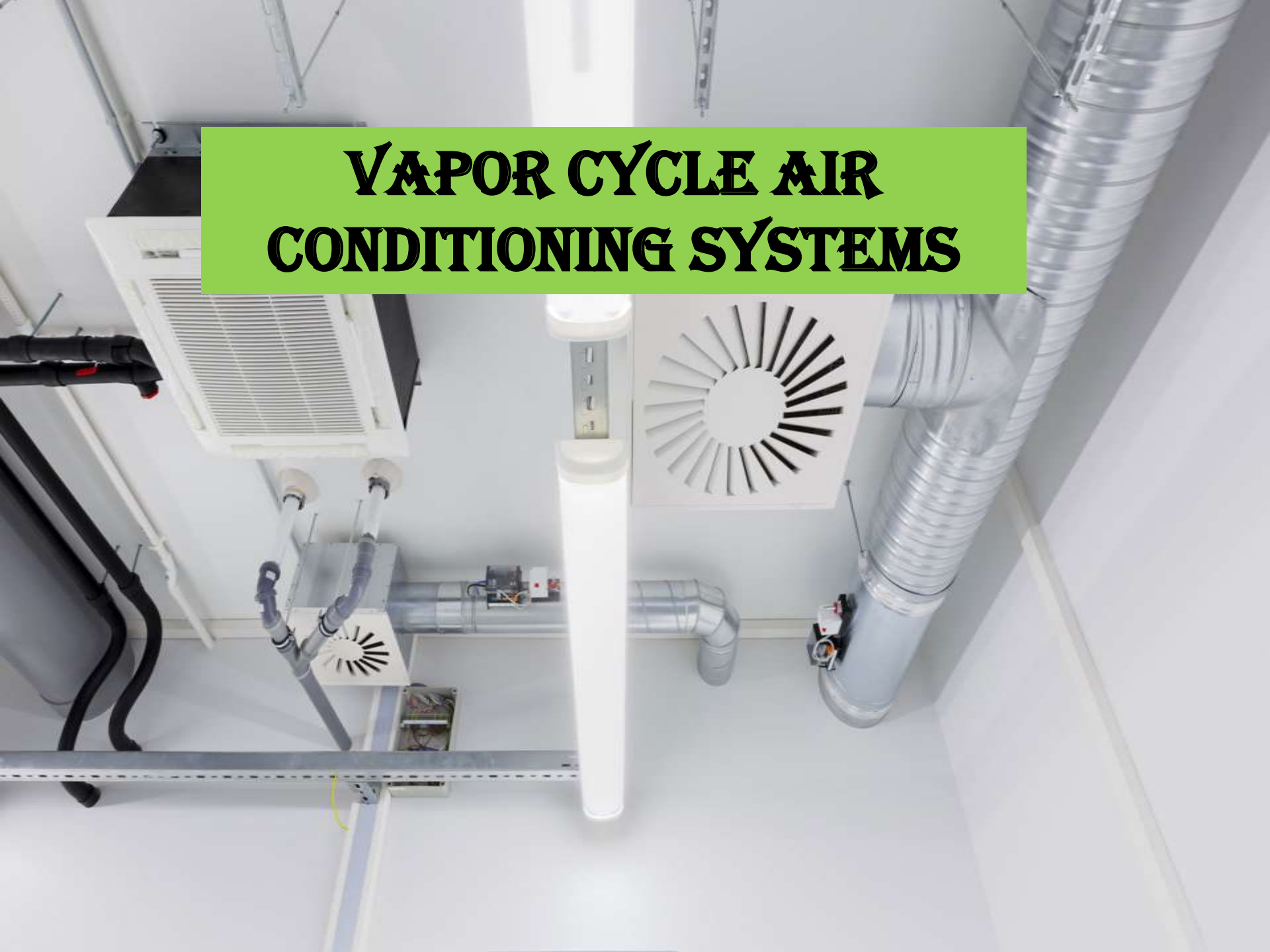
॥ नमस्ते ॥


VAPOR CYCLE AIR
CONDITIONING SYSTEMS

- **There are two types of air conditioning systems commonly used on aircraft.**

1. **Air cycle air conditioning (Air conditioning package or pack)** is used on most turbine-powered aircraft. It makes use of engine bleed air or APU pneumatic air during the conditioning process.
2. **Vapor cycle air conditioning systems** are often used on reciprocating aircraft. This type system is similar to that found in homes and automobiles.

VAPOUR CYCLE AIR CONDITIONING

Highlights

- Used on Non Turbine powered aircraft
- Also Used on Some turbine powered business class aircraft and older transport category aircraft.
- The vapor cycle system only cools the cabin.
- That aircraft uses a different source of air for
- pressurization.

THEORY OF REFRIGERATION

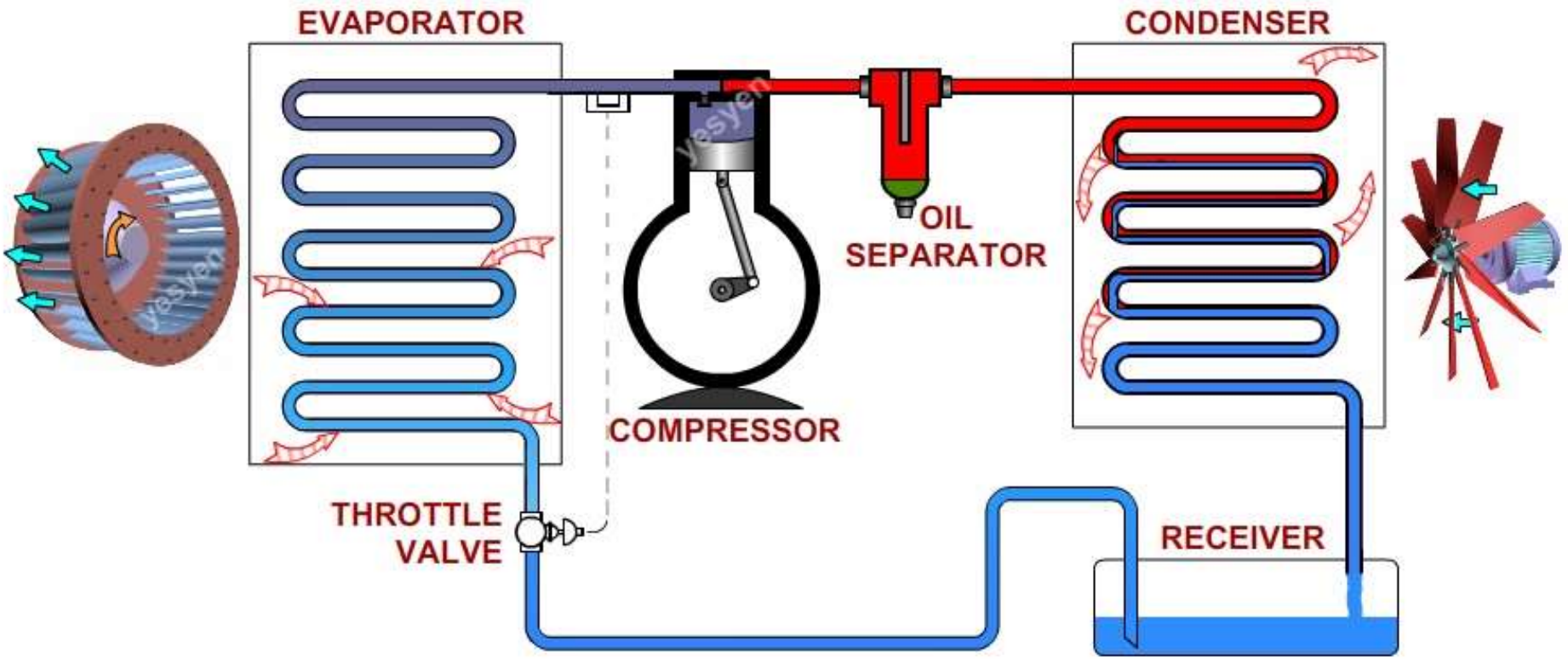
- **Energy can be neither created nor destroyed; however,**

  it can be transformed and moved. This is what occurs during vapor cycle air conditioning.
- **Heat energy is moved from the cabin air into a liquid refrigerant.**
- **Due to the additional energy, the liquid changes into a vapor.**
- **The vapor is compressed and becomes very hot.**
- **It is removed from the cabin where the very hot vapor refrigerant transfers its heat energy to the outside air.**
- **In doing so, the refrigerant cools and condenses back into a liquid.**
- **The refrigerant returns to the cabin to repeat the cycle of energy transfer.**

- **Heat is an expression of energy, typically measured by temperature.**
- **The higher the temperature of a substance, the more energy it contains. Heat always flows from hot to cold.**
- **Adding heat to a substance does not always raise its temperature.**
- **When a substance changes state, such as when a liquid changes into a vapor, heat energy is absorbed. This is called latent heat.**
- **When a vapor condenses into a liquid, this heat energy is given off. The temperature of a substance remains constant during its change of state.**
- **All energy absorbed or given off, the latent heat, is used for the change process. Once the change of state is complete, heat added to a substance raises the temperature of the substance.**

BASIC VAPOUR CYCLE

- Vapor cycle air conditioning is a closed system in which a refrigerant is circulated through tubing and a variety of components. The purpose is to remove heat from the aircraft cabin.
- While circulating, the refrigerant changes state. By manipulating the latent heat required to do so, hot air is replaced with cool air in the aircraft cabin.


EVAPORATOR
CONDENSER
OIL
SEPARATOR
COMPRESSOR
THROTTLE
VALVE
RECEIVER

- To begin, R134a is filtered and stored under pressure in a reservoir known as a receiver dryer.
- The refrigerant is in liquid form.
- It flows from the receiver dryer through tubing to an expansion valve.
- Inside the valve, a restriction in the form of a small orifice blocks most of the refrigerant. Since it is under pressure, some of the refrigerant is forced through the orifice.

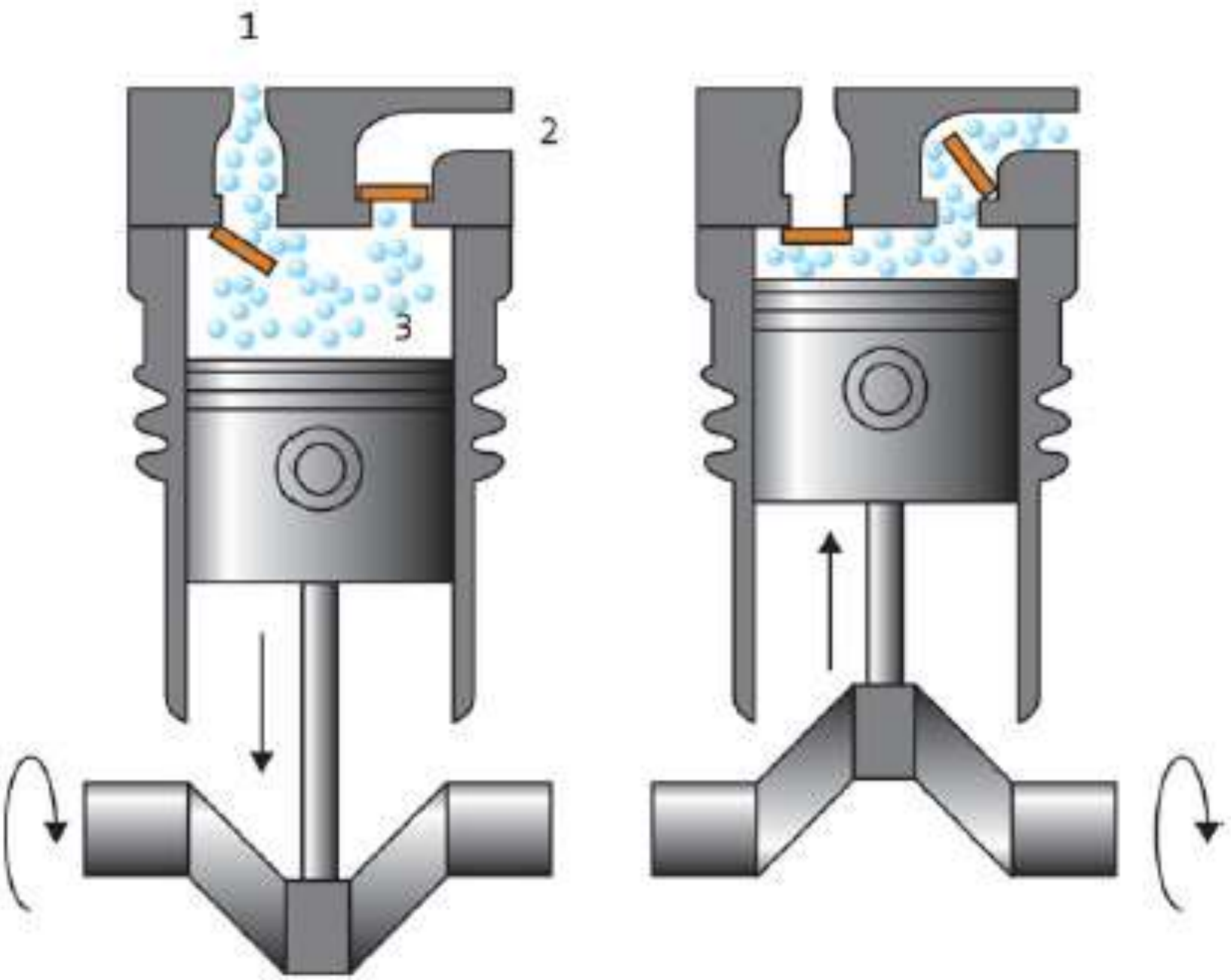
- It emerges as a spray of tiny droplets in the tubing downstream of the valve.
- The tubing is coiled into a radiator type assembly known as an evaporator.
- A fan is positioned to blow cabin air over the surface of the evaporator. As it does, the heat in the cabin air is absorbed by the refrigerant, which uses it to change state from a liquid to a vapor.
- So much heat is absorbed that the cabin air blown by the fan across the evaporator cools significantly.
- This is the vapor cycle conditioned air that lowers the temperature in the cabin.

Process

- **STEP 1: COMPRESSION**
- **STEP 2: CONDENSATION**
- **STEP 3: THROTTLING AND EXPANSION**
- **STEP 4: EVAPORATION**

STEP 1: COMPRESSION

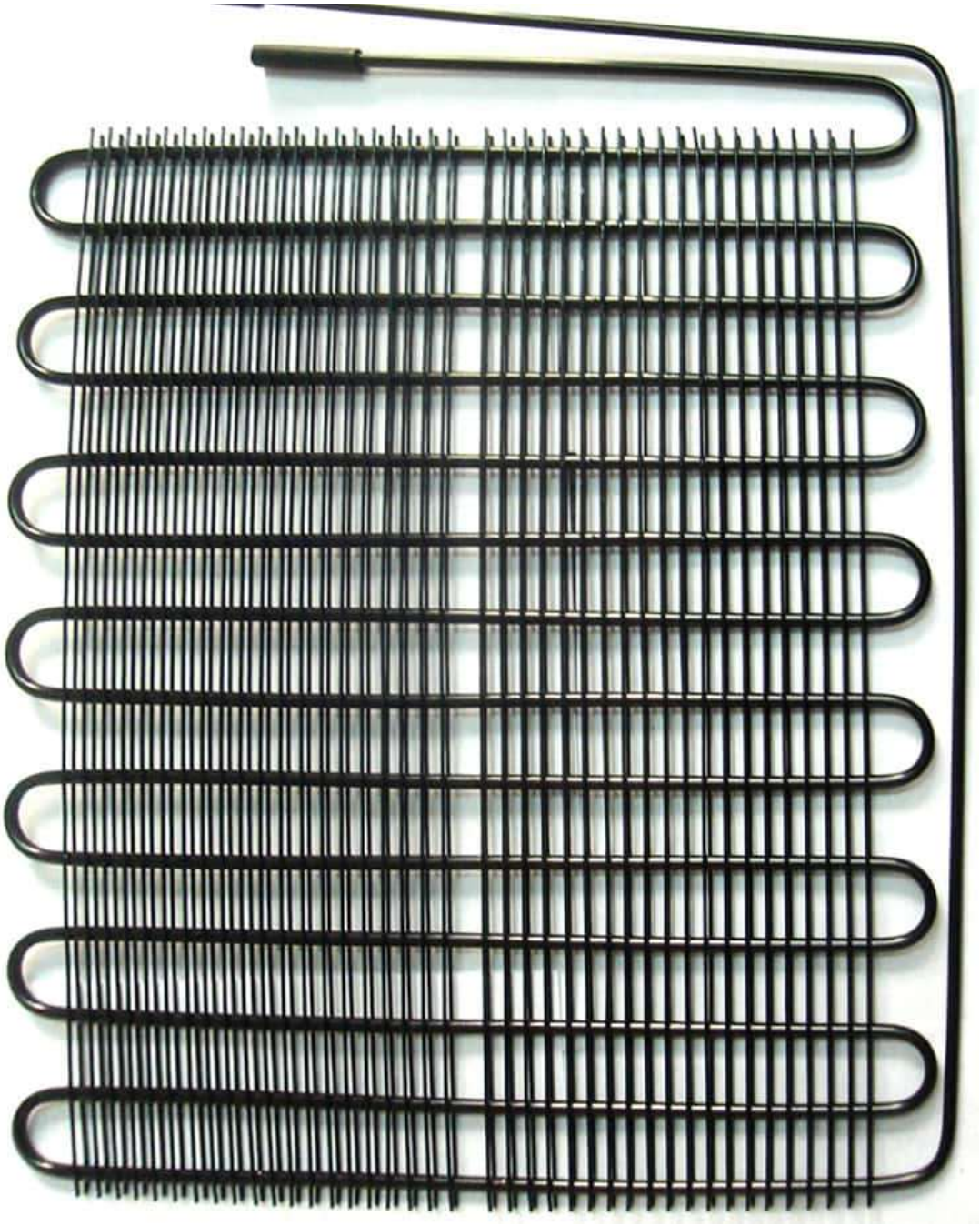
- The refrigerant (for example R-717) enters the compressor at low temperature and low pressure.
- It is in a gaseous state.
- Here, **compression takes place to raise the temperature and refrigerant pressure**.
- The refrigerant leaves the compressor and enters to the condenser.
- Since this process requires work, an electric motor may be used.
- Compressors themselves can be scroll, screw, centrifugal or reciprocating types.


1
2
3


trucool
MEY80QLA
220-240 ~ 50Hz
1PH
R134a
HUAYI

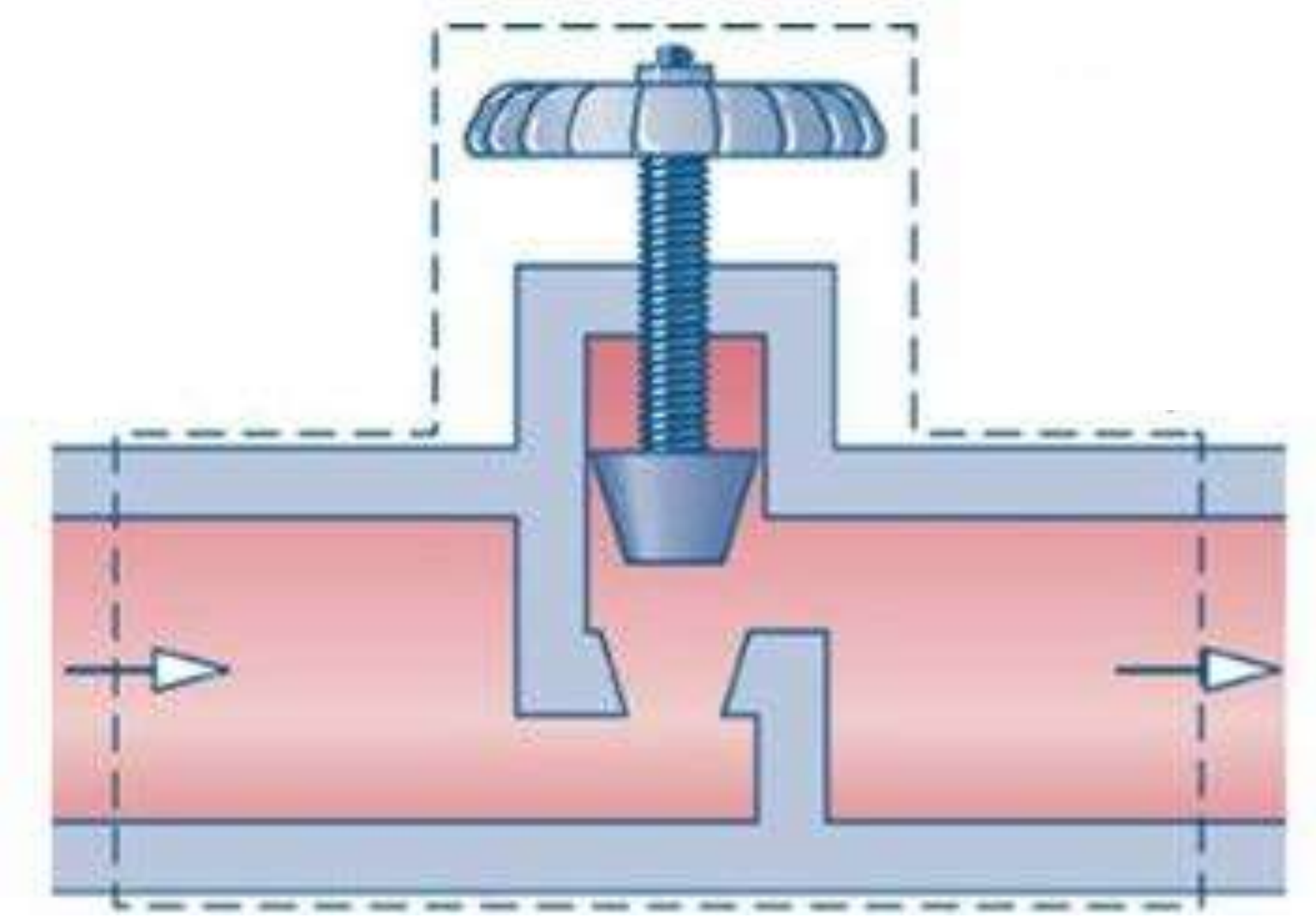
STEP 2: CONDENSATION

- The condenser is essentially a heat exchanger.
- Heat is transferred from the refrigerant to a flow of water.
- This water goes to a cooling tower for cooling in the case of water-cooled condensation. Note that seawater and air-cooling methods may also play this role.
- As the refrigerant flows through the condenser, it is in a constant pressure.



STEP 3: THROTTLING AND EXPANSION

- When the refrigerant enters the throttling valve, it expands and releases pressure.
- Consequently, the temperature drops at this stage.
- Because of these changes, the refrigerant leaves the throttle valve as a liquid vapor mixture, typically in proportions of around 75 % and 25 % respectively.
- Throttling valves play two crucial roles in the vapor compression cycle.
- First, they maintain a pressure differential between low- and high-pressure sides.
- Second, they control the amount of liquid refrigerant entering the evaporator

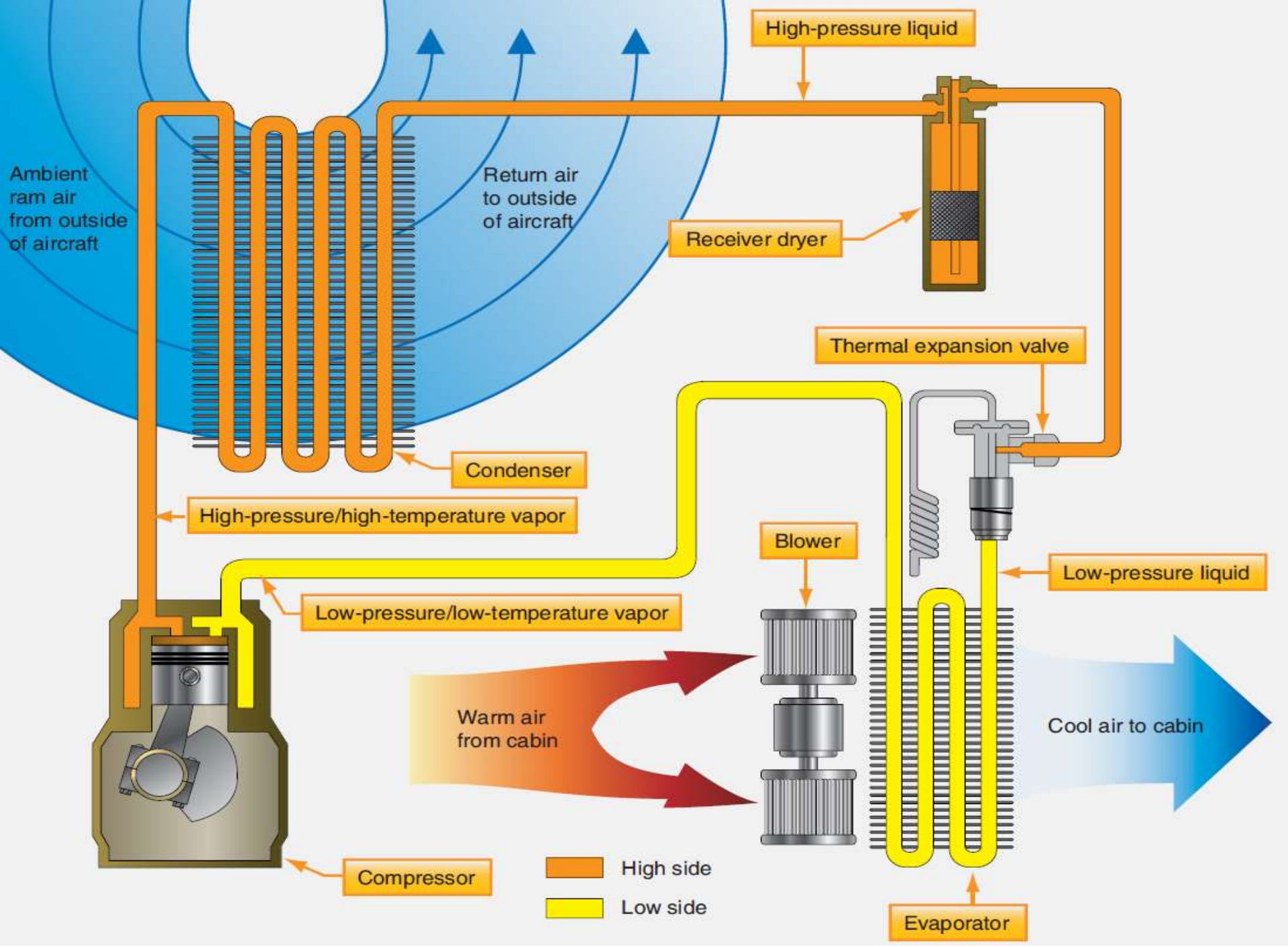


THROTTLING AND EXPANSION

Capillary Tube

STEP 4: EVAPORATION

- At this stage of the Vapor Compression Refrigeration Cycle, the refrigerant is at a lower temperature than its surroundings.
- Therefore, it evaporates and absorbs latent heat of vaporization.
- Heat extraction from the refrigerant happens at low pressure and temperature.
- Compressor suction effect helps maintain the low pressure.


High-pressure liquid
Ambient ram air from outside of aircraft
Return air to outside of aircraft
Receiver dryer
Thermal expansion valve
Condenser
High-pressure/high-temperature vapor
Blower
Low-pressure liquid
Low-pressure/low-temperature vapor
Warm air from cabin
Cool air to cabin
Compressor
High side
Low side
Evaporator

Myth: Our fingers wrinkle in water because they absorb the water.

Fact: No, it's because wrinkly fingers give us better grip in wet surroundings.

धन्यवाद

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