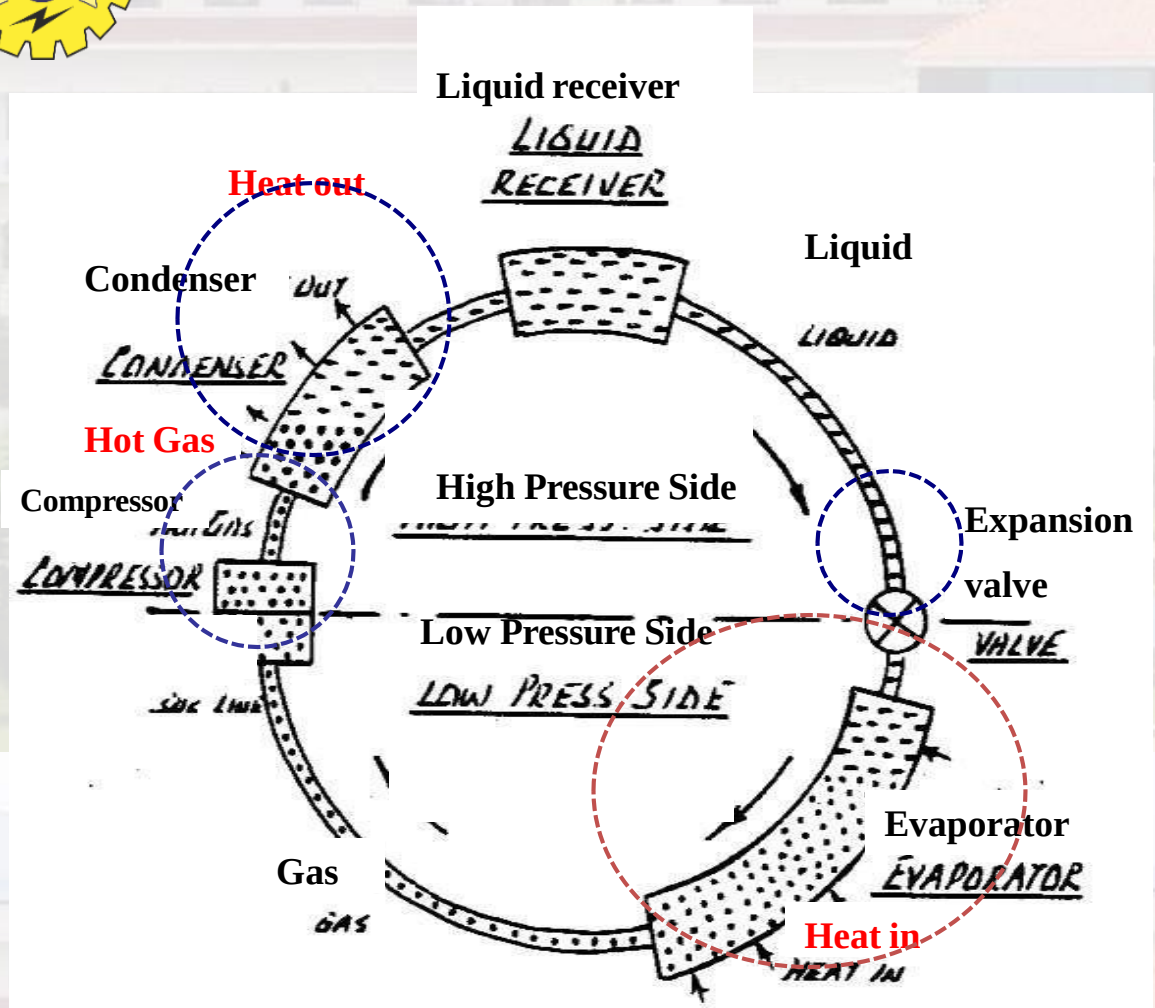
REFRIGERATION AND AIR CONDITIONING (R&AC)

Topic : Vapour Compression System

Reya Tabitha Saji
Assistant Professor of Food Technology
SNS College of Technology

Vapour Compression System



https://tinyurl.com/ya4zylqg

Components of VCS:

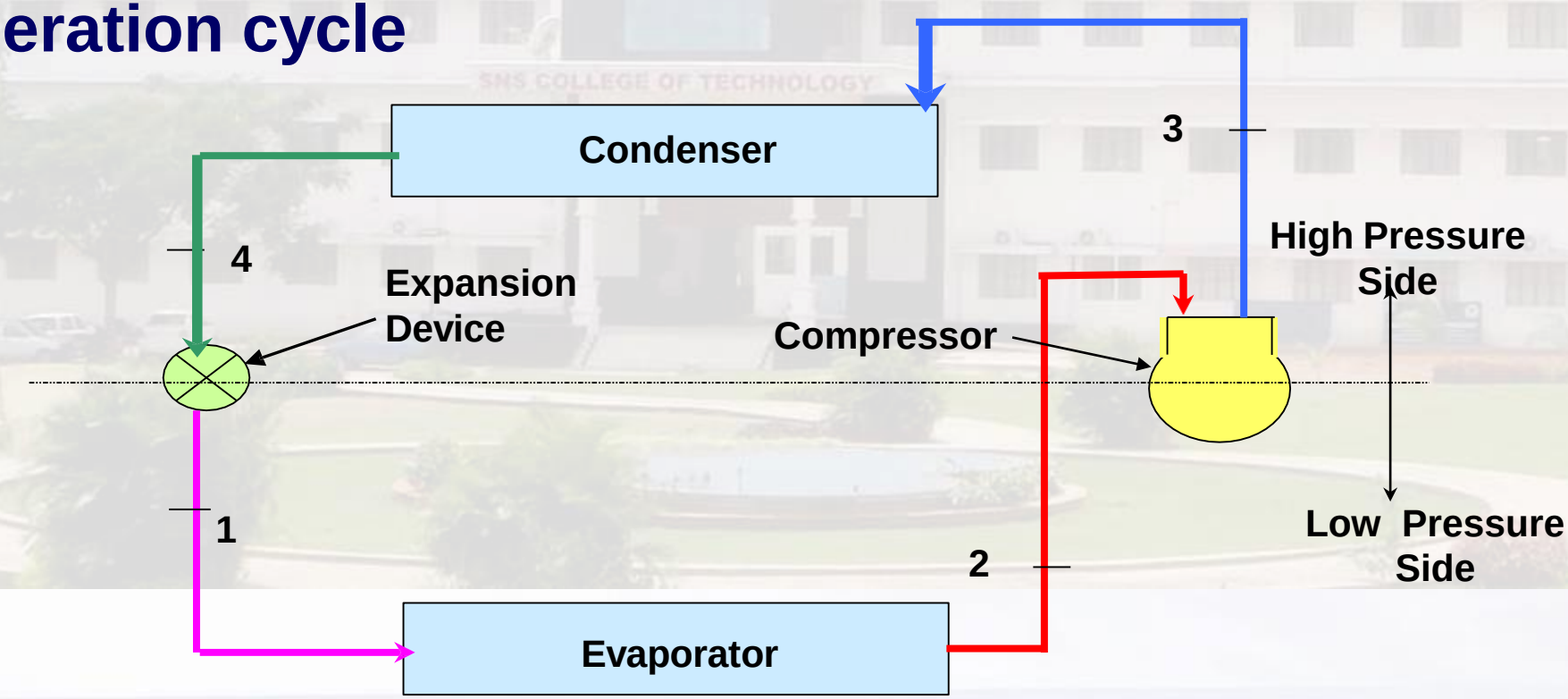
- Evaporator
- Compressor
- Condenser
- Expansion Valve

Vapour Compression System

- **Highly compressed fluids tend to get colder when allowed to expand**
- **If pressure high enough**
  - **Compressed air hotter than source of cooling**
  - **Expanded gas cooler than desired cold temperature**

Vapour Compression System

Refrigeration cycle

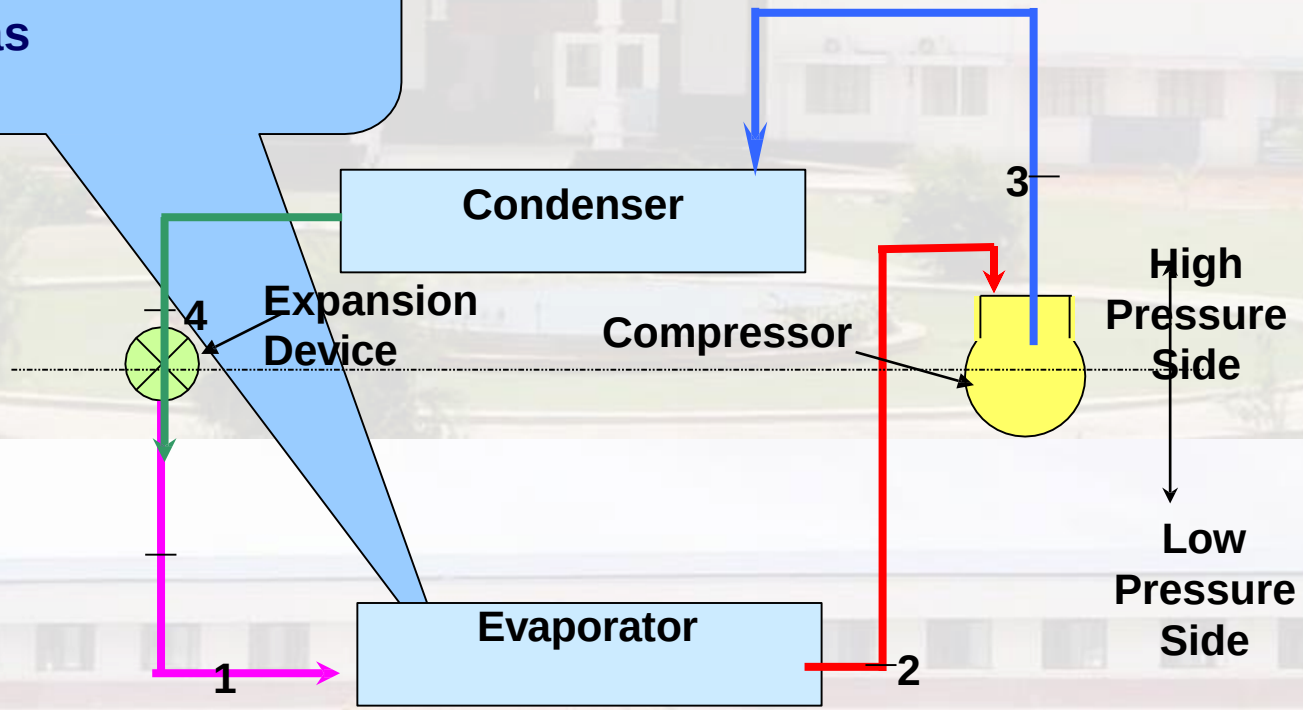


https://tinyurl.com/y76s6n7j

Vapour Compression System

Evaporator

Low pressure liquid refrigerant in evaporator absorbs heat and changes to a gas



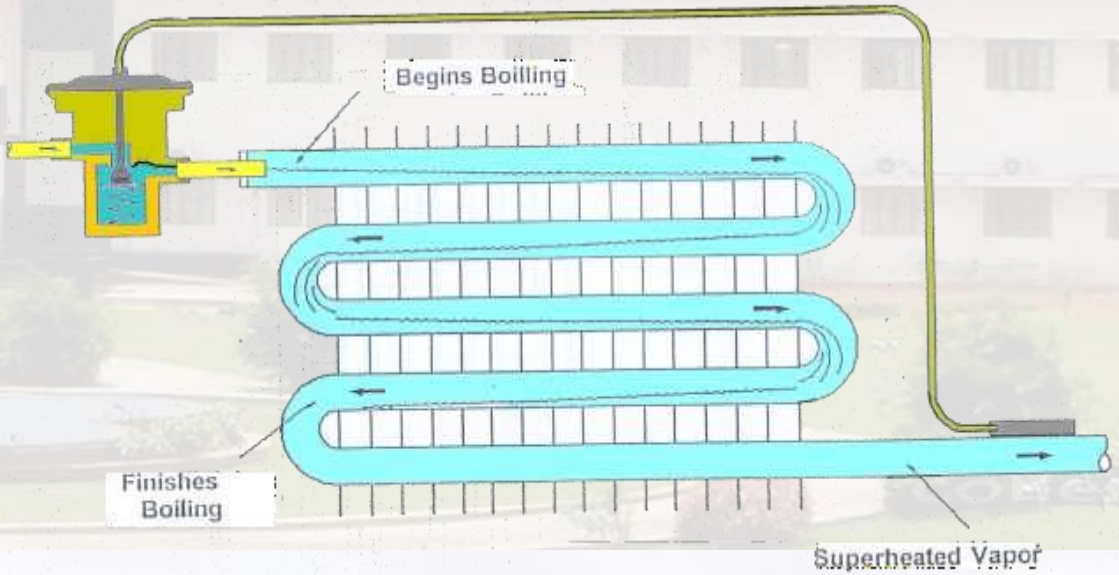
https://tinyurl.com/y76s6n7j

Vapour Compression System

Evaporator

- The evaporator coils are located in the compartment to be cooled

- The low pressure liquid refrigerant, after passing through the expansion valve, expands

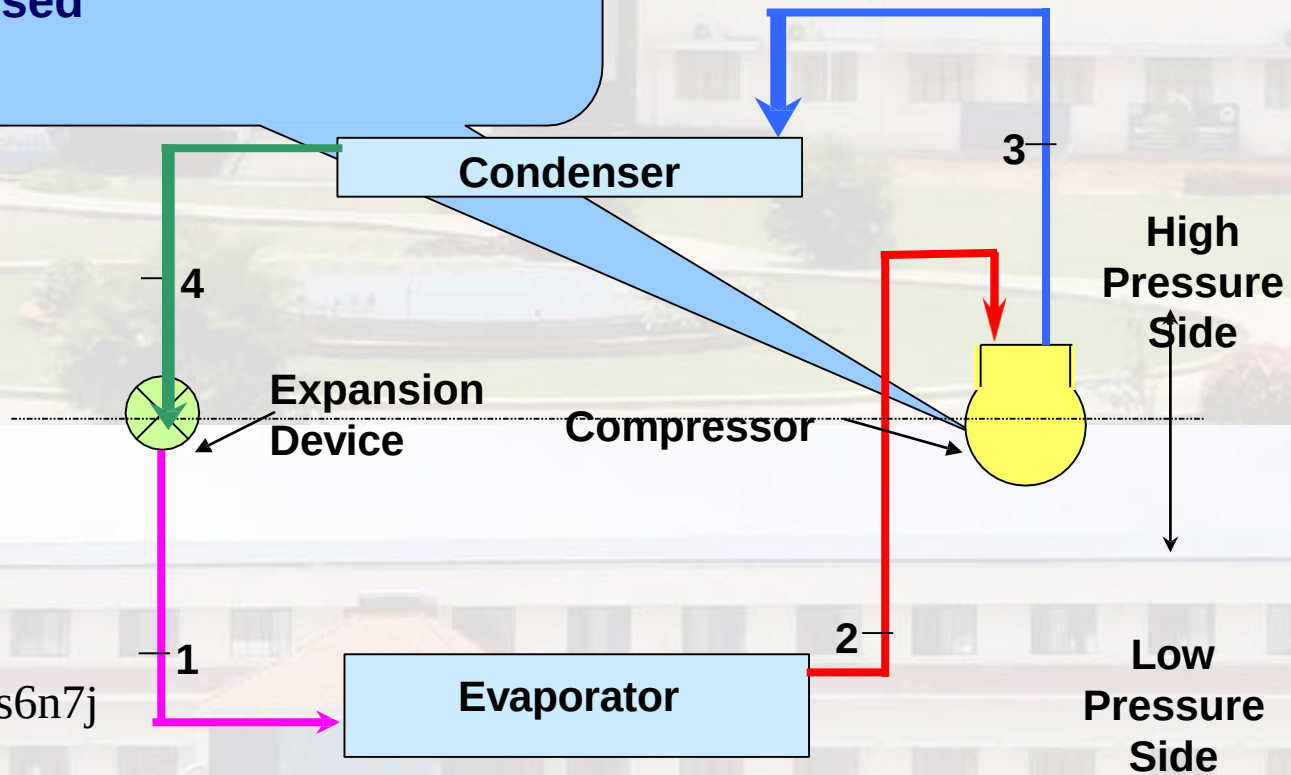


https://tinyurl.com/yb2h6pr8

Vapour Compression System

Compressor

The superheated vapour enters the compressor where its pressure is raised



https://tinyurl.com/y76s6n7j

Vapour Compression System

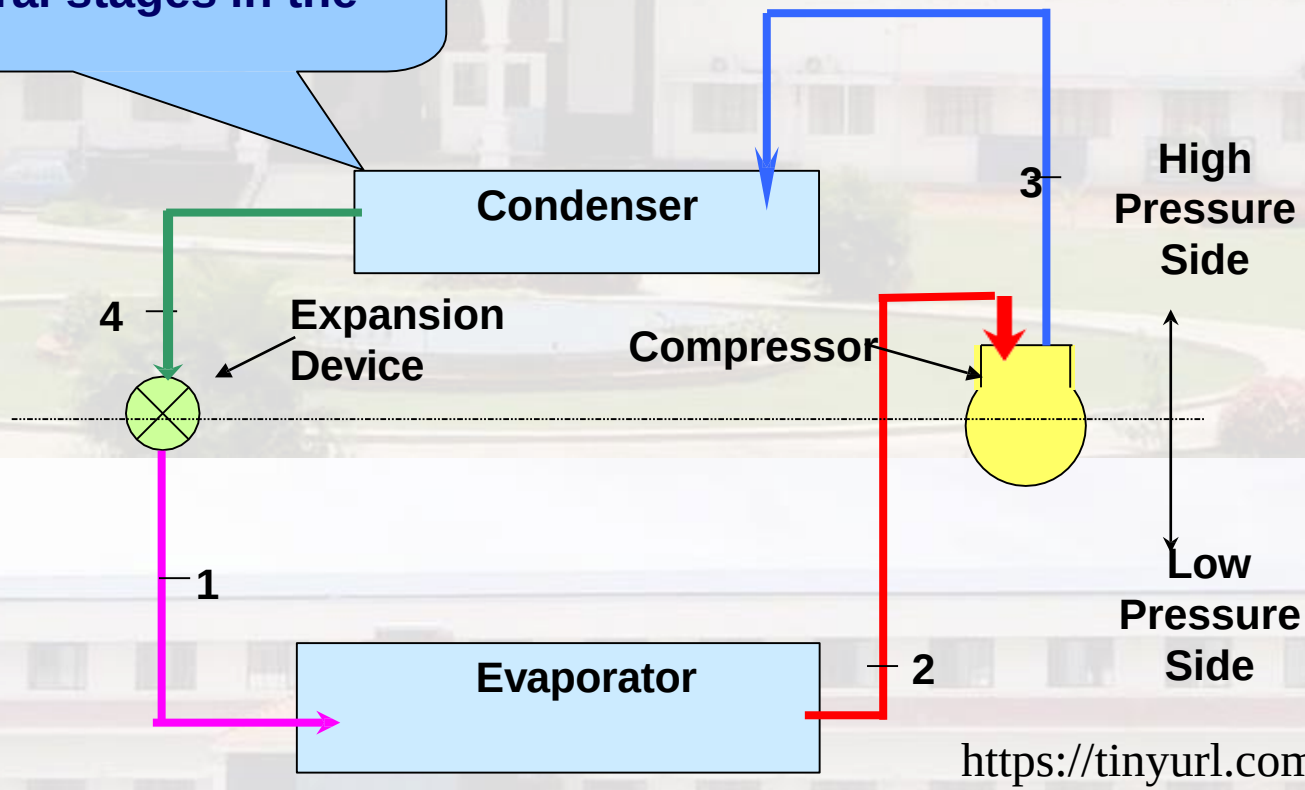
- The compressor is the **heart** of the system
- It compresses the low pressure refrigerant vapor from the evaporator and compresses it into a high pressure vapor
- The inlet to the compressor is called the Suctionon Line

https://tinyurl.com/yb2h6pr8

Vapour Compression System

Condenser

The high pressure superheated gas is cooled in several stages in the condenser



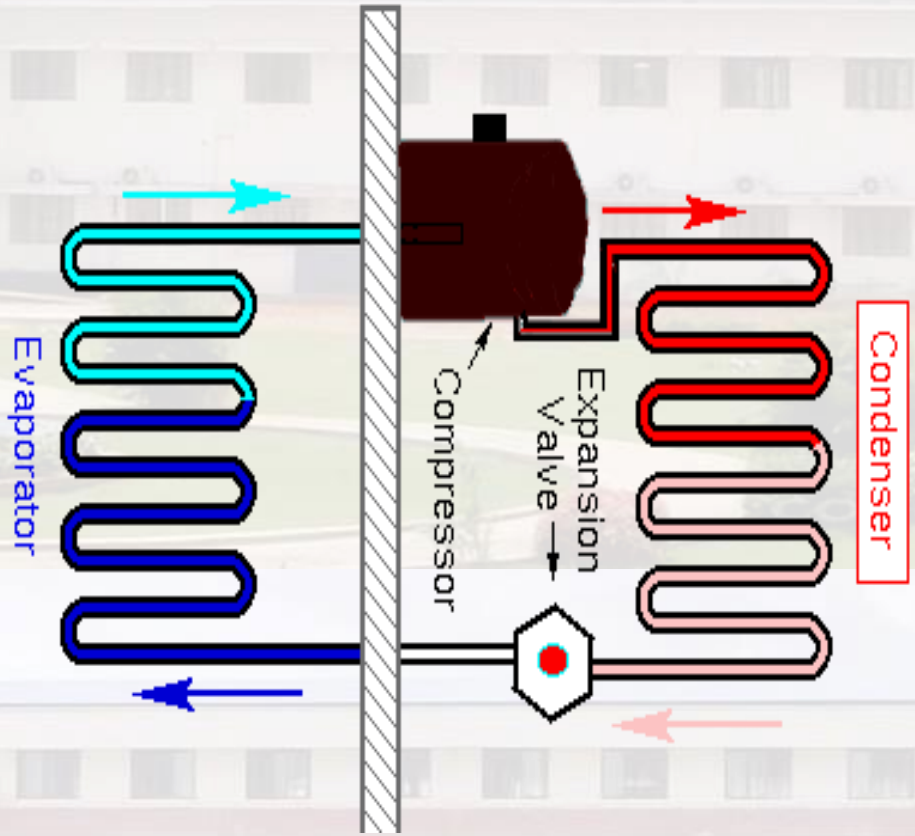
https://tinyurl.com/y76s6n7j

Vapour Compression System

Condenser

- The Discharge Line leaves the compressor and runs to the inlet of the condenser.

- Because the refrigerant was compressed, it is a hot high pressure vapor (as pressure goes up – temperature goes up).

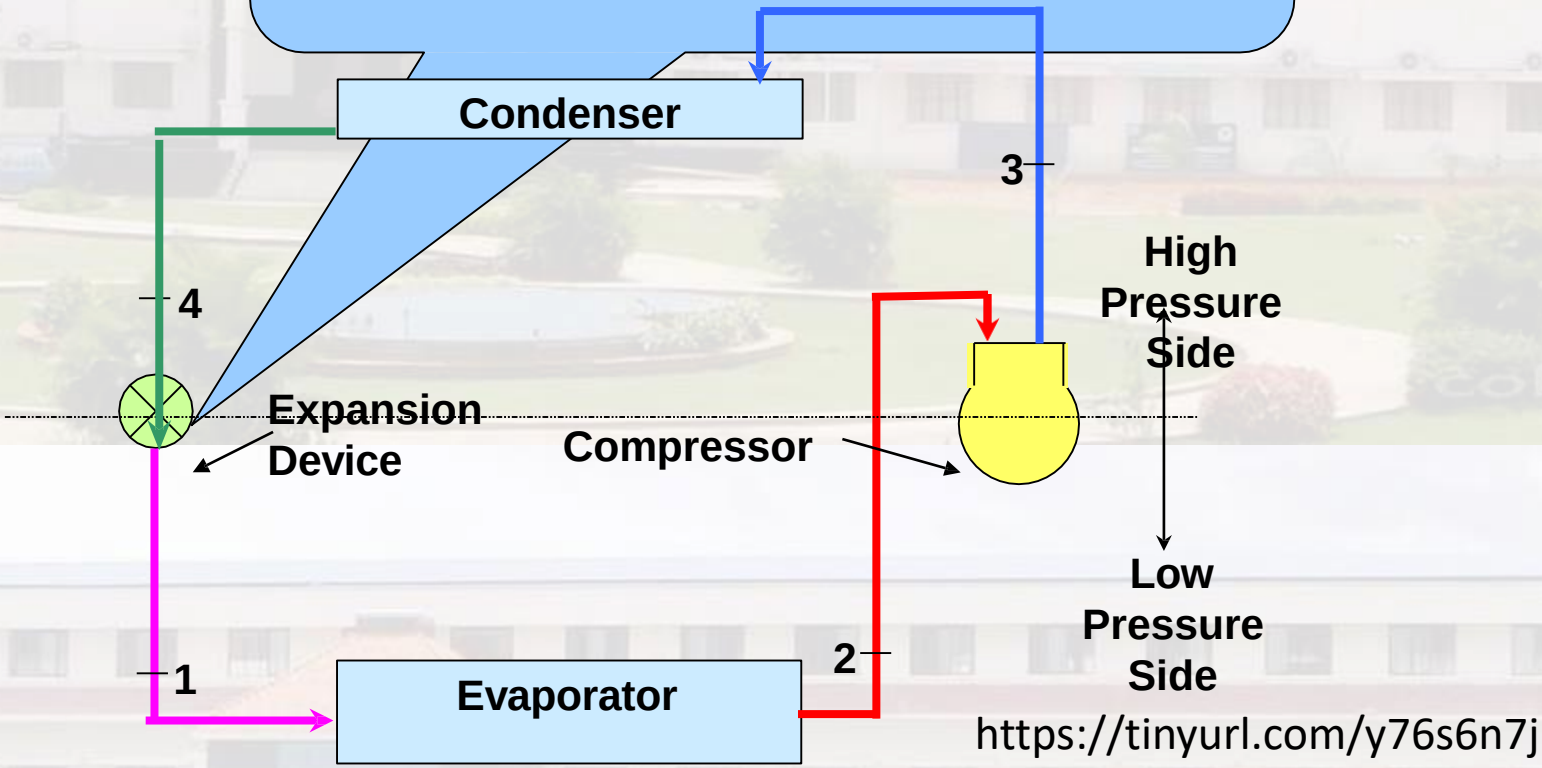


https://tinyurl.com/y76s6n7j

Vapour Compression System

Expansion Device

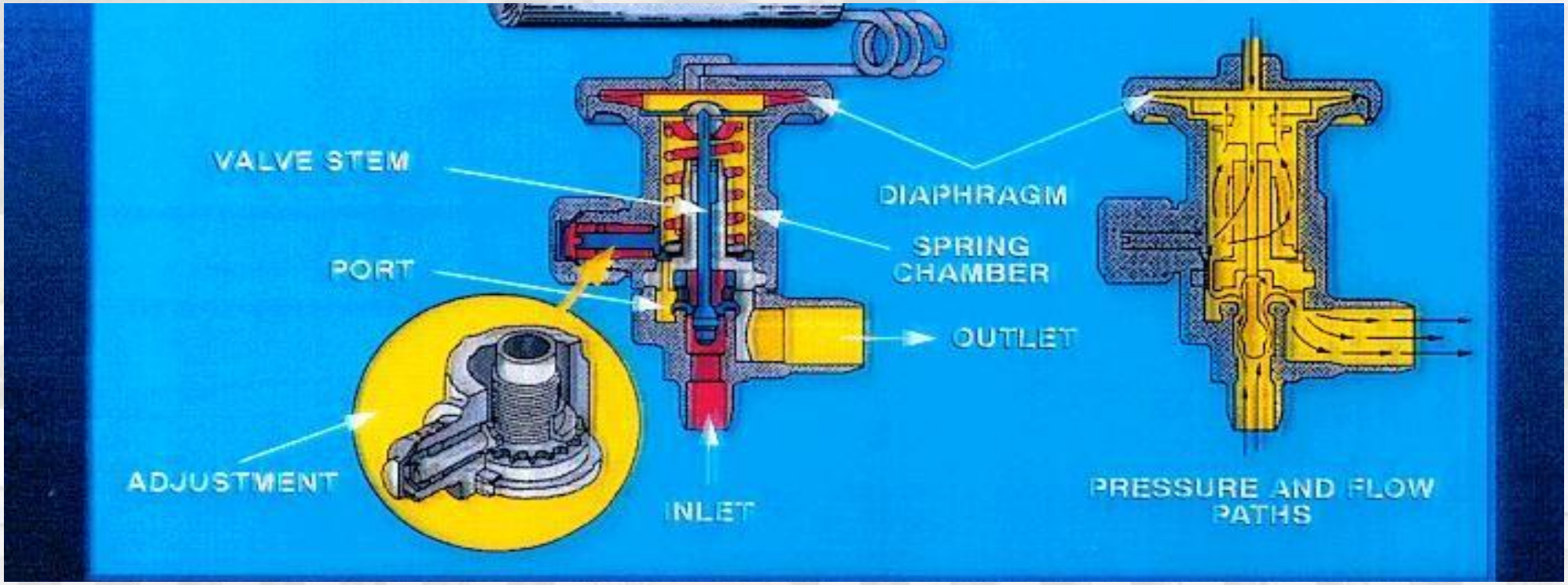
Liquid passes through expansion device, which reduces its pressure and controls the flow into the evaporator



https://tinyurl.com/y76s6n7j

Vapour Compression System

Thermal Expansion Valves

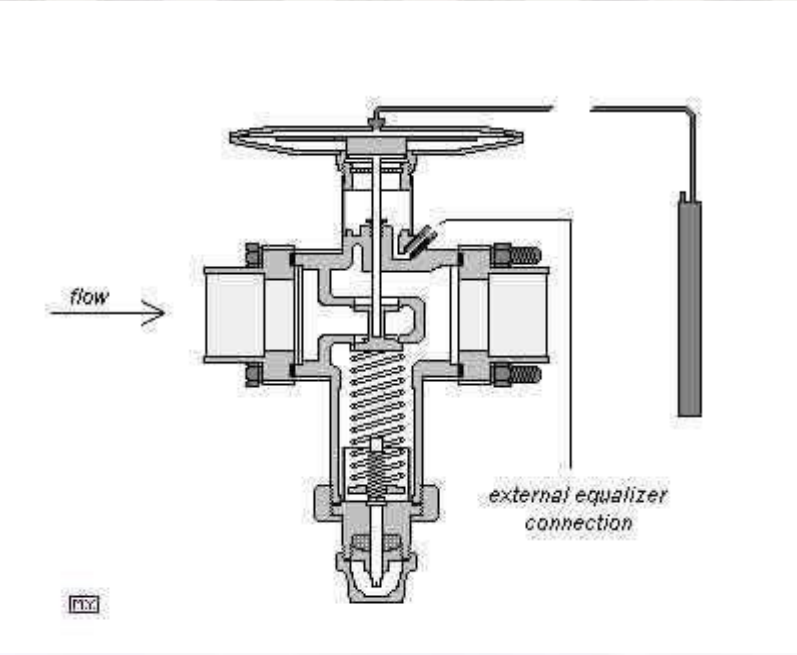


https://tinyurl.com/y76s6n7j

Vapour Compression System

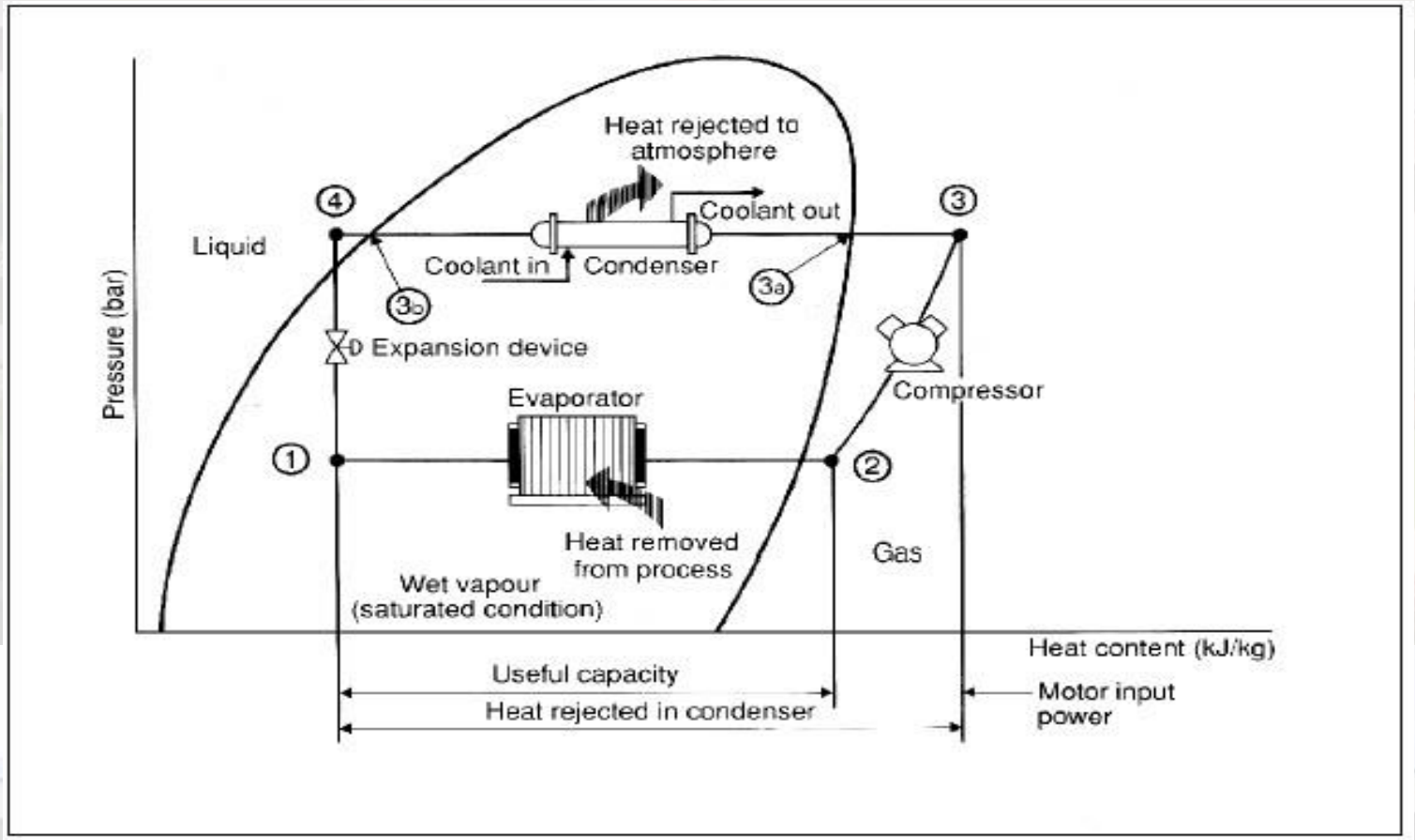
Thermal Expansion Valves

- The expansion valve acting as a regulating valve, limits the amount of refrigerant flowing through.
- Resulting in reduction of pressure of the liquid and expansion takes place.



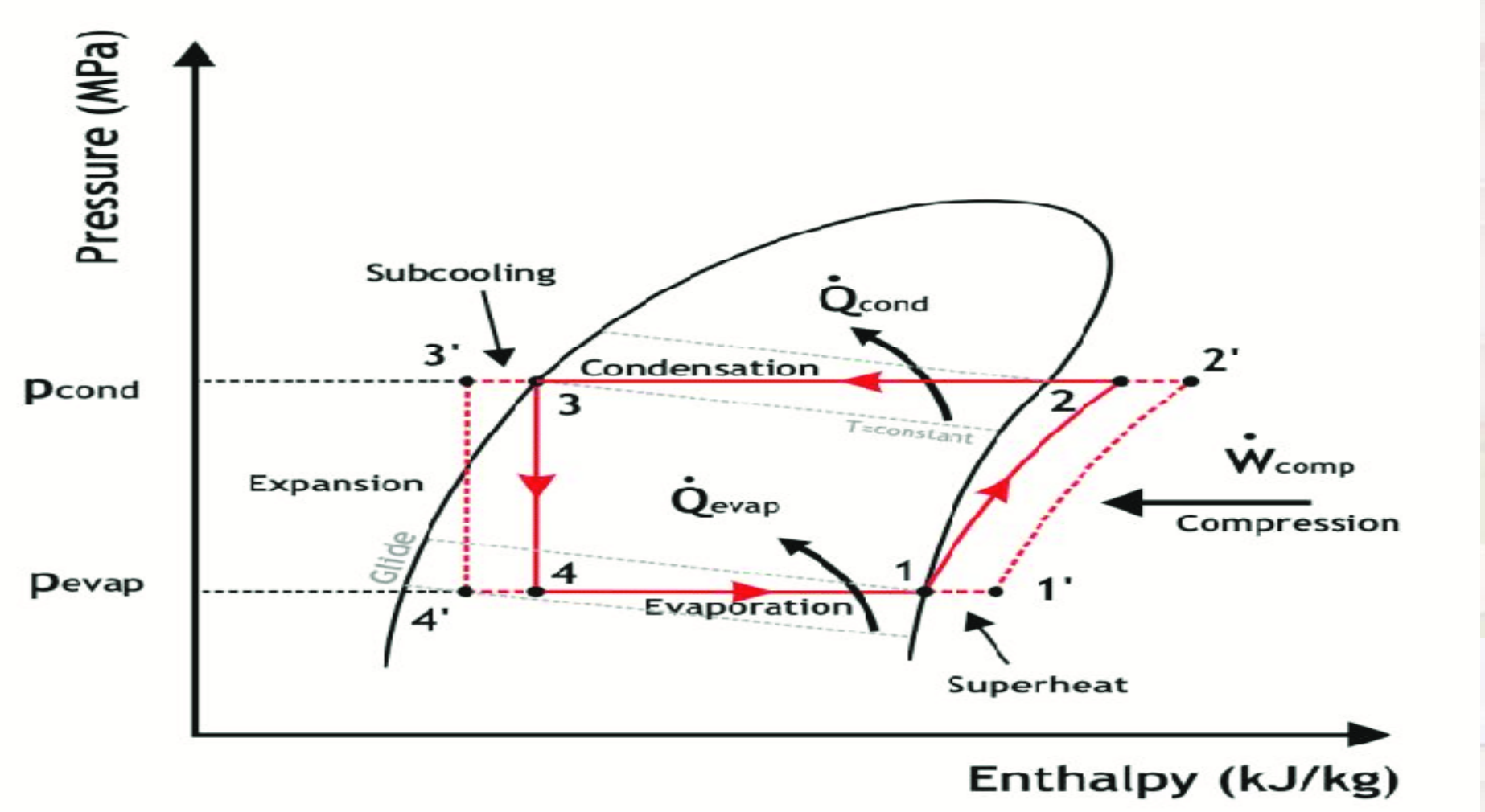
https://tinyurl.com/yb2h6pr8

Vapour Compression System



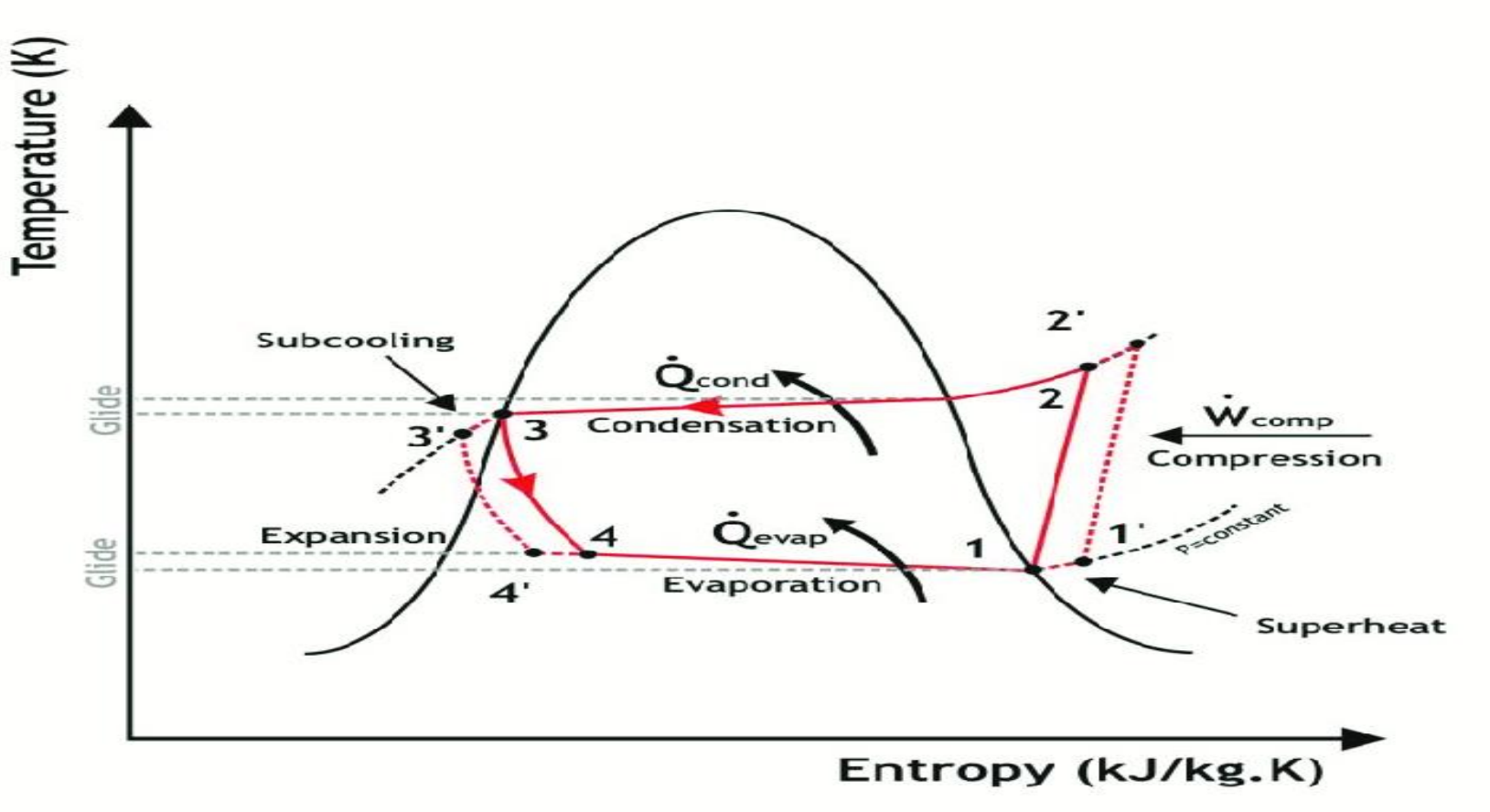
https://tinyurl.com/y76s6n7j

Vapour Compression System



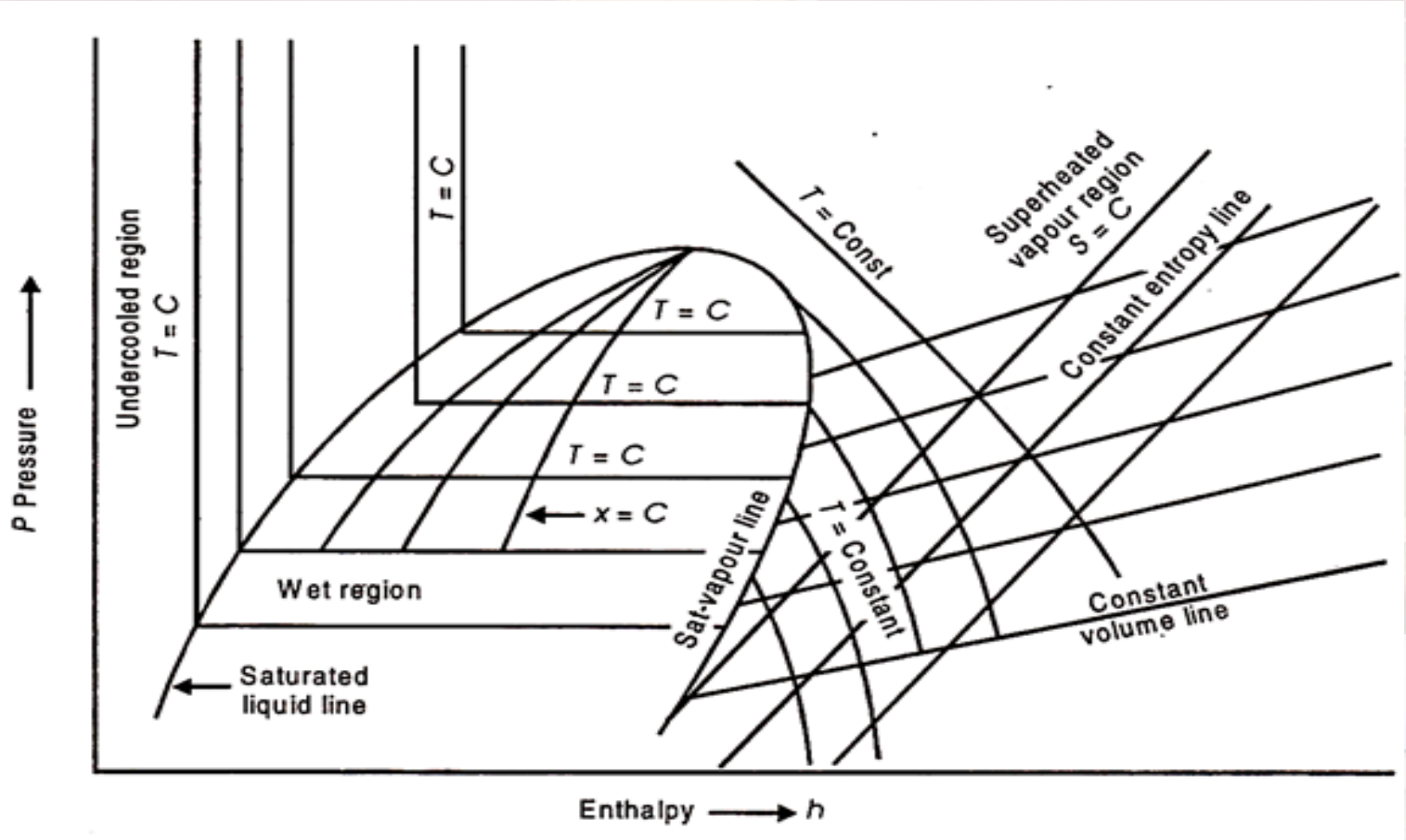
P-h diagram of the vapour-compression refrigeration cycle considered

Vapour Compression System



T-s diagram of the vapour-compression refrigeration cycle

Vapour Compression System



P-h diagram of the vapour-compression refrigeration cycle considered

Vapour Compression System

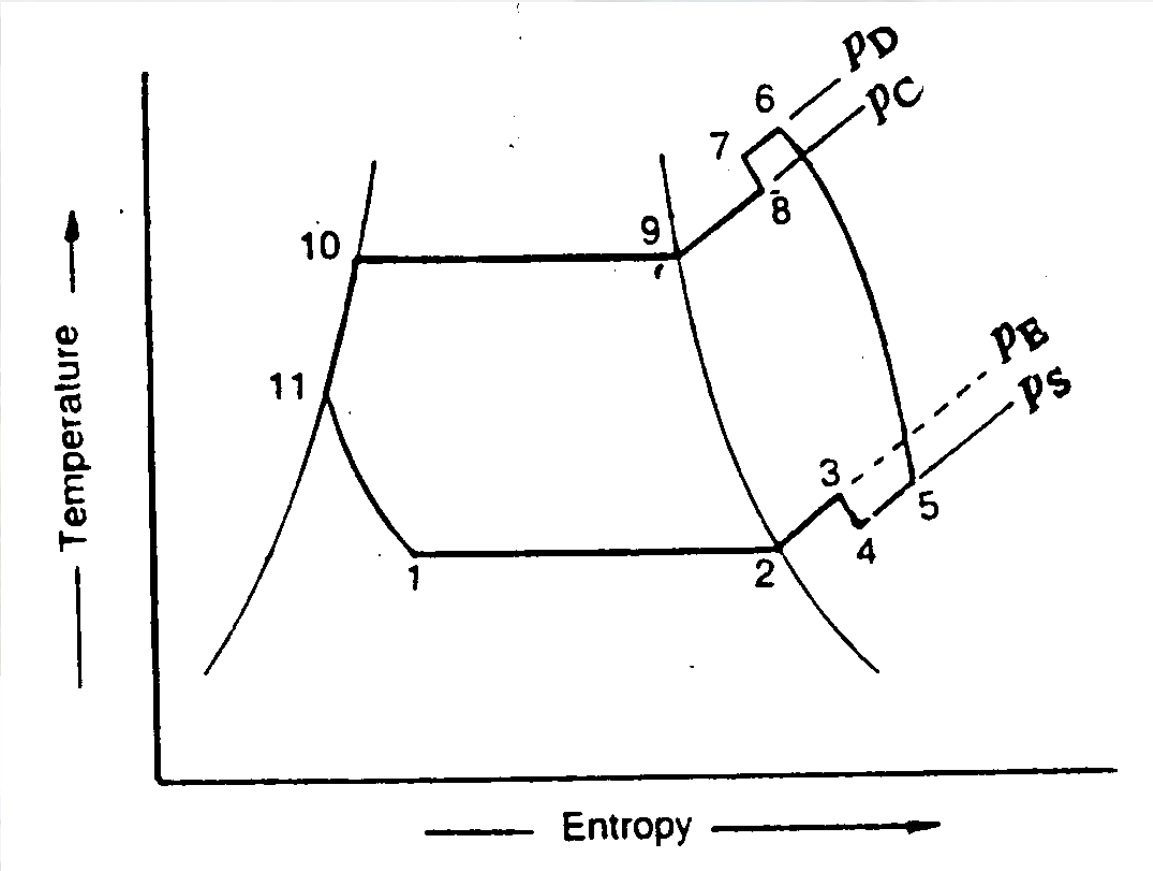
Deviations between the theoretical cycle and actual cycle

- The vapour refrigerant leaving the evaporator is in superheated state.
- The compression of refrigeration is neither isentropic nor polytropic.
- The liquid refrigerant before entering the expansion valve is sub-cooled in the condenser.
- The pressure drops in the evaporator and condenser.

P-h diagram of the vapour-compression refrigeration cycle considered

Vapour Compression System

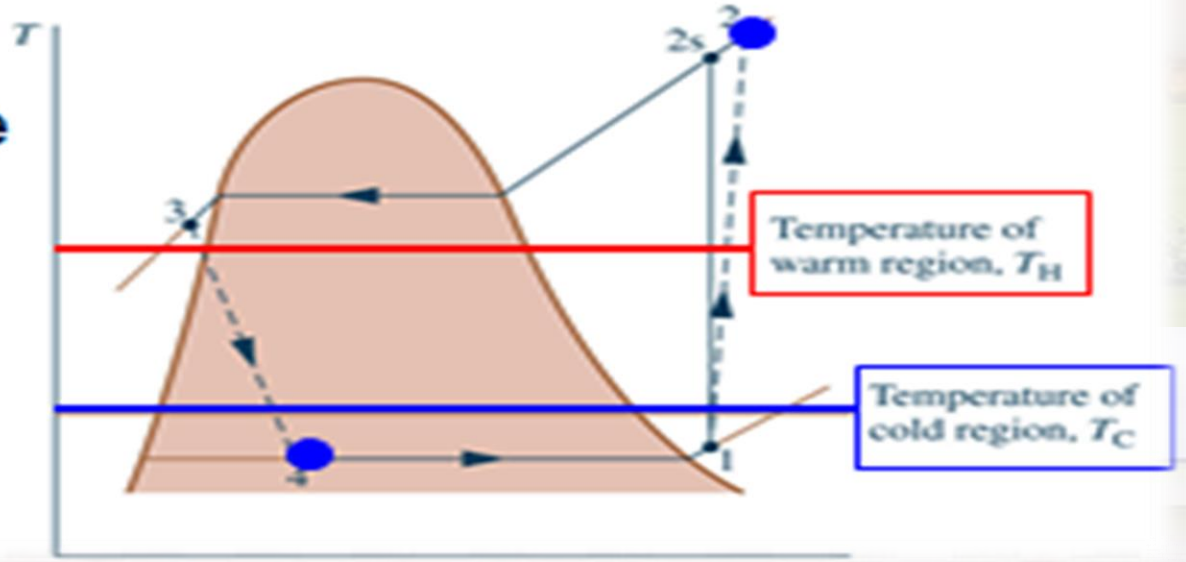
Deviations between the theoretical cycle and actual cycle



P-h diagram of the actual vapour compression cycle differs from the theoretical vapour compression cycle

Features of Actual Vapor-Compression Cycle

- Heat transfers between refrigerant and cold and warm regions are not reversible.
  - Refrigerant temperature in evaporator is less than T_C.
  - Refrigerant temperature in condenser is greater than T_H.
  - Irreversible heat transfers have negative effect on performance.



Vapour Compression System

Effect of Superheating

COP of Original Cycle :

$$COP = \frac{R_n}{W} = \frac{h_1 - h_4}{h_2 - h_1}$$

COP when Delivery Pr. increased :

$$COP = \frac{R_n}{W} = \frac{h_{1'} - h_4}{h_{2'} - h_{1'}}$$

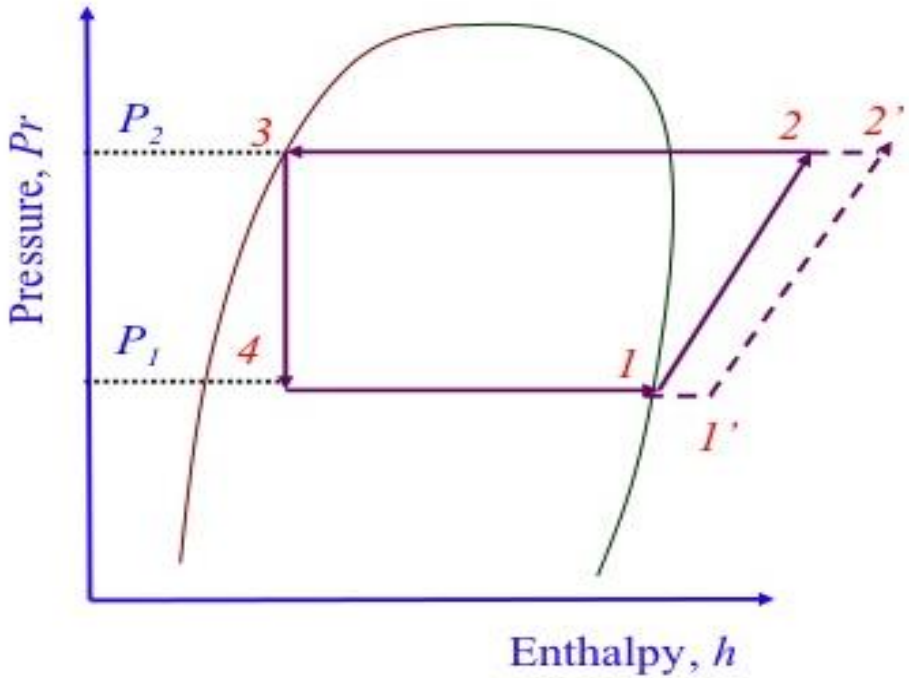
$$= \frac{(h_1 - h_4) + (h_{1'} - h_1)}{(h_2 - h_1) + (h_{2'} - h_2) + (h_{1'} - h_1)}$$

Thus,

Refrig. Effect ↑

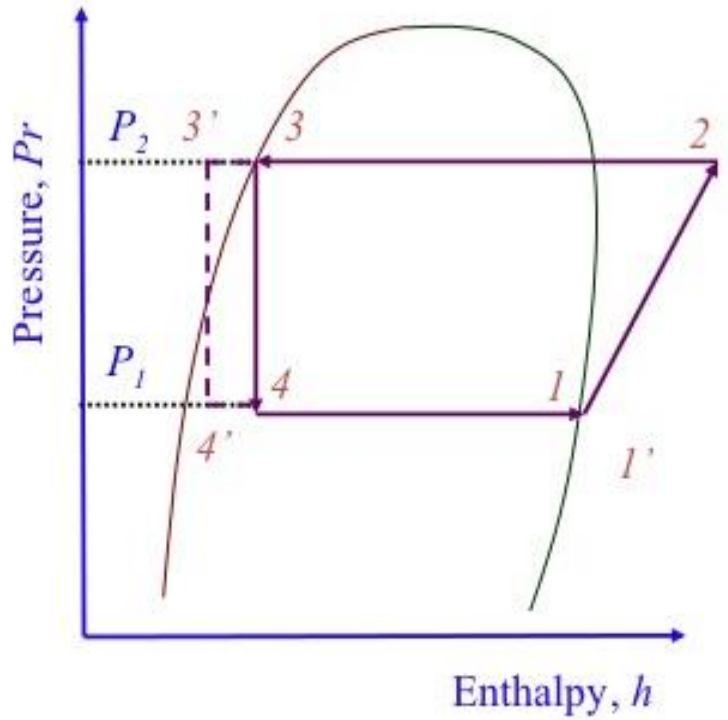
Work Input ↑ or ↓

$\Rightarrow$ COP ↓ or ↑



Vapour Compression System

Effect of Sub Cooling



COP of Original Cycle :

$$COP = \frac{R_n}{W} = \frac{h_1 - h_4}{h_2 - h_1}$$

COP when Delivery Pr. increased :

$$COP = \frac{R_n}{W} = \frac{h_1 - h_{4'}}{h_2 - h_1}$$

$$= \frac{(h_1 - h_4) + (h_4 - h_{4'})}{(h_2 - h_1)}$$

Thus,

Refrig. Effect ↑

Work Input : SAME

$\Rightarrow$ COP ↑

Vapour Compression System

1. The ideal refrigeration cycle is like

a. Carnot cycle
b. Reversed Carnot cycle
c. Rankine cycle
d. Reversed Rankine cycle

2. As the evaporator temperature lowers down, the required compression ratio

a. Becomes lower for a given condensation temperature
b. Becomes higher for a given condensation temperature
c. Becomes steady for a given condensation temperature
d. Cannot say


THANK-YOU