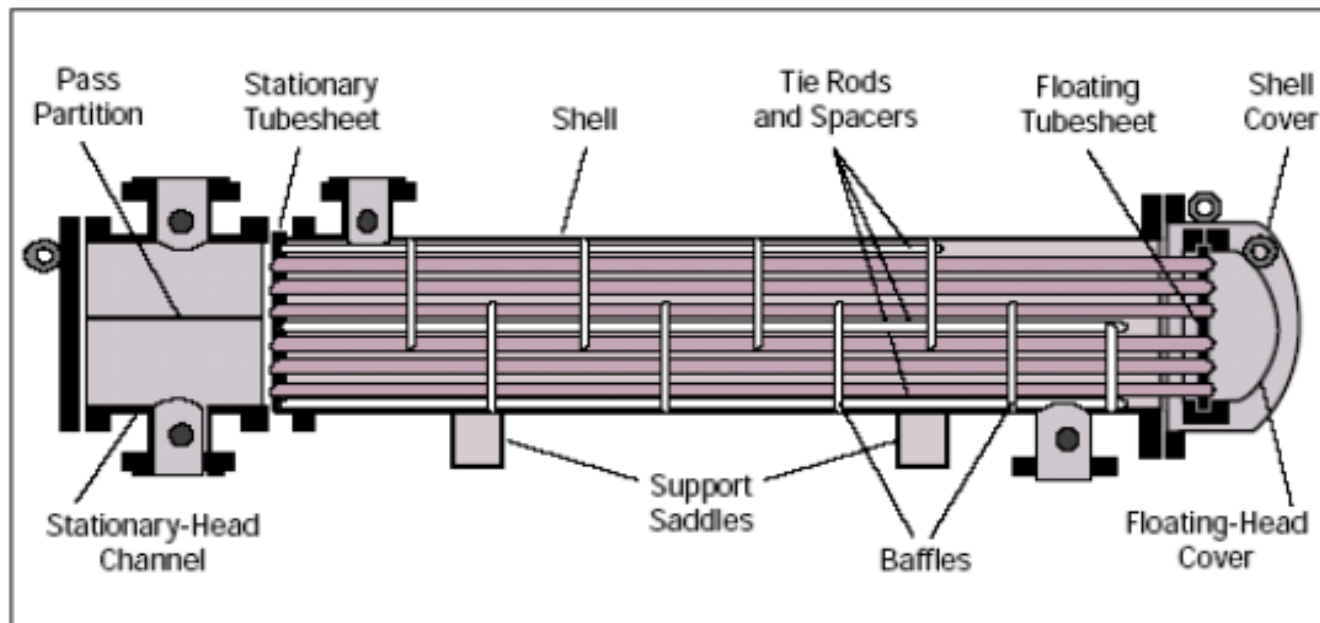


FIXED TUBE HEAT EXCHANGERS

- 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.



SHELL AND TUBE HEAT EXCHANGERS

SINGLE-PASS 1-1 EXCHANGER

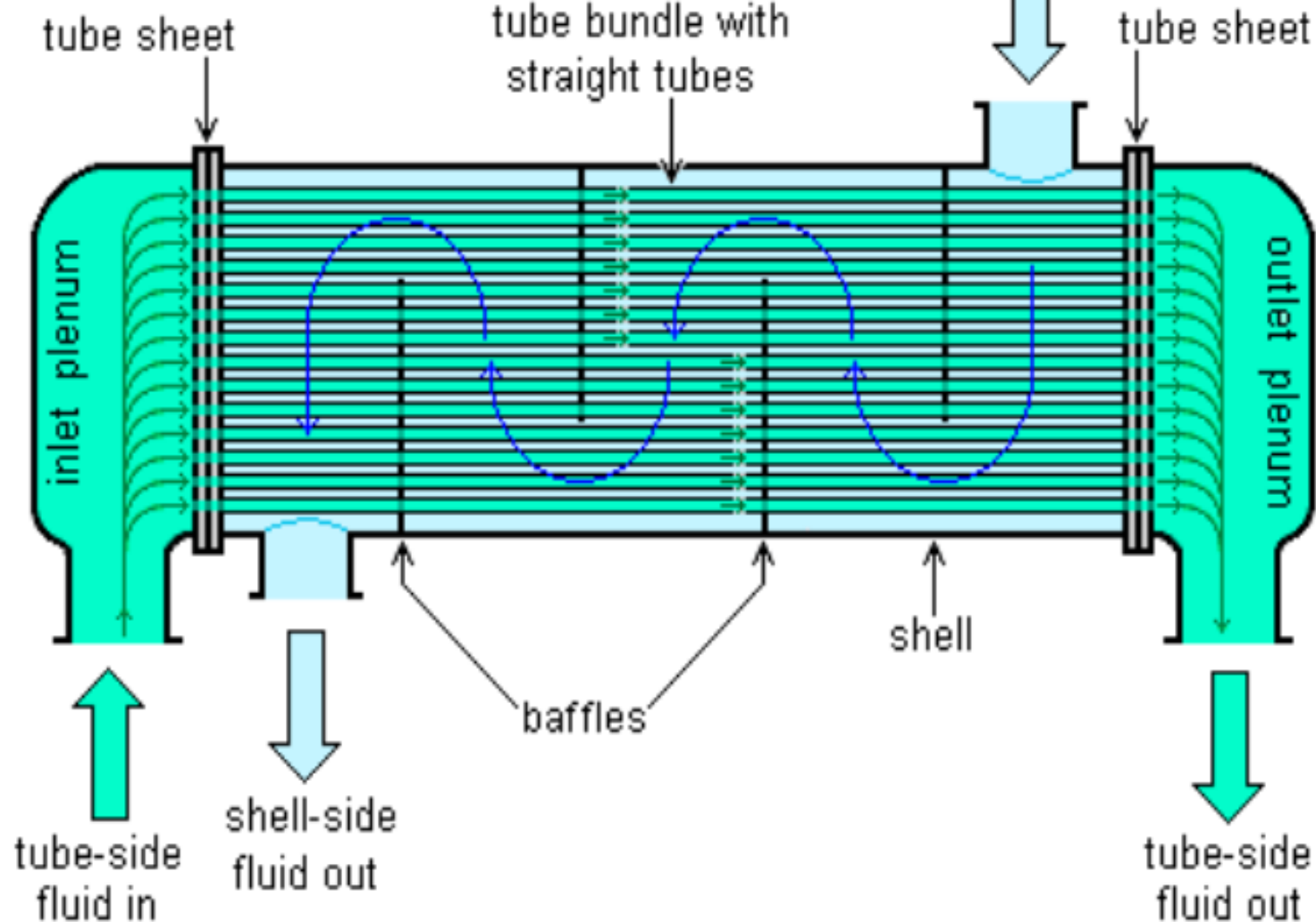
1-2 PARALLEL-COUNTER FLOW EX.

2-4 EXCHANGER.

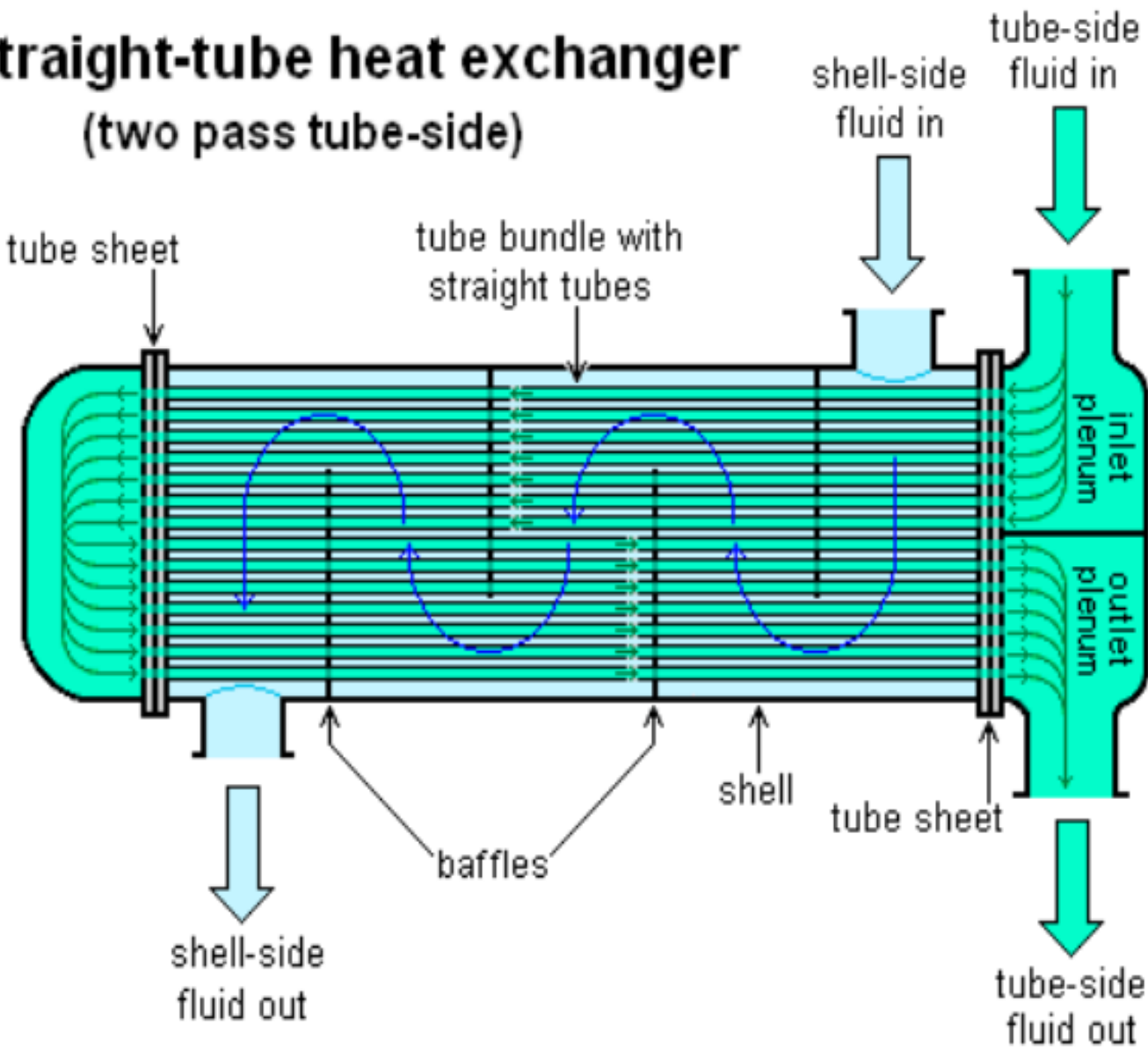
Straight-tube heat exchanger (one pass tube-side)

shell-side
fluid in

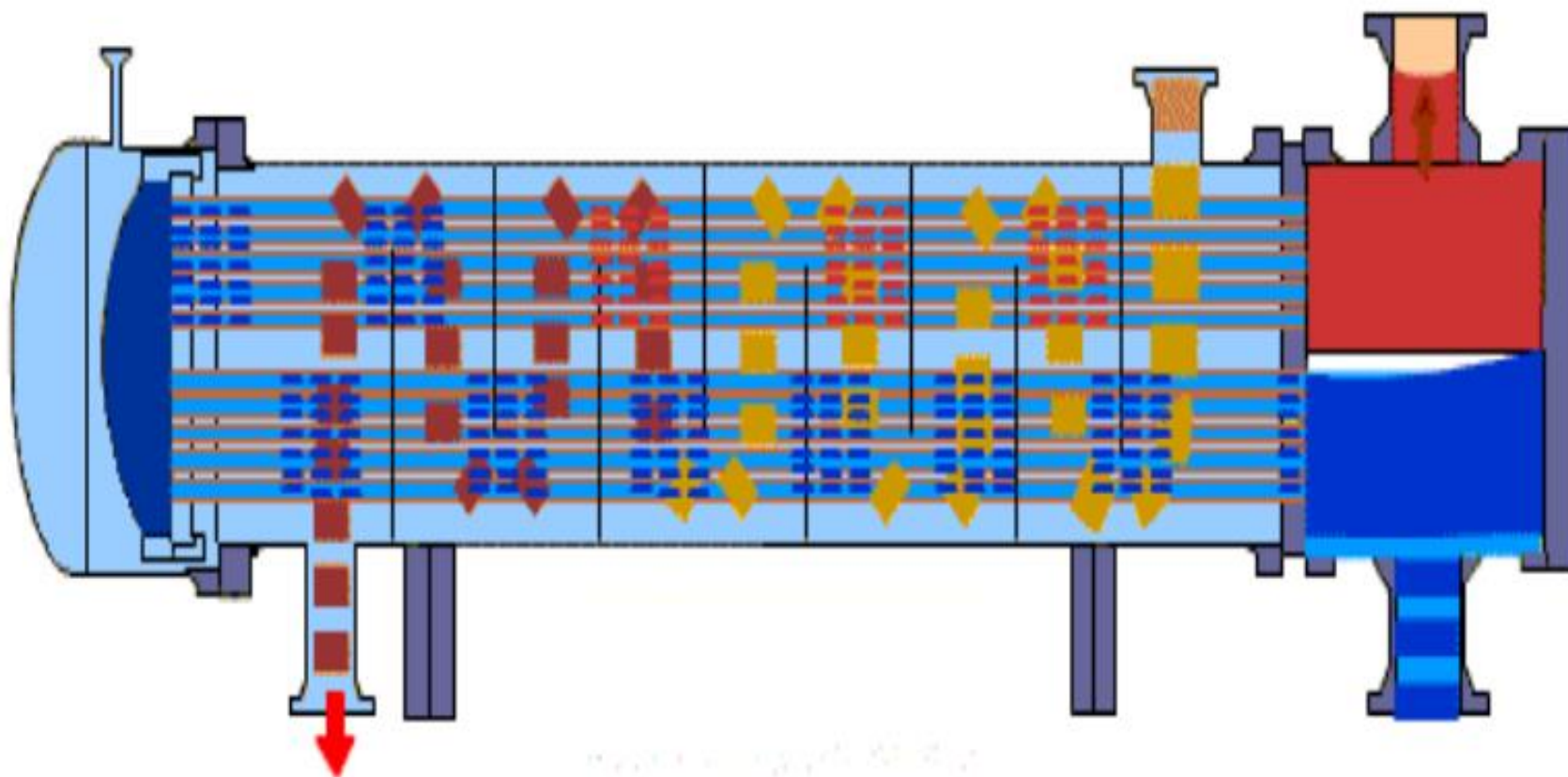
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Straight-tube heat exchanger (two pass tube-side)

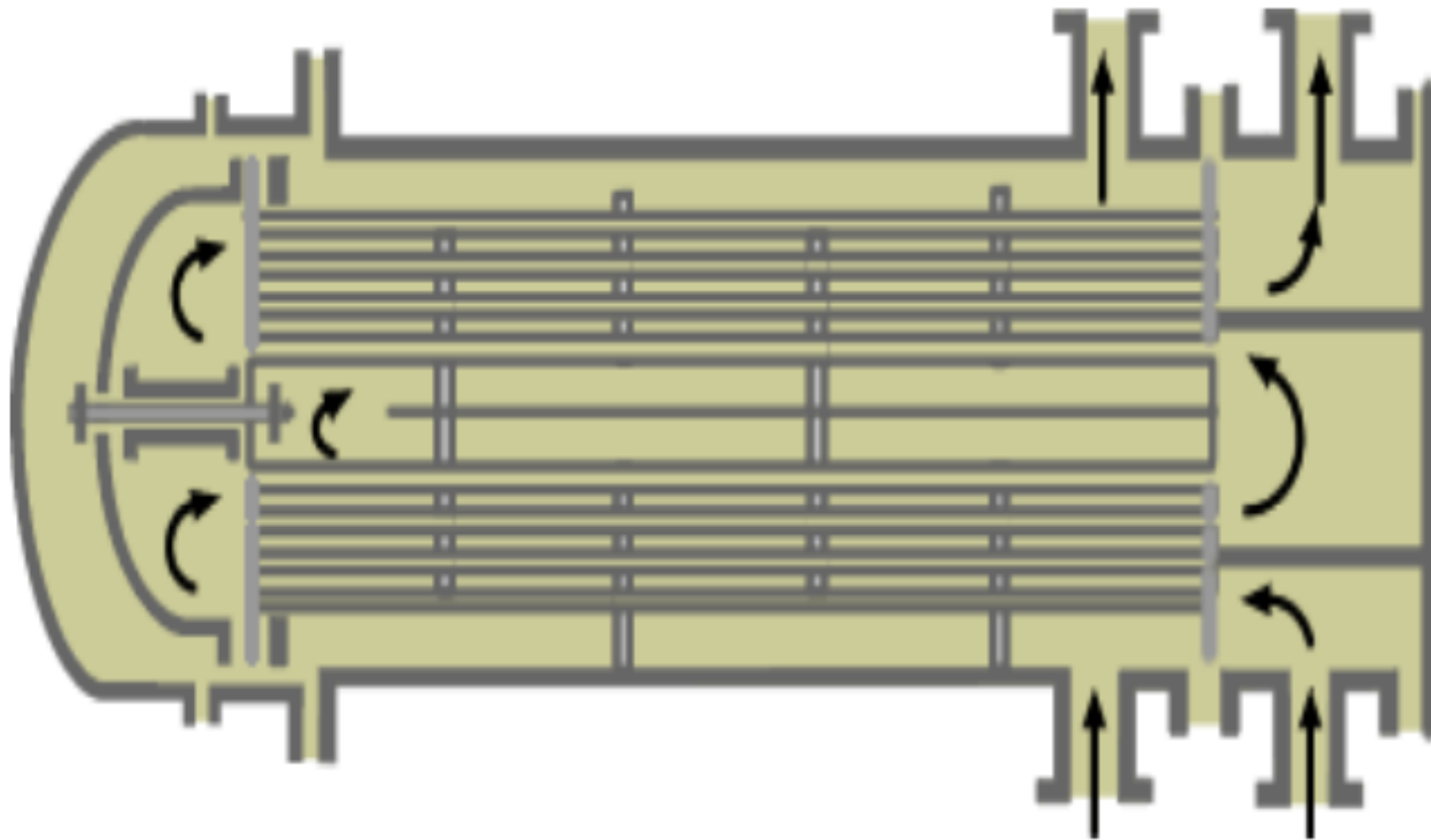


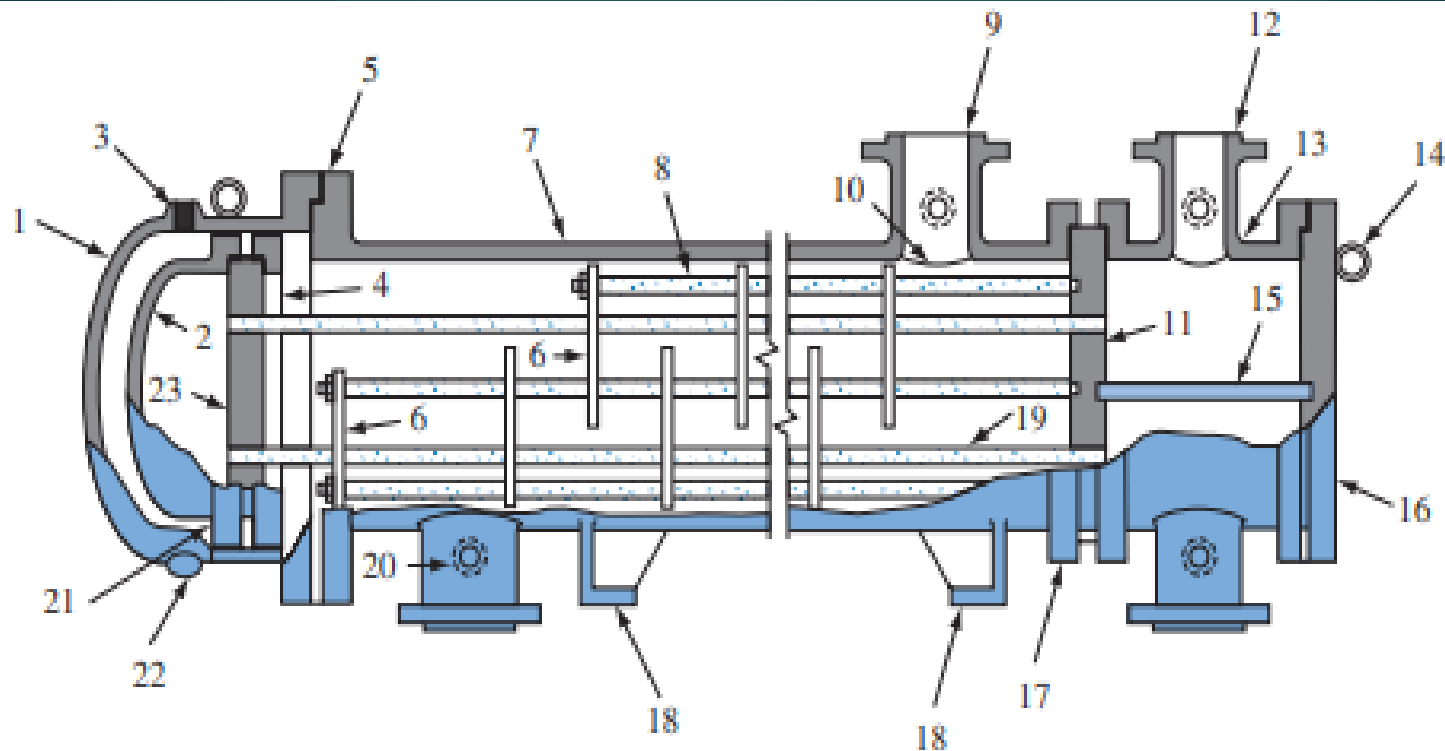
1-2 shell and tube Heat Ex.



2-4 shell and tube Heat Ex.

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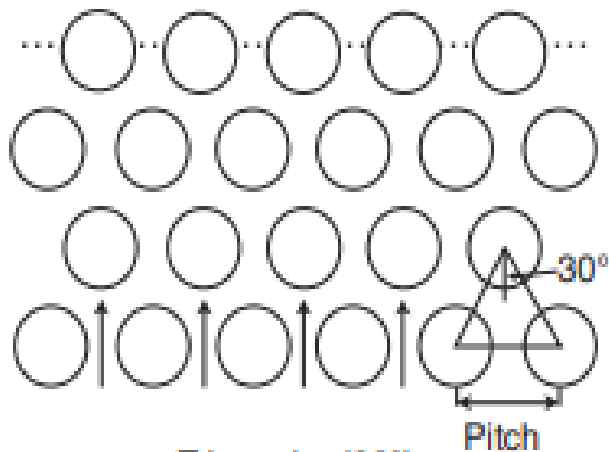




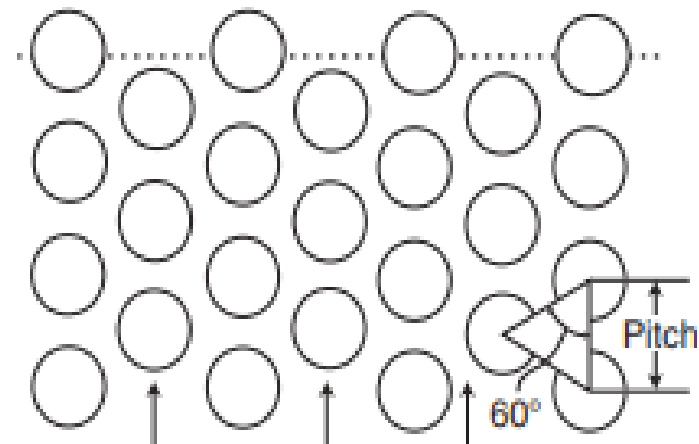
Key:

- | | |
|---|------------------------------|
| 1. Shell cover | 13. Channel |
| 2. Floating head | 14. Lifting ring |
| 3. Vent connection | 15. Pass partition |
| 4. Floating-head backing device | 16. Channel-cover |
| 5. Shell cover-end flange | 17. Shell channel-end flange |
| 6. Transverse baffles or support plates | 18. Support saddles |
| 7. Shell | 19. Heat transfer tube |
| 8. Tie rods and spacers | 20. Test connection |
| 9. Shell nozzle | 21. Floating-head flange |
| 10. Impingement baffle | 22. Drain connection |
| 11. Stationary tube sheet | 23. Floating tube sheet |
| 12. Channel nozzle | |

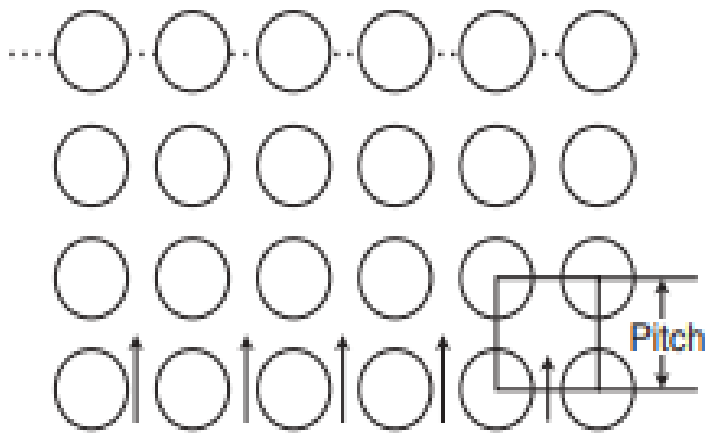
▶ Tubes layout



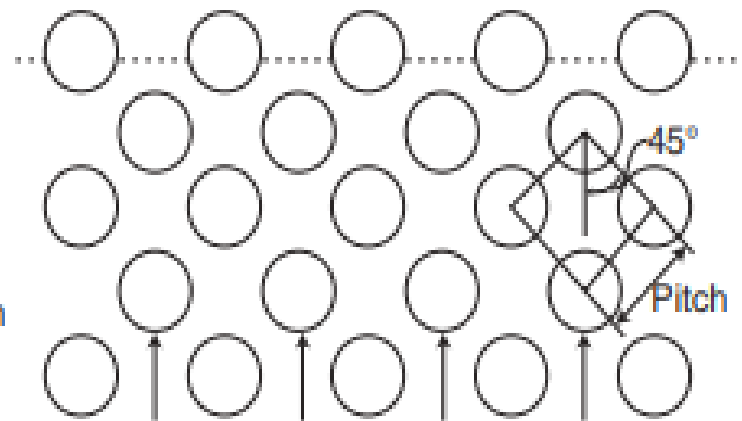
Triangular (30°)



Rotated triangular (60°)



Square (90°)



Rotated square (45°)

Types of tube pitches used in shell and tube heat exchangers.⁽¹⁾