

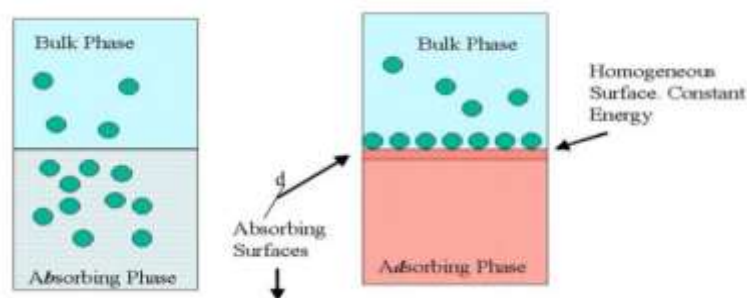


CHAPTER EIGHT

ADSORPTION REFRIGERATION SYSTEMS

1. Adsorption Refrigeration Cycle

- The use of solids for removing substances from either gaseous or liquid solutions has been widely used since biblical times.
- This process, known as adsorption, involves nothing more than the preferential partitioning of substances from the gaseous or liquid phase onto the surface of a solid substrate.
- From the early days of using bone char for decolorization of sugar solutions and other foods, to the later implementation of activated carbon for removing nerve gases from the battlefield, to today's thousands of applications, the adsorption phenomenon has become a useful tool for purification and separation.



- **Definition:** The process of adsorption involves separation of a substance from one phase accompanied by its accumulation or concentration at the surface of another. The adsorbing phase is the [adsorbent](#) (char or zeolites), and the material concentrated or adsorbed at the surface of that phase is the [adsorbate](#).

the adsorption materials is

- 1- Silica-gel
- 2- Zeolites
- 3- Activated Carbons

Where the working pairs fluid in adsorption refrigeration system is

- 1- zeolite-water
- 2- silica gel – water
- 3- active carbon – methanol
- 4- active carbon – ammonia
- 5- active carbon – R134a



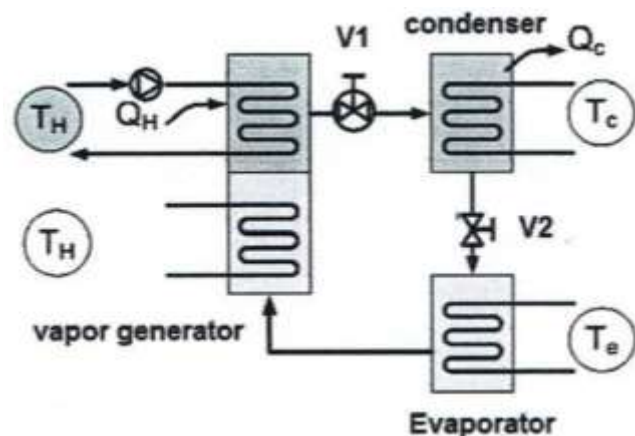
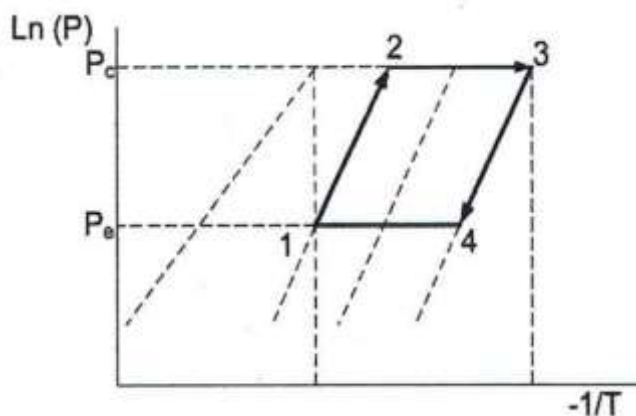
- It is easier to reversed by heat
- Do not used any mechanical energy only heat energy
- Used water or methanol as a refrigerant
- There are many types of adsorbent materials such as activated carbon (char)or ziolites
- Consist of condenser, evaporator, one or several adsorber
- Show no problems with corrosion and crystallization

2. The Components of Adsorption Refrigeration Cycle

An adsorption cycle for refrigeration does not use any mechanical energy, but only heat energy. Moreover, this type of cycle basically is a four temperature discontinuous cycle. An adsorption unit consists of:

1. Condenser connected to heat sources.
2. Evaporator, connected to heat sources.
3. one or several adsorbers

3. The cycle consist of four periods:





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- 1- Close the valve (v1) and then heating the vapor generation by heating source (TH) due to increase the pressure from evaporator pressure to condenser pressure as show in process (1-2) this called (heating and pressurization)
 - 2- Open the valve (v1) due to flow the refrigerant to condenser and rejected the heat to the atmosphere as show in process (2-3) this called (desorption and condensation)
 - 3- Close the valve (v1) and then cooling the vapor generation by cooling source (TL) due to decrease the pressure of vapor generator from condenser pressure to evaporator pressure, and at the same time open the valve (v2) due to flow the refrigerant through the expansion device and lead to decrease the pressure of refrigerants as show in process (3-4) this called (cooling and depressurization)
 - 4- The refrigerant entering to the evaporator at low pressure and temperature and absorb the heat from surrounding and the refrigerant become vapor as show in process (4-1) this called (adsorption and evaporation)



ADSORPTION SYSTEM	ABSORPTION SYSTEM
1. It involves separation of a substance from one phase accompanied by its accumulation or concentration at the surface of another	1. It is the passage of one substance into or through the bulk of another medium
2. It is easier to reversed by heat	2. It is harder to reversed
3. Do not used any mechanical energy only heat energy	3. Used small amount of mechanical energy
4. Used water or methanol as a refrigerant	4. Used water or Ammonia
5. There are many types of adsorbent materials such as activated carbon or zeolites	5. Used Br Li or H ₂ O
6. Consist of condenser, evaporator, one or several adsorber	6. Consist of condenser, evaporator, absorber, and generator
7. Show no problems with corrosion and crystallization	7. There is a problems with corrosion and crystallization

Adsorption cycle	Absorption cycle	Vapor compression cycle
1- (Adsorbent and desorbed) vapor generation act as compressor	1- Absorber and vapor generation act as compressor	1-Compressor pressurized the refrigerant from evaporator pressure to condenser pressure
2- operated at temperature of 50°C	2- operated at temperature of 50°C	2- temperature depended on the compressor type and refrigerant
3- no danger of crystallization	3- danger of crystallization	3- no danger of crystallization
4- Low COP	4- COP higher than adsorption but below than vapor compression	4- High COP
5- Intermittence operation	5- Continue operation	5- Continue operation



Advantages

- 1- No risk of crystallization, no danger of damage due to temperature.
- 2- Low electricity consumption.
- 3- Little moving parts. Low maintenance cost.
- 4- Low production cost.
- 5- Friendly environmental
- 6- Operating at many heating of source such as solar energy
- 7- Quite operation

Disadvantages

- 1- High requirements to the vacuum in the condenser.
- 2- Lower COP comparable to the absorption system.
- 3- Required careful design of the external hydraulic system.
- 4- Intermittence operation.
- 5- Small refrigeration capacity