

Heat Exchanger

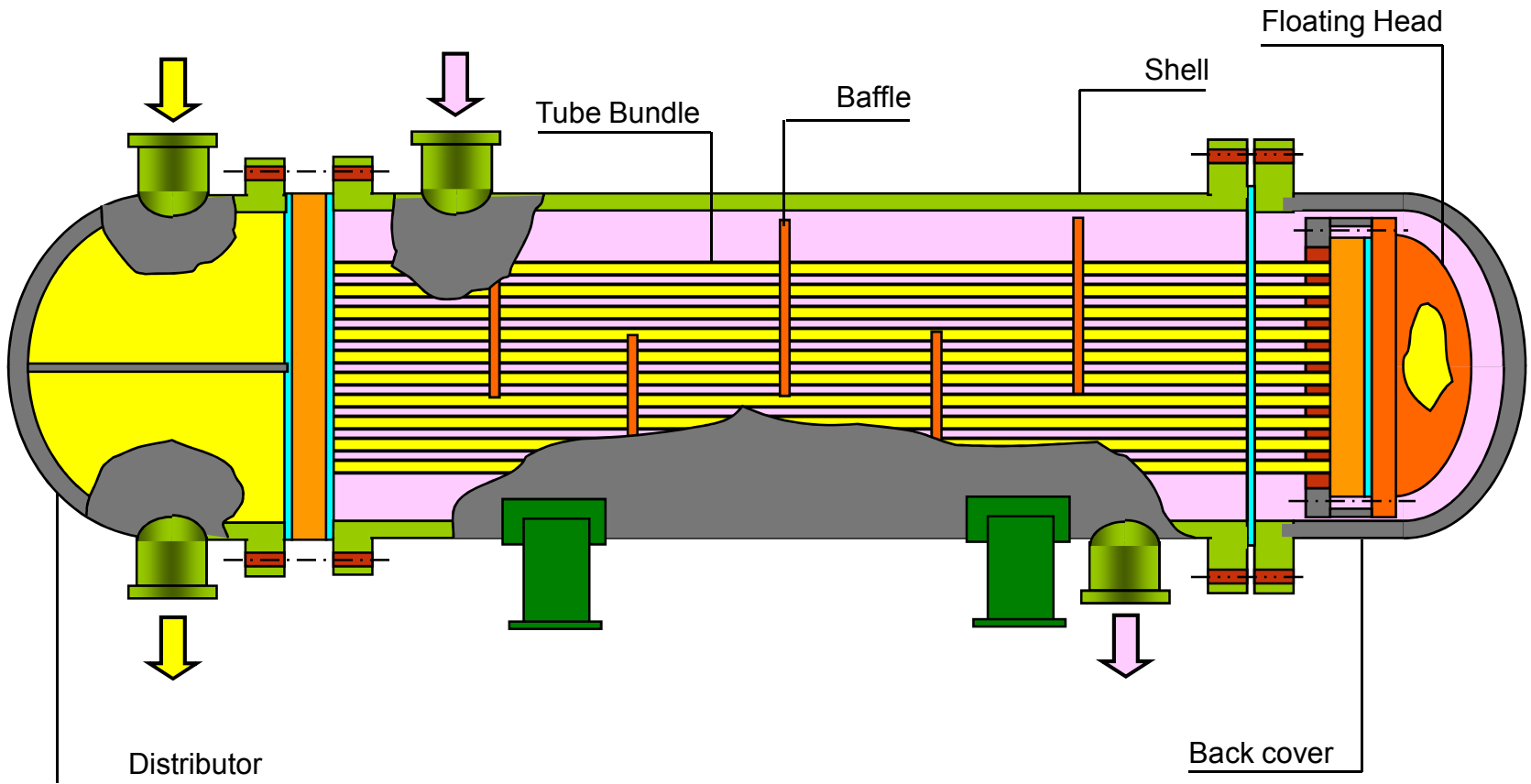
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NA Operation



Heat Exchanger



Course outline

- Basic Definitions.
 - Heat Transfer.
 - Heat Exchanger.
 - Types of Heat exchanger.
 - Feature of Heat Exchanger
 - Inspection & Cleaning of Heat Exchanger
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Heat & Temperature

- Form of energy which makes the things hot or cold. Or kinetic energy of molecules is named as heat.
 - The degree of coldness or hotness is called temperature. The measurement of the intensity of heat or average kinetic energy of molecule is called temperature
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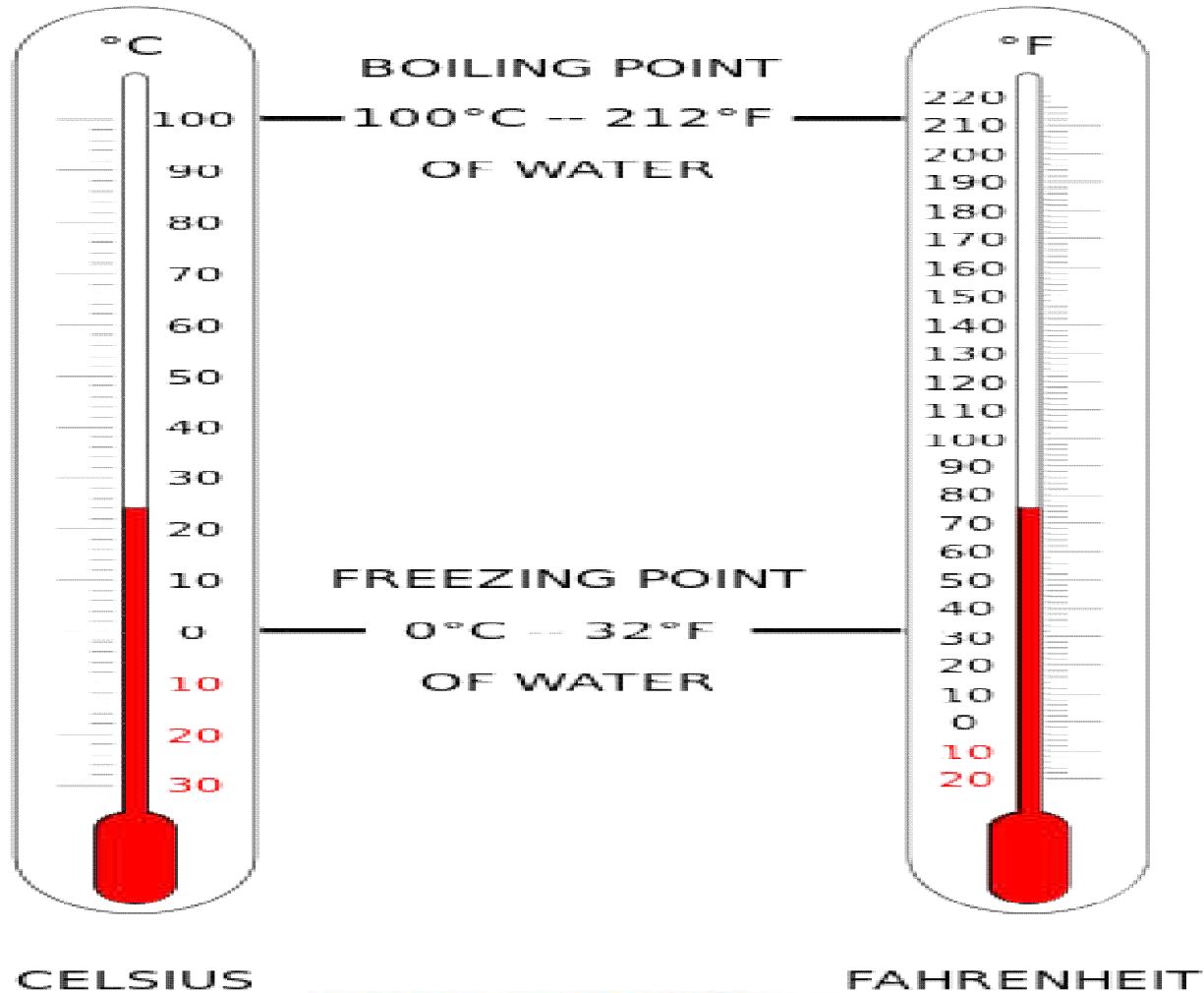
Measure of Heat

- **Joule.** Amount of energy expended when a force of one Newton moved an object one meter in the direction in which force is applied.
 - The **Calorie.** heat required to raise the temperature of one gram of water through one degree centigrade.
1 cal = 4.0184 Joule.
 - **BTU.** Amount of heat required to raise the temperature of one pound of water through one degree Fahrenheit.
1 BTU= 252 cal.
 - **CHU.** Amount of heat required to raise the temperature of one pound of water through one degree centigrade.
1 CHU = 453.6 cal.
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Measurement of Temperature

1. Centigrade or Celsius scale.
 2. Fahrenheit scale.
 3. Kelvin scale.
 4. Rankin scale.
- The above scales are based on the two fixed points.
 - A. Freezing point of the water.
 - B. Boiling point of water.
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Measurement Of Temperature



Measurement of Temperature

- **Centigrade or Celsius scale.** On this scale the FP of water is marked as zero & BP of water is marked as 100. The space between the two points is divided into 100 equal parts.

$$C = (F - 32) / 1.8$$

$$C = K - 273.16$$

- **Fahrenheit scale.** On this scale FP of water is marked as 32F, & BP of water is marked as 212. The space between the two points is dividing into 180 equal parts.

$$F = 1.8C + 32$$

$$F = R - 460.$$

Absolute Scale

This, for all sorts of calculations is taken as -273C or - 460F. The temperature measure from zero is called absolute temperature. In other words we can say the scale at which no negative sign is used is called absolute temperature.

- **Absolute scale of centigrade is**

$$\mathbf{K = C + 273.16}$$

- **Absolute scale of Fahrenheit scale is**

$$\mathbf{R = F + 460}$$


Mode Of Heat Transfer

1. Convection
2. Radiation
3. Conduction



Mode Of Heat Transfer

- **Conduction.** Heat transfer due to physical contact of the two bodies. Heat is transferred by the vibration (collision) of molecules.
 - In most of heat exchangers, there are metal walls (tube) separating one fluid from another at different temperatures. Heat from hotter fluid passes through the separating wall to the cooler fluid. The heat transfer is depending upon following.
 1. The temperature difference of the two fluids.
 2. The area of heat path.
 3. The nature of substances involved in heat transfer
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Convection

- In this process the heat is transferred from one place to another place by the actual movement of the molecules. This process is accruing in fluids.
- This method of heat transfer is the one of commonly to heat one's house. Air is heated by the radiator or some form of heat source. As the air becomes hotter, it becomes lighter it moves up wards& replaced by the heavier colder air. This process is called natural convection & same phenomena applied to fluid heat transfer

Radiation

- Every body emitted heat in all direction. If this energy strikes a receiver, part of energy may be absorbed rest is reflected. Heat transfer from hot to cold body in this manner is known as radiation. In this mode the heat is transferred with out any physical media.
- We are all familiar with the radiant heat given off by the sun. The heat is transferred through the space in the forms of electromagnetic waves. Radiant heat play a relatively minor part heat exchangers & heat transfer, but major part in furnace & boiler heat teamster.

Forms Of Heat

Sensible Heat:

Adding or removing of heat cause change in the temperature of the object is called sensible heat. For example, the heat is added to the water raised the temperature from 32F to its boiling point 212F at atmospheric pressure.



Forms Of Heat

Latent Heat:

Adding or removing of heat cause to change the physical state of the object but temperature remained same. For example, heat is added to water at 212F in the result there is no change in temperature, only change physical state of water, which is steam from water.



Forms Of Heat

Specific Heat:

- Amount of heat required to raise the temperature of unit mass of an object through one degree. it is denoted by C_p . Mathematically it is written as following.
 - $C_p = \text{Cal} / \text{gm } ^\circ\text{C}$
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Factor Effecting on Heat Transfer

- **Temperature difference.**

The greater the temperature difference between the two fluids greater will be the heat transfer.

- **Thermal conductivity.**

Every material has a definite thermal conductivity, which affects the amount of heat transferred. For example, Copper is good conductor while wood is very poor conductor.

- **Area.**

The cross sectional area also effects heat transfer. Longer the area, greater heat can be transferred.

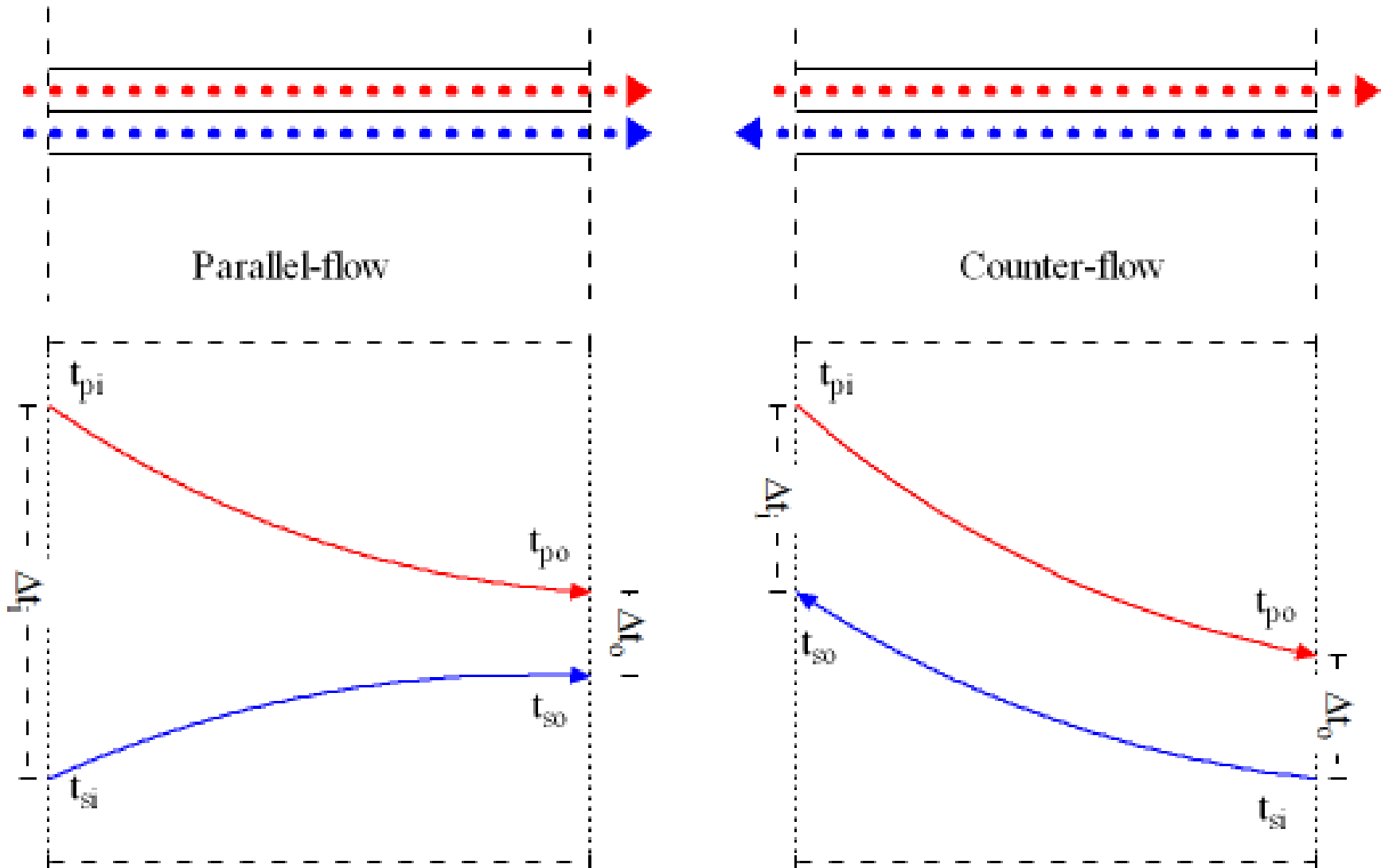


Factor Effecting on Heat Transfer

- Flow pattern of fluids have most important in in heat transfer.
- In counter flow the Temperature difference between the both fluids remain same in heat exchanger.
- In Parallel flow temperature difference between fluids is high as they inter in exchanger and continuous decrease as they travel towards the other end of the exchanger.
- Which shown in the graph a



Pattern in Parallel & Counter Flow



Heat Exchanger

- A heat exchanger means equipment exchanging heat energy between two fluids of high & low temperature. However, equipment which is directly heated or cooled by fire, water or oil cannot be categorized in heat exchangers. Fundamentally, the heat exchanger is equipment which indirectly exchange heat energy between the fluids of high & low temperature through walls made by metal, etc- the heat exchanger has a specific function cross pounding to the requirements of the user.
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Function Of Heat Exchanger

- A vaporizer evaporates the fluids.
 - A heater heats up to raise liquid temperature.
 - A cooler cools down the liquid.
 - A condenser condenses gas (vapors) to liquid.
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- A decorative graphic at the bottom of the slide consisting of several overlapping, wavy, horizontal bands in shades of orange and red, creating a sense of motion or a stylized horizon.

Types of heat exchangers

Generally the heat exchangers are classified as under.

- Double pipe heat exchanger.
 - Plate & Frame type heat exchanger.
 - Shell & tube heat exchanger.
 - Fin Fan i.e. Air Cooled Heat Exchangers
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Double pipe heat exchanger

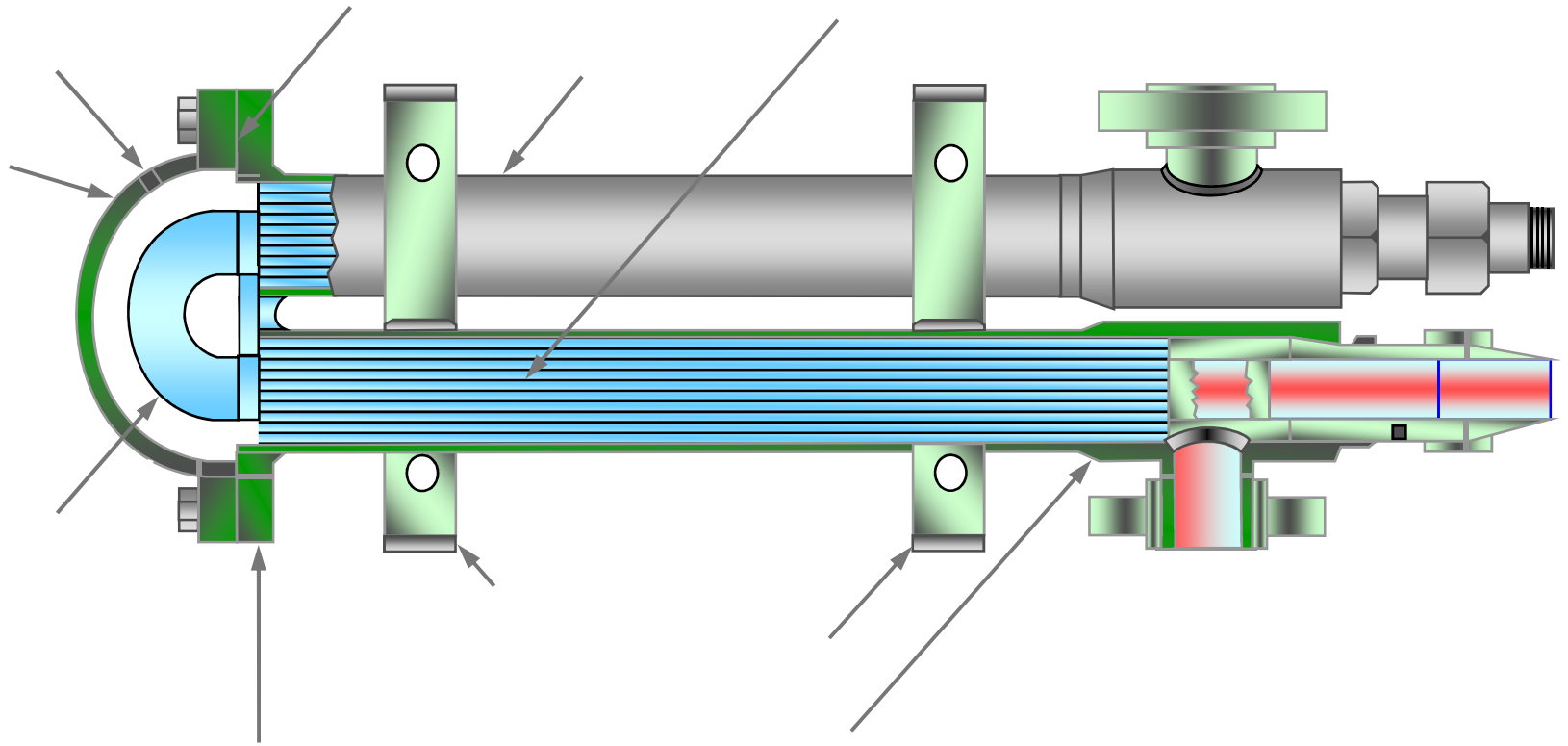
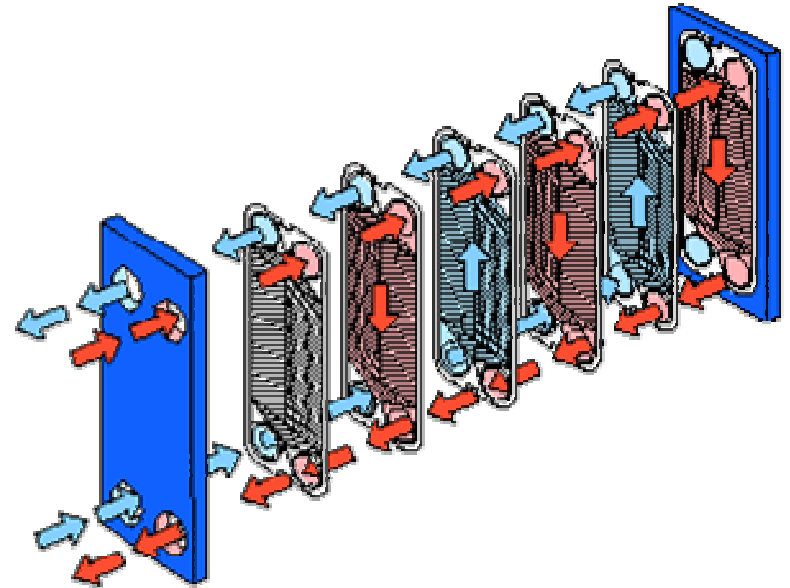
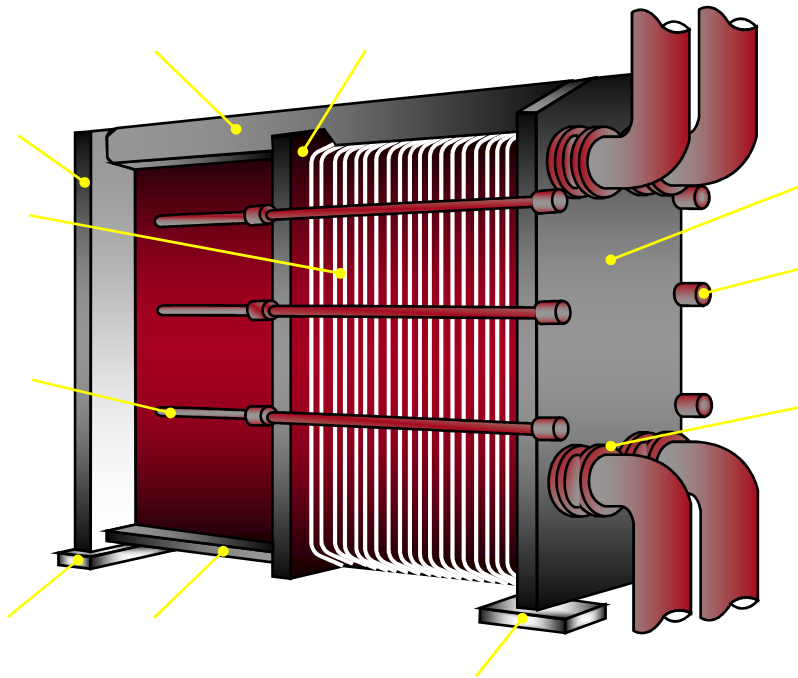
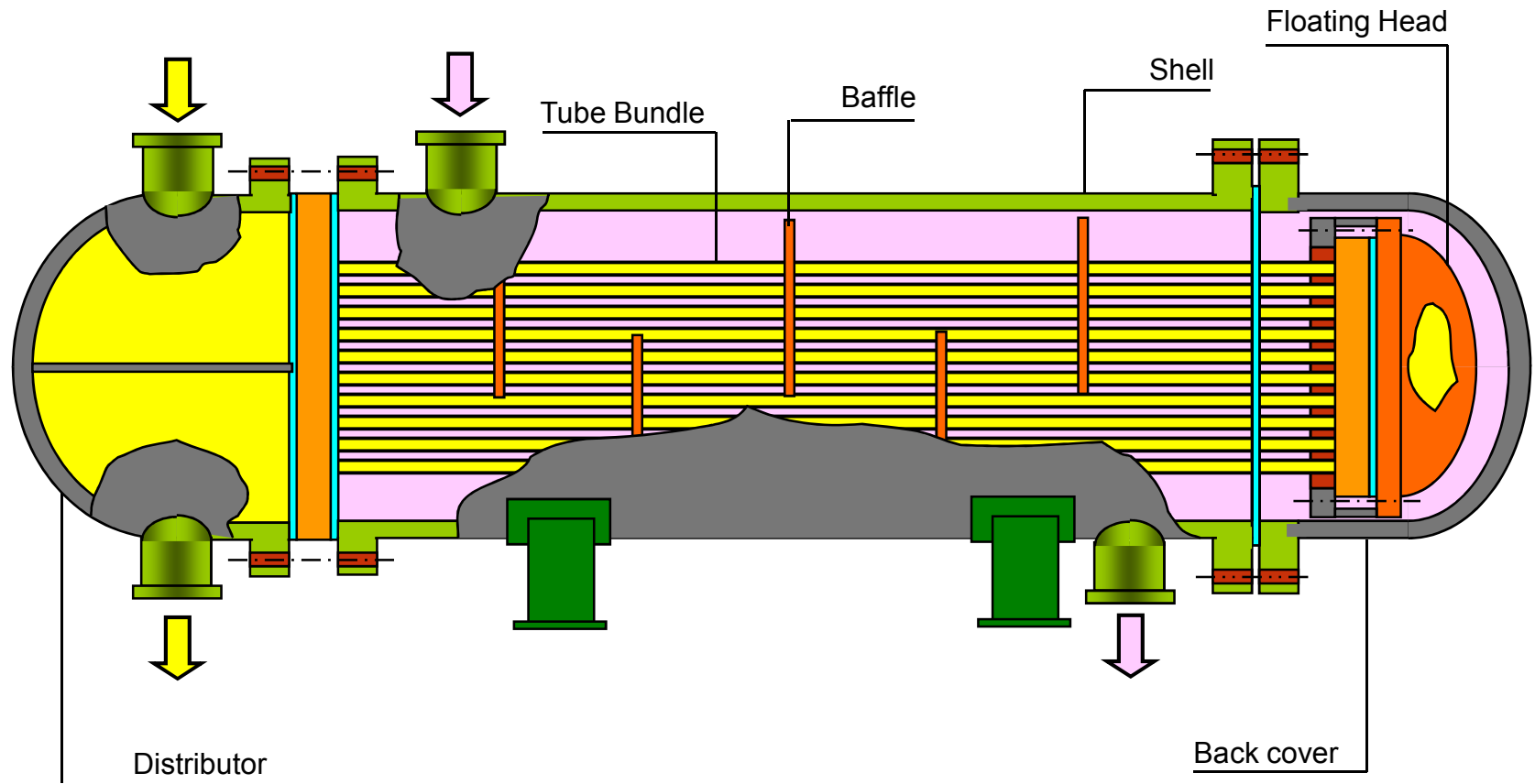


Plate & Frame Type Heat Exchanger.



Shell & Tube Heat Exchanger



Air Cooled Heat Exchangers



Types of Shell & Tube Heat Exchanger

Fixed Tube Heat Exchanger.

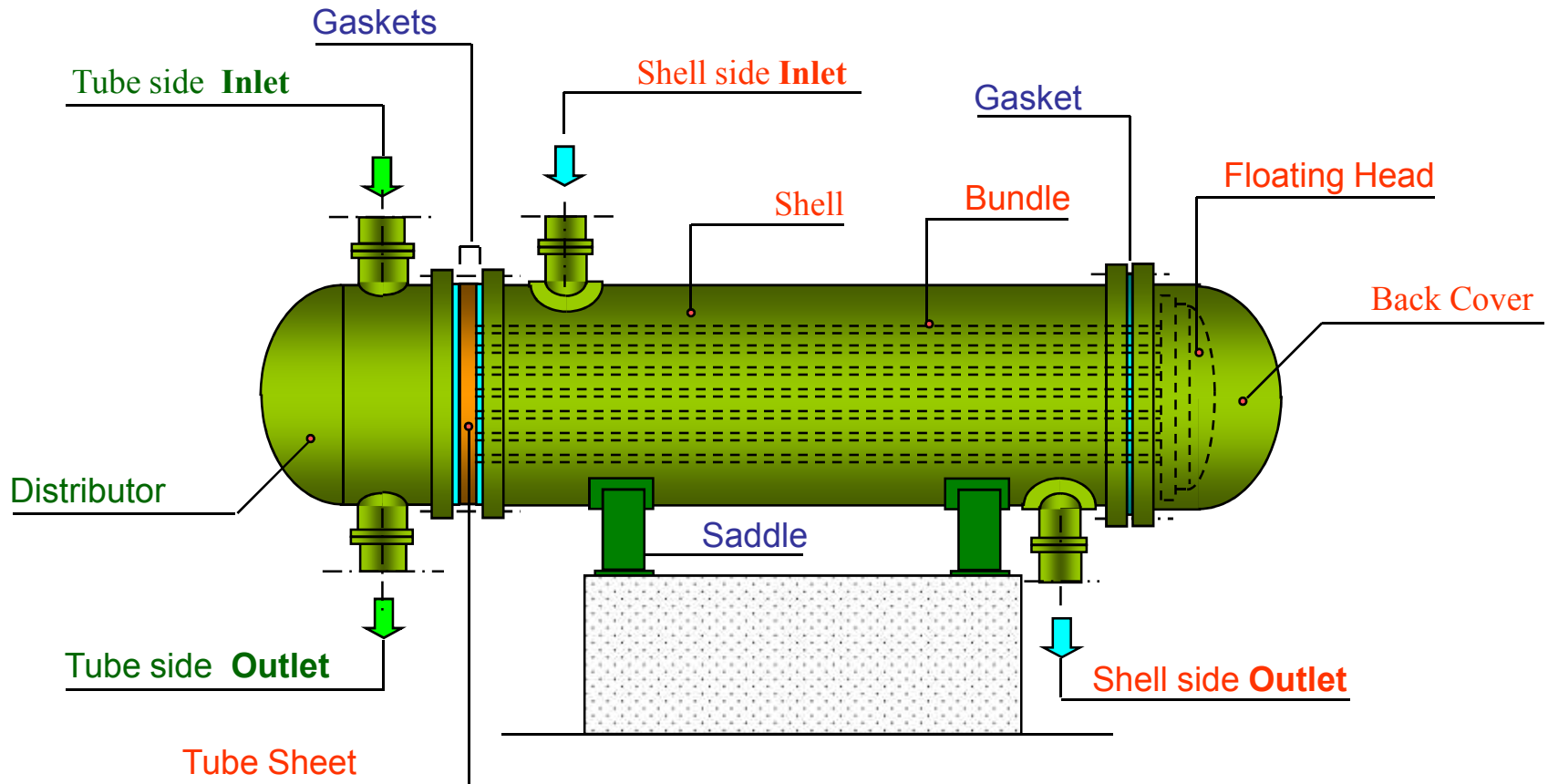
U tube Heat Exchanger.

Floating Tube Heat Exchanger.

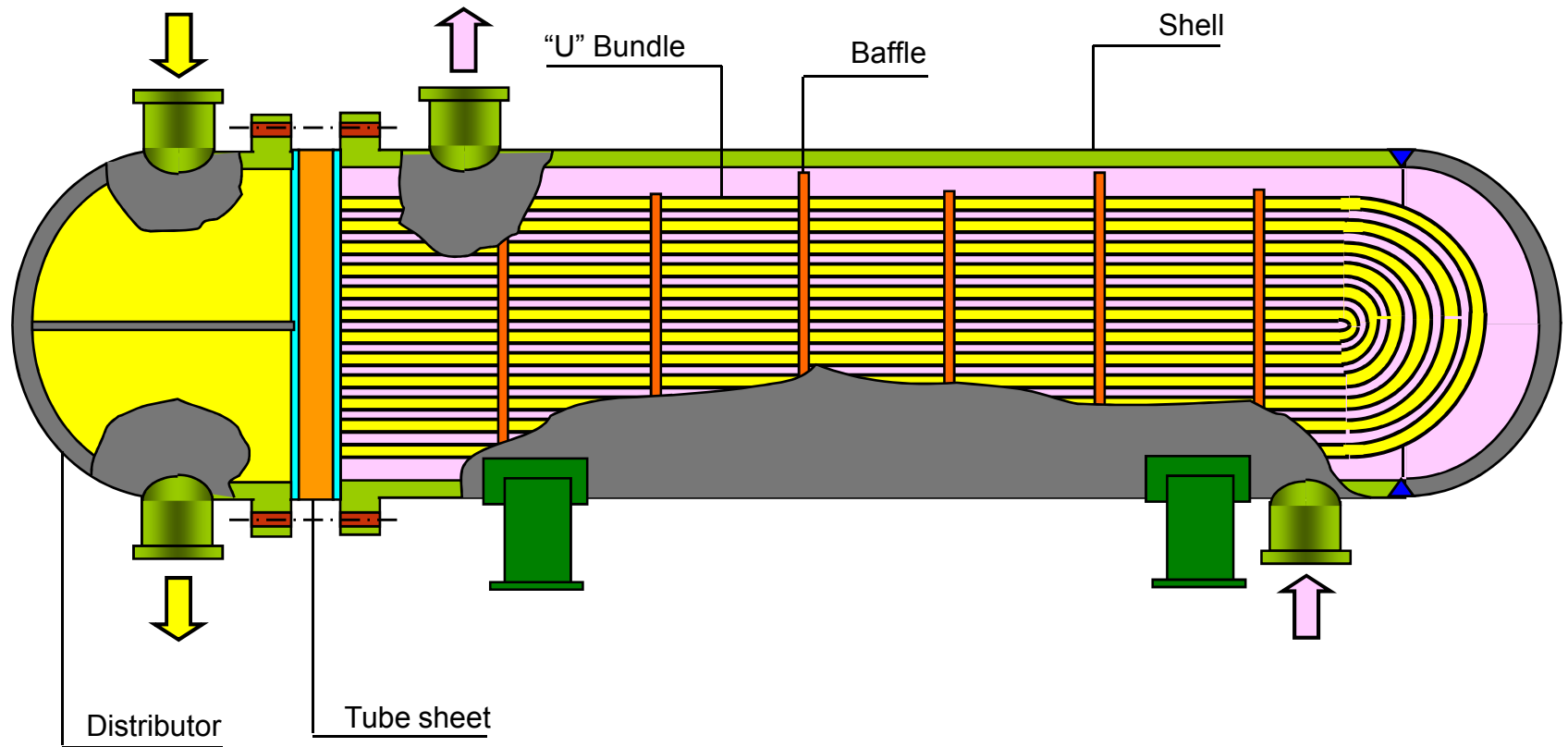
Kettle type Heat Exchanger.



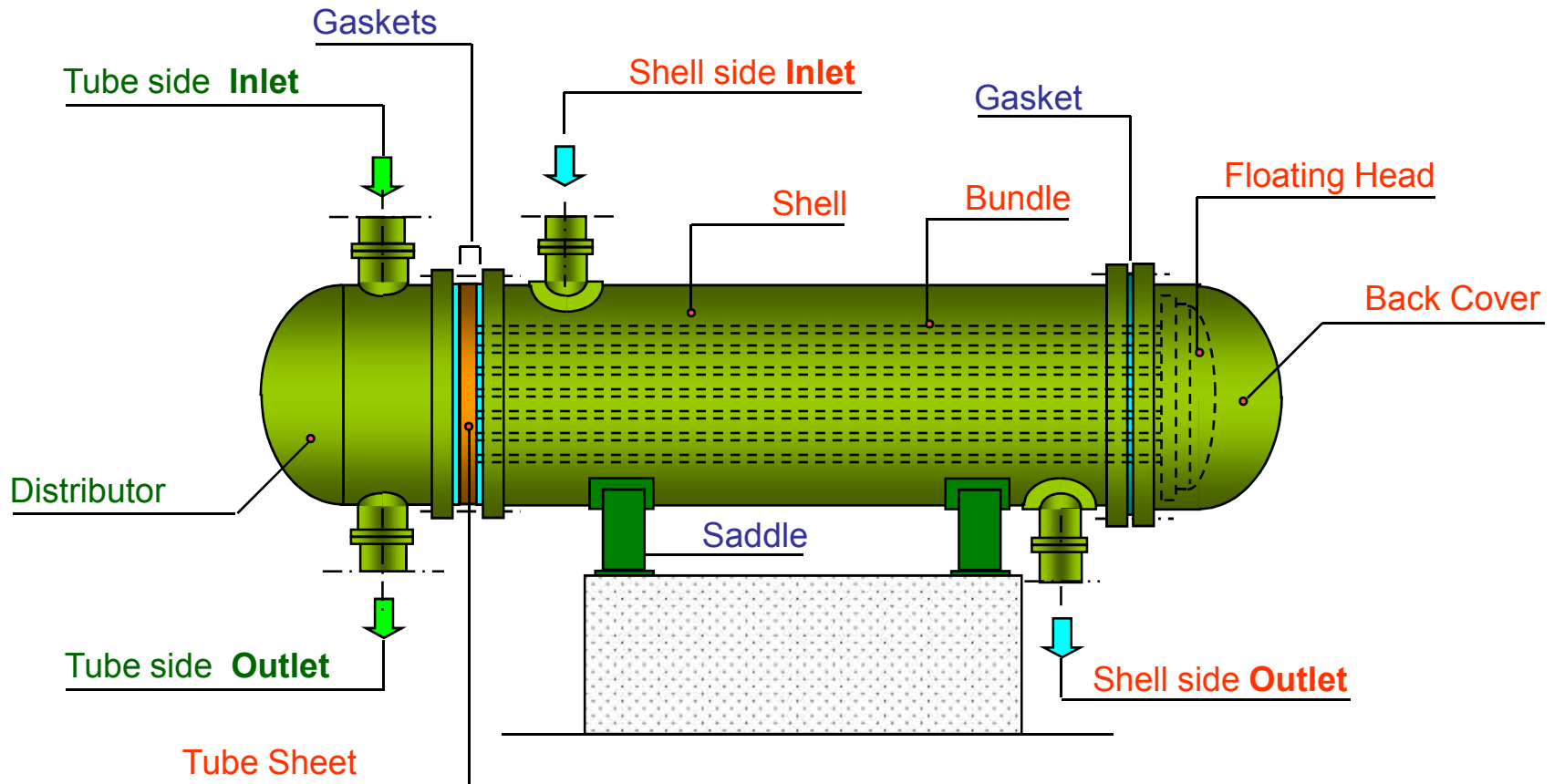
Fixed Tube Heat Exchanger



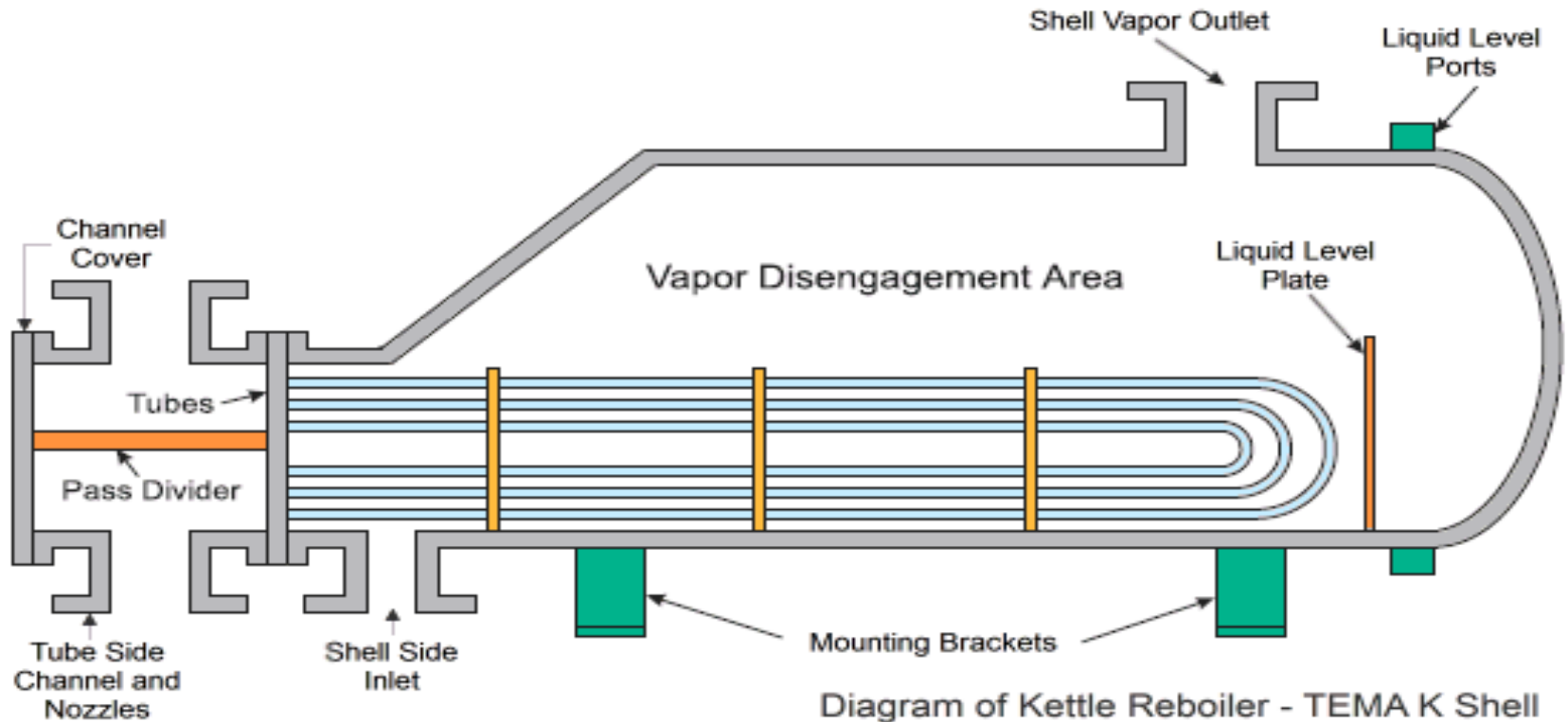
U Tube Heat Exchanger



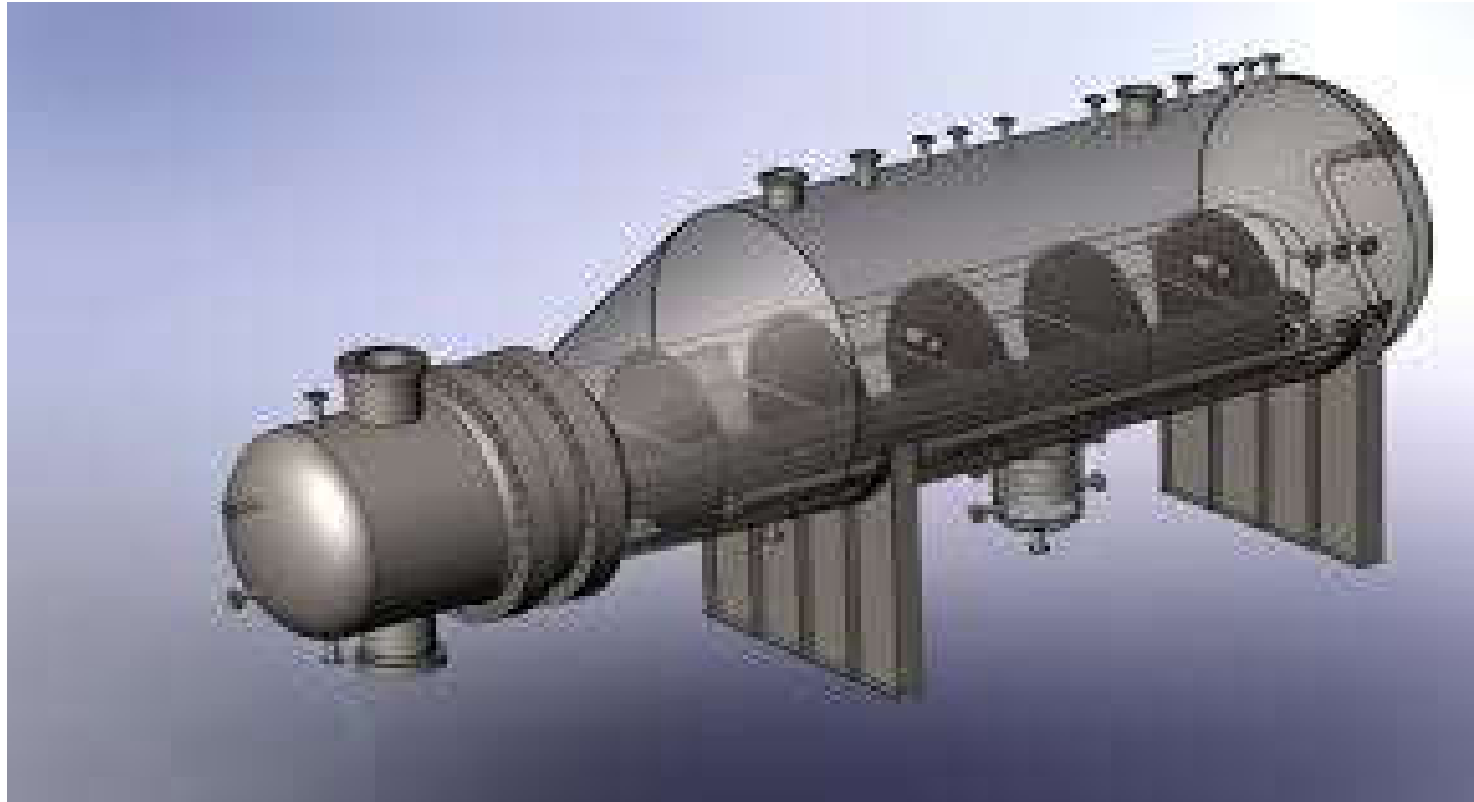
Floating Head Heat Exchanger



Kettle type Heat Exchanger







Main Features

Shell

Cannel

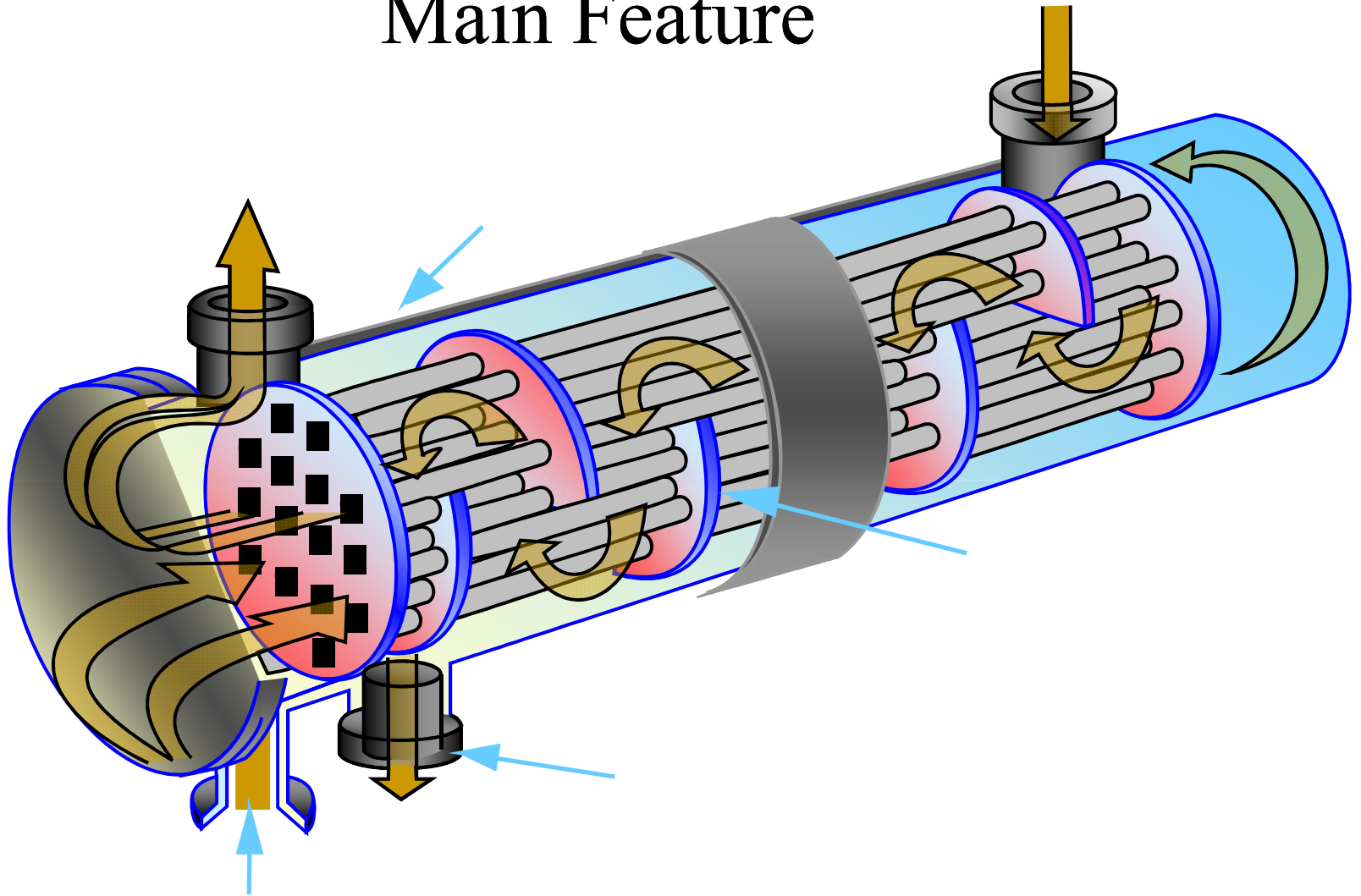
Tube- Sheet

Baffle - Plate

Tubes



Main Feature



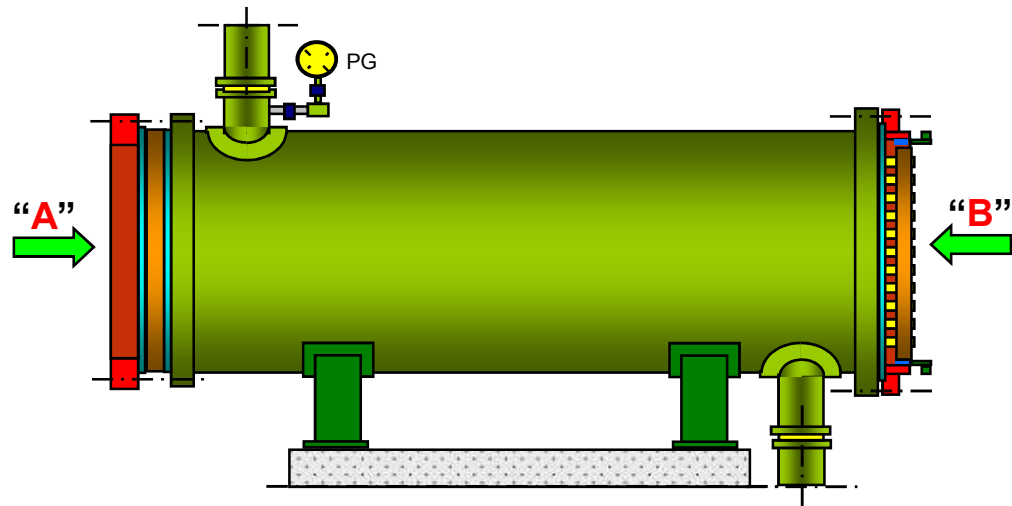
Main Features

Shell

It is the main part of the heat exchanger. One of two fluids is passing inside the shell & exchange heat energy with another fluid through the tube walls.



Main Feature



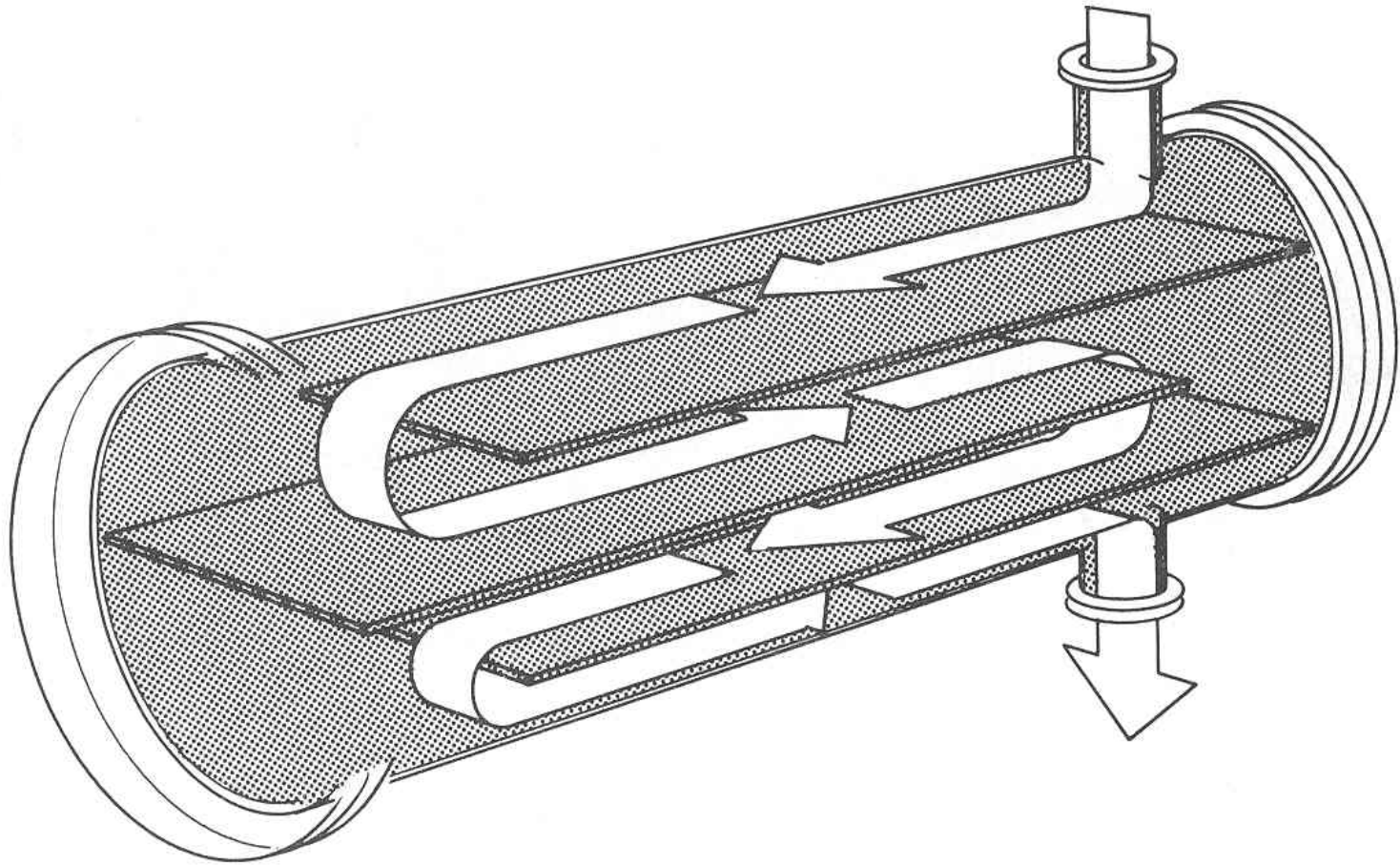
Main Features

Channel.

It has two rooms, one of which is used for introducing the inlet fluid passing the tubes side, & another for delivering the fluid. A pass partitions is installed inside the channel to separate the two rooms.



Channel



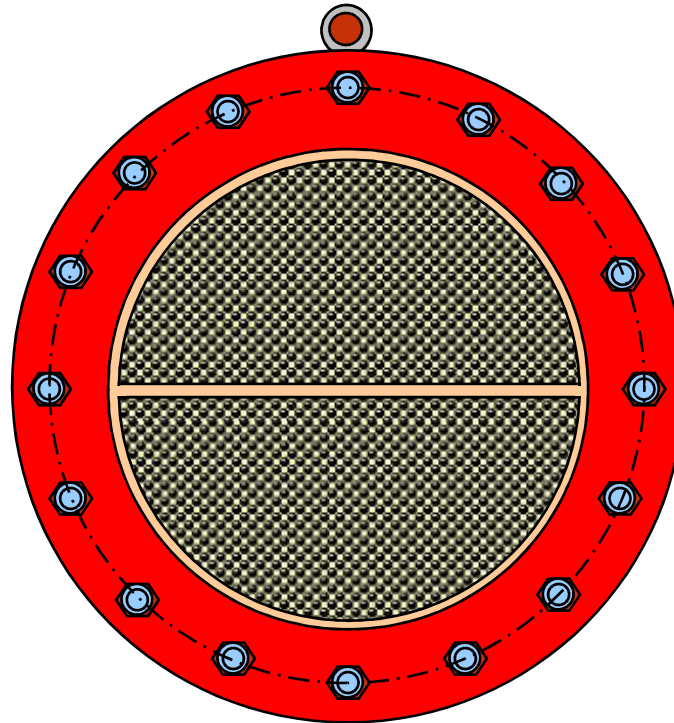
Main Features

Tube- Sheet

There are two types of tubes sheets. That is the floating tube sheet & fixed tubes sheet. The fix tube sheet is commonly used for fixed tube type, U- tube type & floating head type. The floating tube sheet is used for the floating tube type heat exchangers.



Tube Sheet



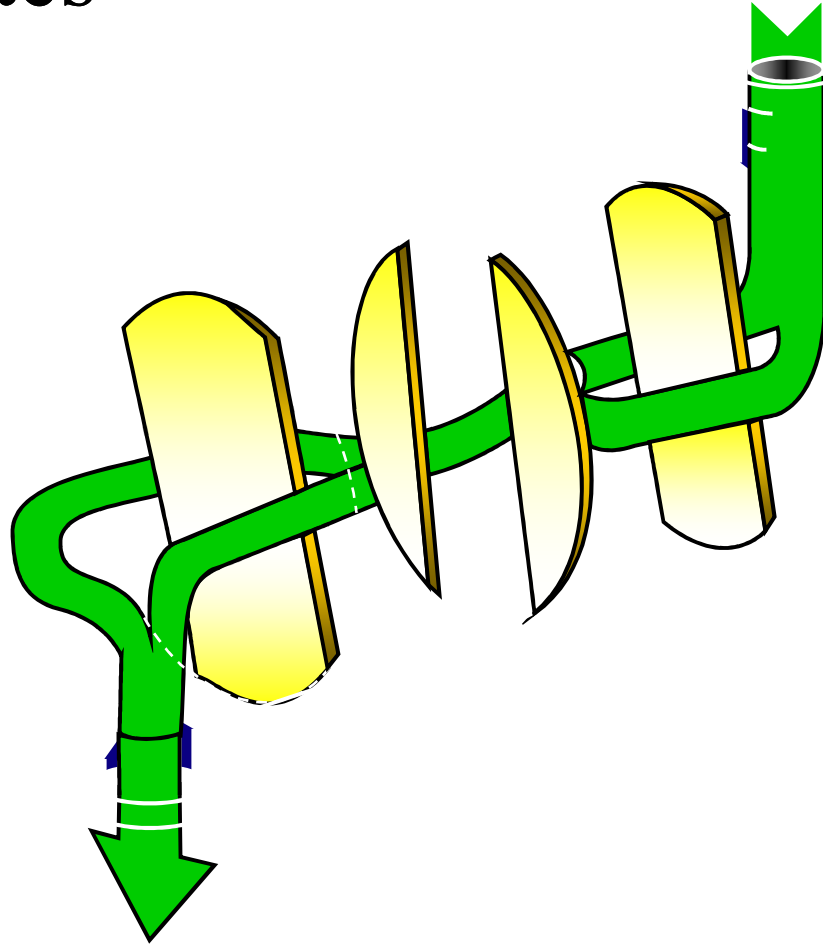
Main Features

Baffle – Plate

The baffle plate is installed inside the shell so that the shell side fluid works effectively against the tube arrangement for obtaining high heat transfer ratio of heat exchanger.



Baffle Plates

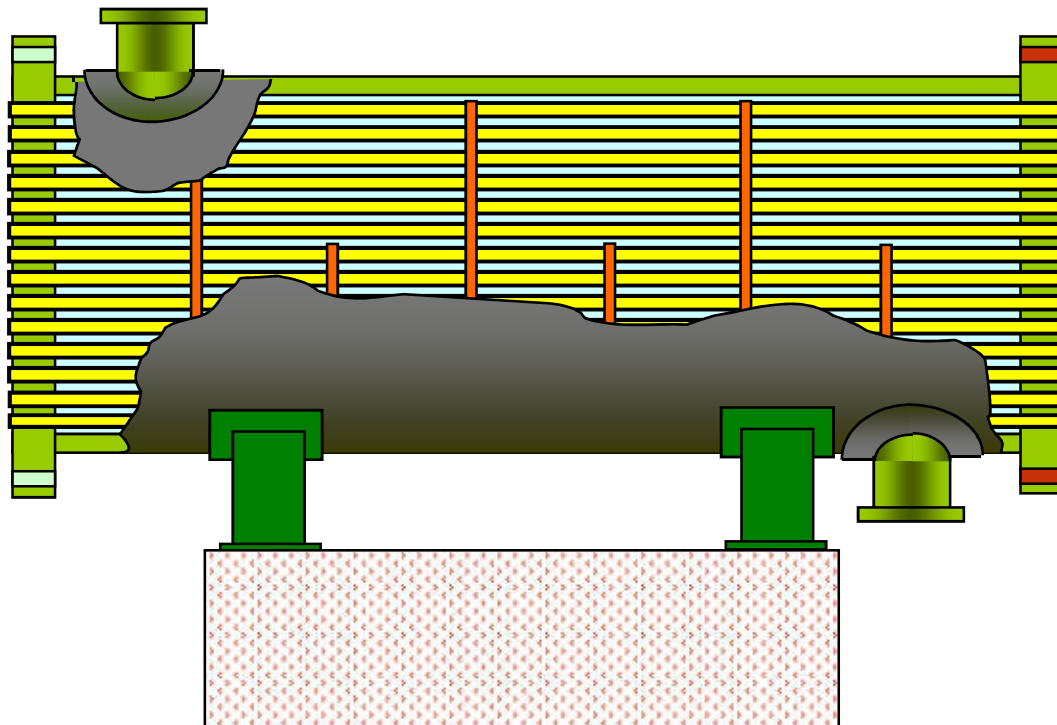


Main Features

Tubes

1. Tube side fluid passes inside the tubes. & exchange heat energy with the shell side through the tubes wall.
 2. Weight of bundle usually shears 40 to 50% of the total weight of the heat exchanger.
 3. As the tubes & tubes sheet & floating head are exposed to the fluids of the tubes & shell sides, materials of the side parts must be applicable to the both fluid
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Tubes



Main Features

