VAPOUR ABSORPTION REFRIGERATION SYSTEM

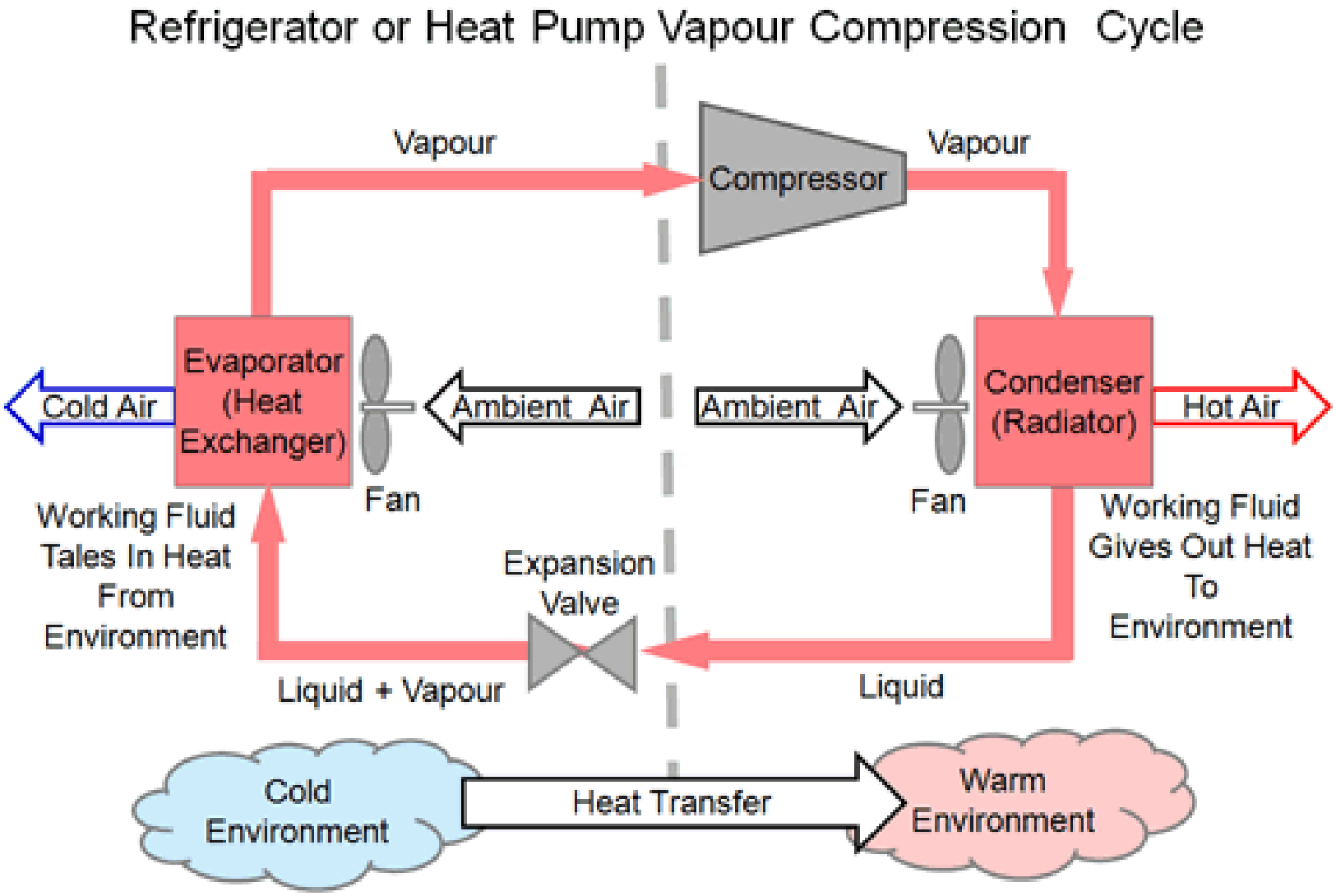
Introduction

- The first vapour absorption refrigeration machine was developed by a French scientist Ferdinand Carre in 1860.
- This system may be used in both the domestic and large industrial refrigerating plants.
- The refrigerant, commonly used in a vapour absorption system, is **ammonia.**
- The vapour absorption system uses heat energy, instead of mechanical energy as in vapour compression system, in order to change the conditions of the refrigerant required for the operation of the refrigeration cycle.
- Both the mechanical vapor compression refrigeration cycle and the absorption refrigeration cycle accomplish the removal of heat through the evaporation of a refrigerant at a low pressure and the rejection of heat through the condensation of the refrigerant at a higher pressure.

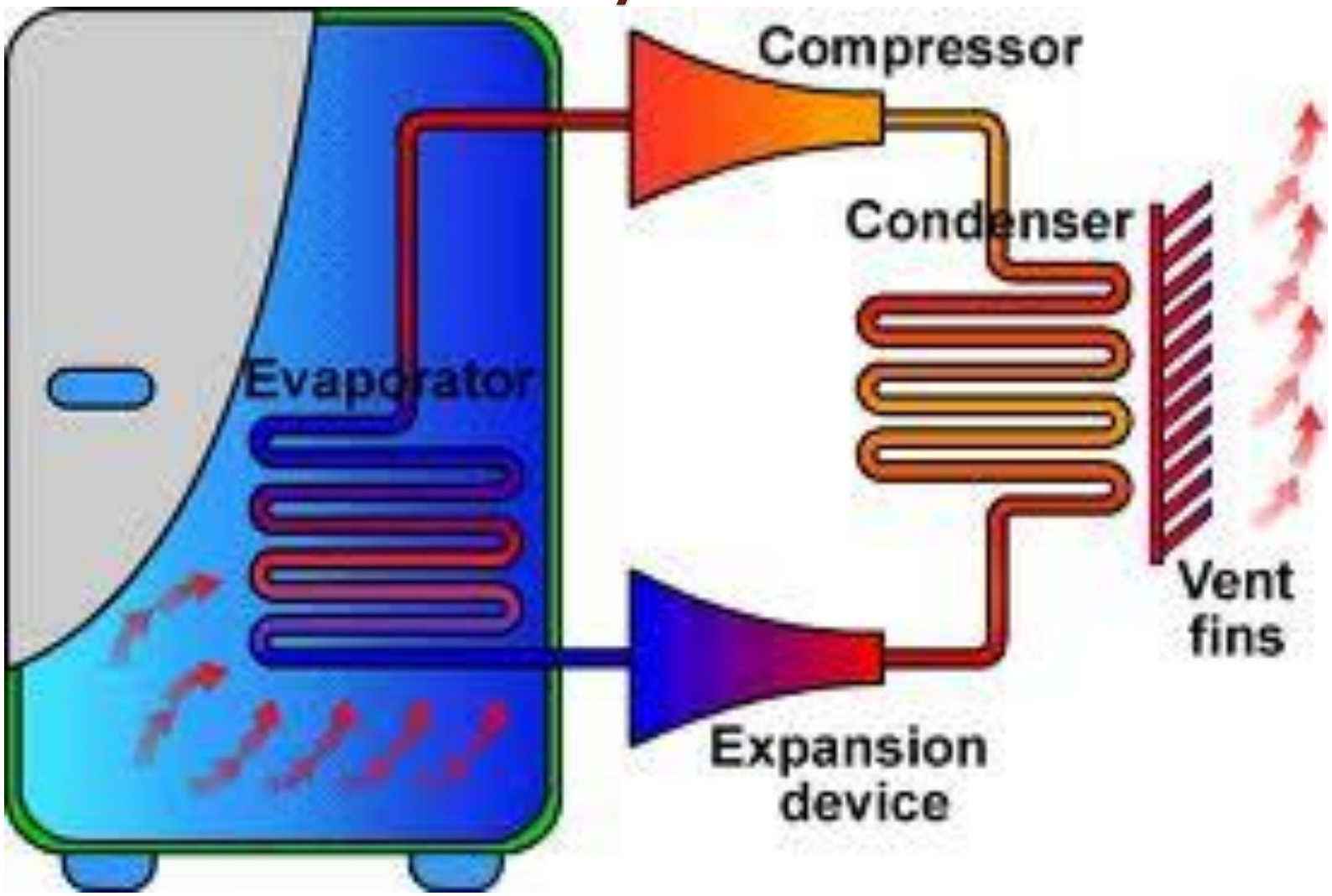
Principle of absorption system

- In the vapour absorption system, the compressor is replaced by an absorber, a pump, a generator and a pressure reducing valve.
- These components in vapour absorption system perform the same function as that of a compressor in vapour compression system.
- The method of creating the pressure difference and circulating the refrigerant is the primary difference between the two cycles.
- The mechanical vapour compression cycle employs a mechanical compressor to create the pressure difference necessary to circulate the refrigerant.
- In the absorption system, another liquid, which is called absorbent, is used to circulate the refrigerant.

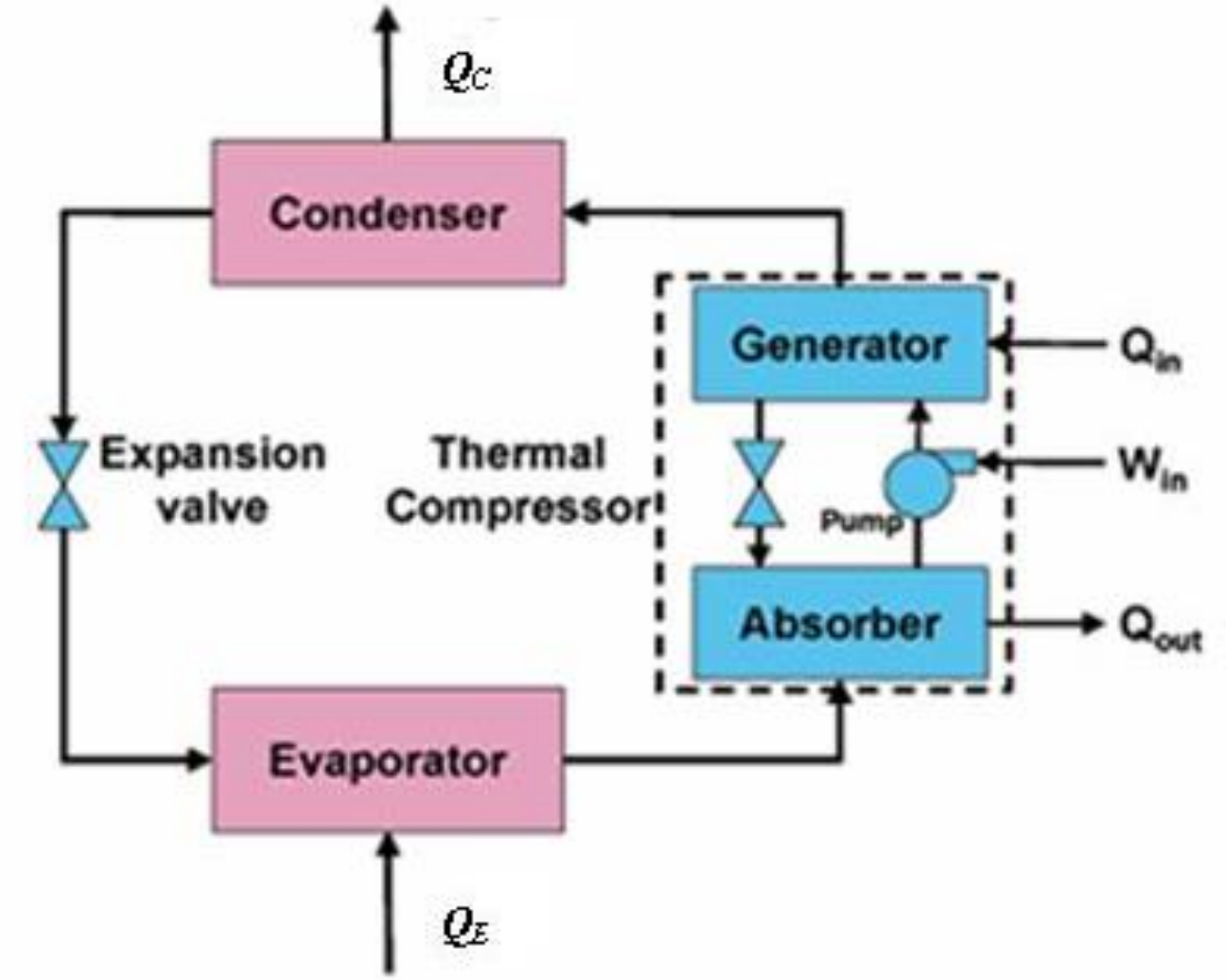
Vapour compression refrigeration system



Vapour compression refrigeration system



Vapour absorption refrigeration system

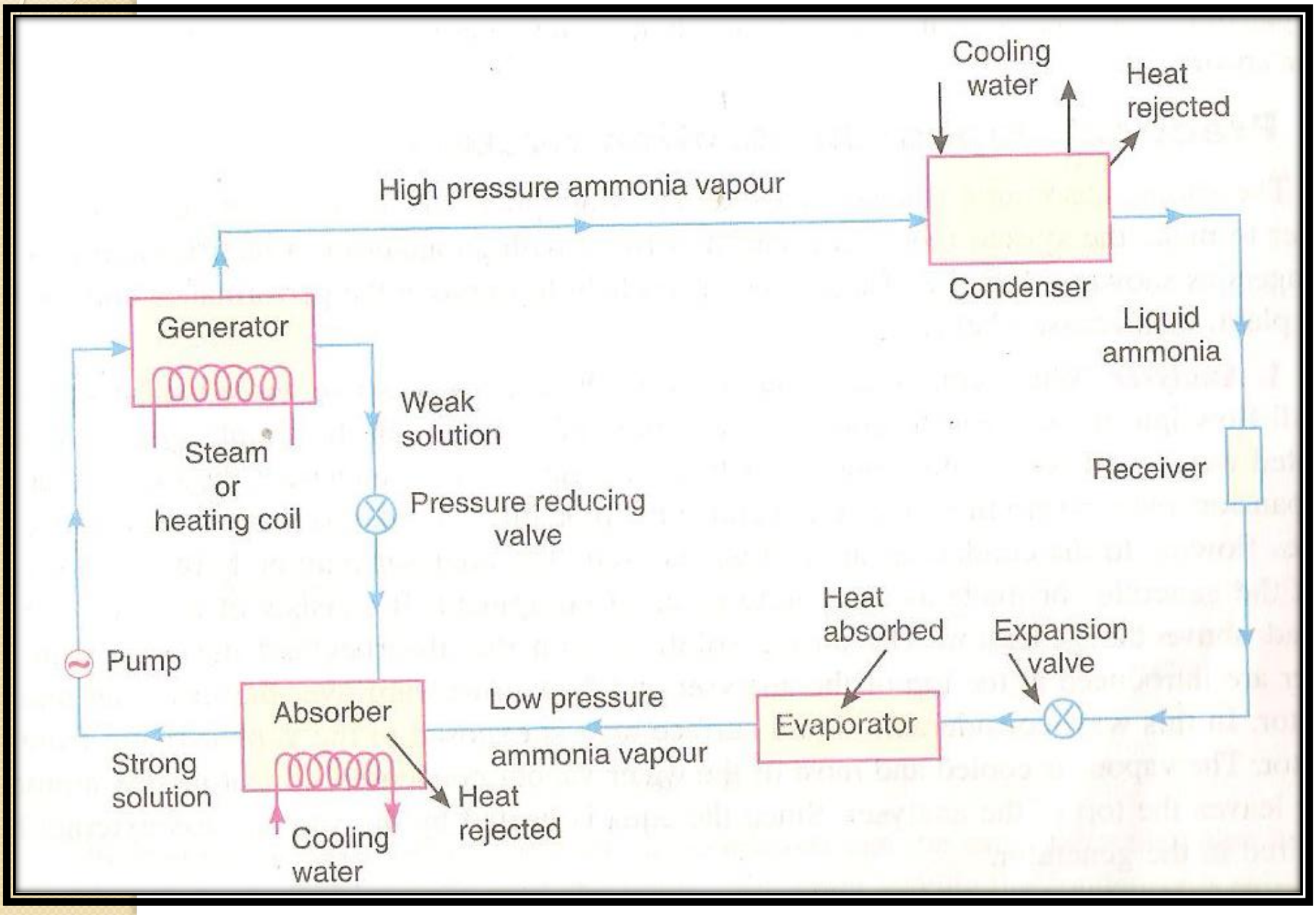


Mechanical compressor, however, is replaced by a thermal compressor which consists of absorber, solution pump, generator (or boiler) and liquid valve.

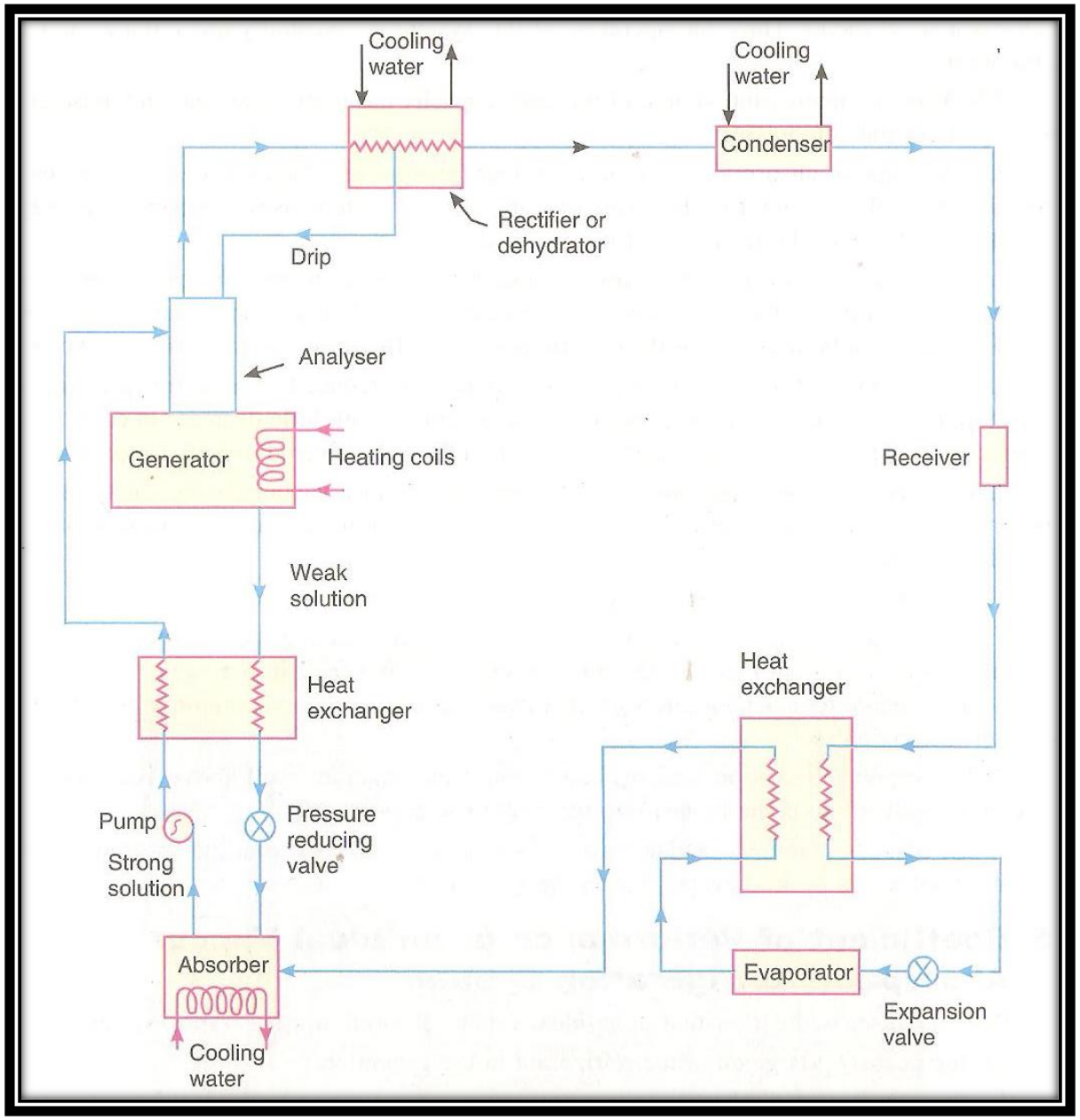
Vapour absorption refrigeration system

- In an ammonia-water absorption system, ammonia is used as the refrigerant and water as the absorbent.
- In lithium bromide-water absorption refrigeration systems, water is the refrigerant and lithium bromide is the absorbent.
- This explains that the lithium bromide absorption system is strictly limited to evaporation temperatures above 0ºC; and the ammonia absorption system is mainly used for low temperatures below 0ºC.

Simple vapour absorption system



Practical vapour absorption system



COP of vapour absorption refrigeration system

- In vapour absorption refrigeration system, the net refrigerating effect is the heat absorbed by the refrigerant in the evaporator. The total energy supplied to the system is the sum of the work done by the pump and the heat supplied in the generator.
- Therefore, the coefficient of performance of the system is given by

$$COP = \frac{Heat\ absorbed\ in\ evaporator}{Work\ done\ by\ pump + Heat\ supplied\ in\ generator}$$

Difference between vapour compression and vapour absorption

S.no	Aspect	Vapor Absorption System	Vapor Compression System
1	Energy Input	Vapor absorption system takes in low grade energy such as waste heat from furnace, exhaust team or solar heat for its operations.	Vapor compression system takes in high grade such as electrical or mechanical energy for its operation of compressor used in the cycle.
2	Moving part	It uses a small pump as moving part, which is run by a small motor.	It uses a compressor driven by an electric motor or engine.
3	Evaporator pressure	It can operate with reduced evaporator pressure, with little decrease in refrigerant capacity.	The refrigerant capacity decreases with lowered evaporator pressure.
4	Load variation	The performance of vapor absorption system does not change with load variation	The performance of vapor compressing system is very poor at partial load.
5	Evaporator exit	In vapor absorption system, the liquid refrigerantleaving the evaporator does not put any bad effect on the system except to reduce the refrigerant effect.	In a vapor compression system, it is desirable to superheat vapor before leaving the evaporator, so no liquid can enter the compressor.
6	Lowest temperature	Since water is used as refrigerant, thus the lowest temperature attained is above 0°C.	With cascading, the temperature can be lowered upto -150°C or even less temperature.
7	Coefficient of Performance	The COP of the system is poor.	The COP of the system is excellent.
8	Capacity	It can built in capacities well above 1000 TR.	For a single compression system, it is not possible to have a system with more than 1000 TR capacity.
9	Refrigerant	Water or ammonia is used as refrigerant.	Chloroflourocarbon, hydroflorocarbon and hydrochlorofluorocarbon are used in most of the systems.

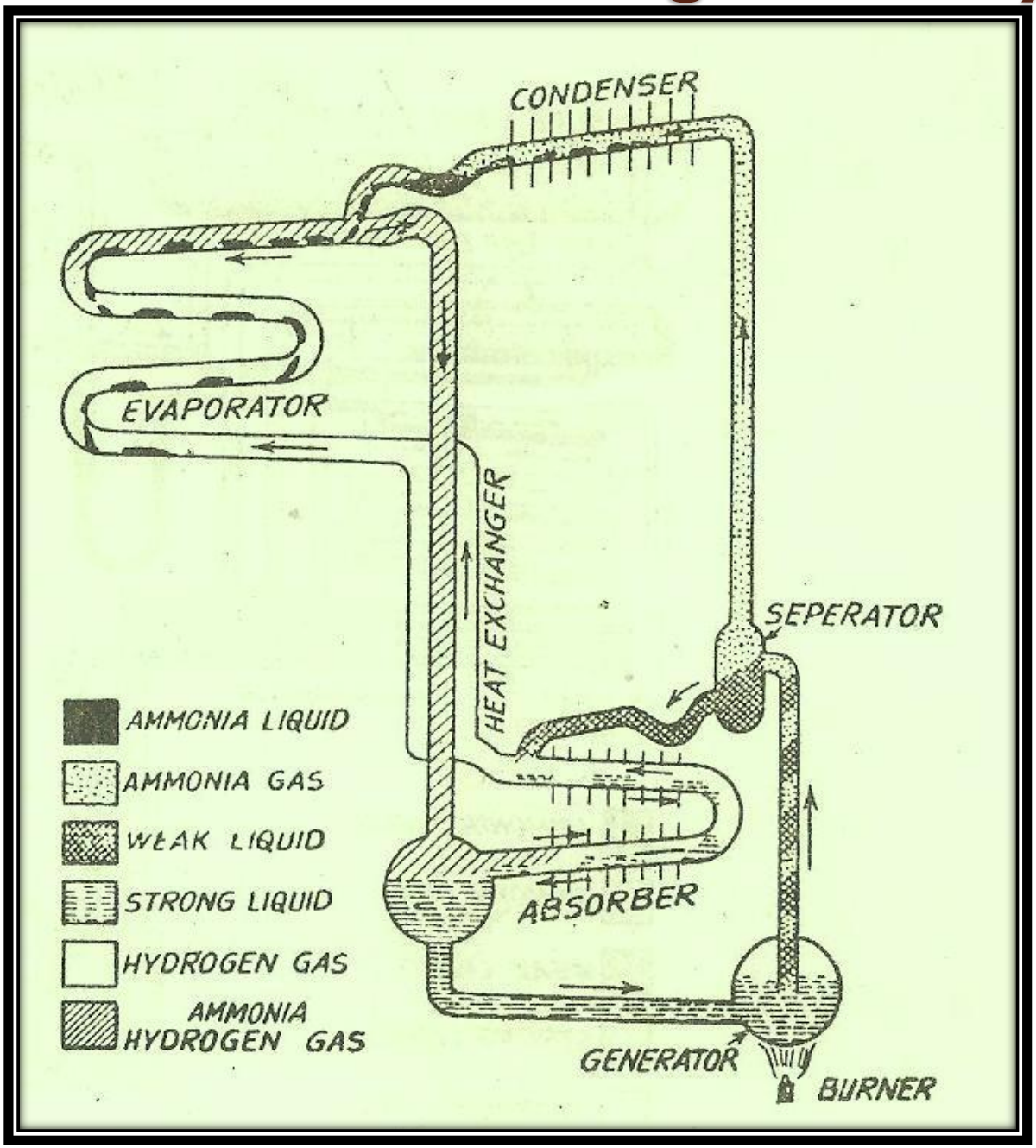
Domestic Electrolux Refrigeration System

- The domestic absorption type refrigerator was developed from an invention by Carl Munters and Baltzer Von Platen.
- This system is often called Munters Platen system.
- This type of refrigerator is also called "Three-fluids absorption system".
- The three fluids used in this system are **ammonia, hydrogen and water.**
  - The "ammonia" is used as a refrigerant because it possesses most of the desirable properties. Though it is toxic, and not otherwise preferred in domestic appliances, it is very safe in this system due to absence of any moving parts in the system and , therefore, there is the least chance of any leakage.
  - The "hydrogen" being the lightest gas, is used to increase the rate of evaporation (the lighter the gas, faster is the evaporation) of the liquid ammonia passing through the evaporator. The hydrogen is also non-corrosive and insoluble in water. This is used in the low-pressure side of the system.
  - The "water" is used as a solvent because it has the ability to absorb ammonia readily

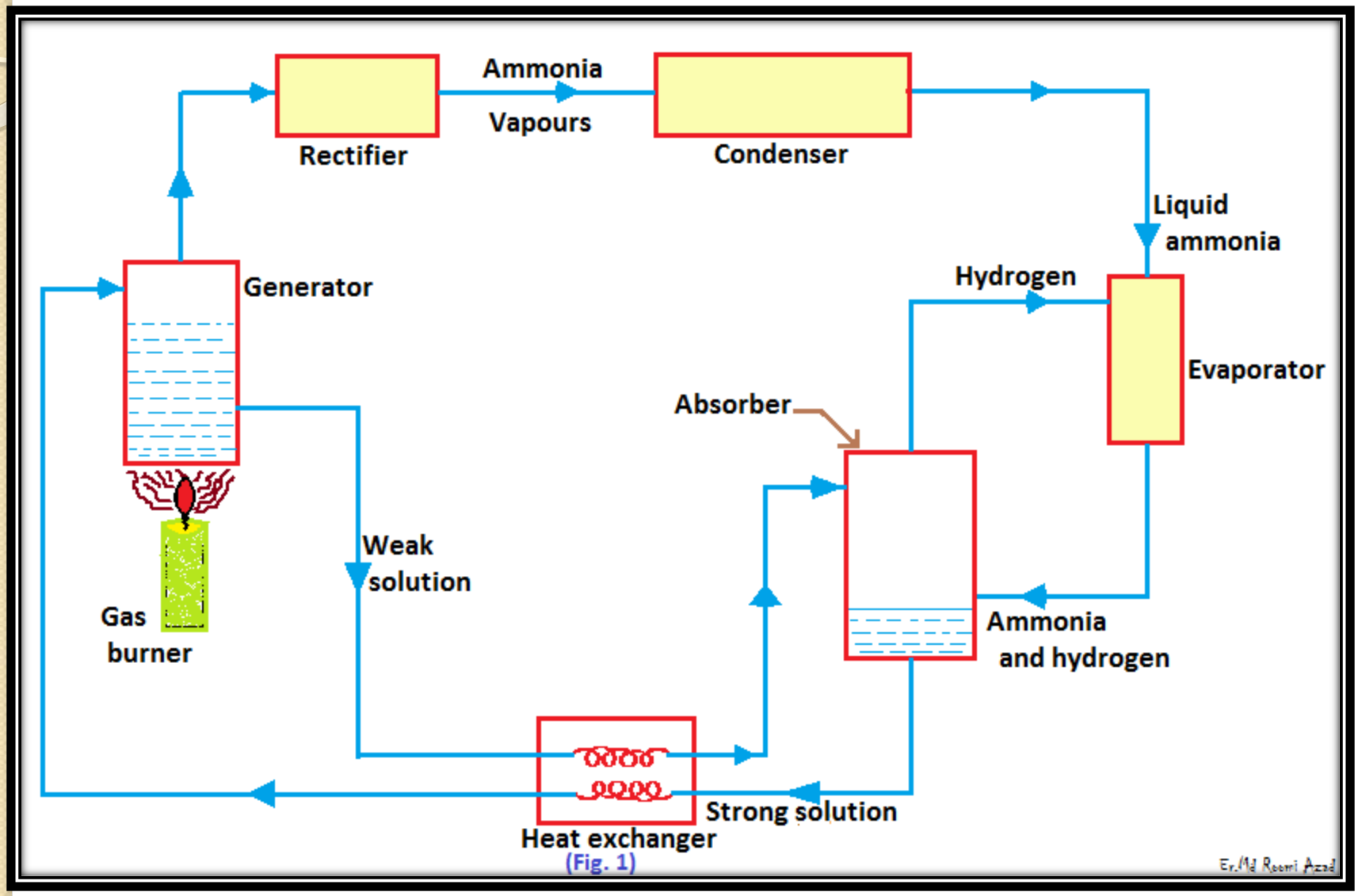
Domestic Electrolux Refrigeration System

- The operation of this system is based on the concept of Dalton's Law.
- The total pressure in the condenser is approximately the same as in the evaporator.
- The ammonia in the condenser is condensed to liquid and flows to evaporator by gravity.
- The whole plant is charged to a pressure of about 15 bar.
- In the evaporator the liquid ammonia meets an atmosphere of hydrogen at about 12 bar.
- Thus the partial pressure of ammonia falls to about 3 bar, keeping the same total pressure, and the temperature falls to about -10°C.
- In order to prevent hydrogen passing from evaporator to the condenser, a U bent is provided between the condenser and the evaporator to serve as ammonia liquid seal.

Domestic Electrolux Refrigeration System



Domestic electrolux refrigeration system



Advantages

- No pump or compressor is required.
- No mechanical troubles, maintenance cost is low.
- No lubrication problem; no wear and tear.
- Completely leak proof.
- Noiseless.
- No chance of pressure unbalancing and no need of valves.

Disadvantages

- More complicated in construction and working.
- C.O.P. very low.
- The major disadvantages of this type of refrigerator are that if it is spoiled once, it cannot be repaired and has to be replaced fully.