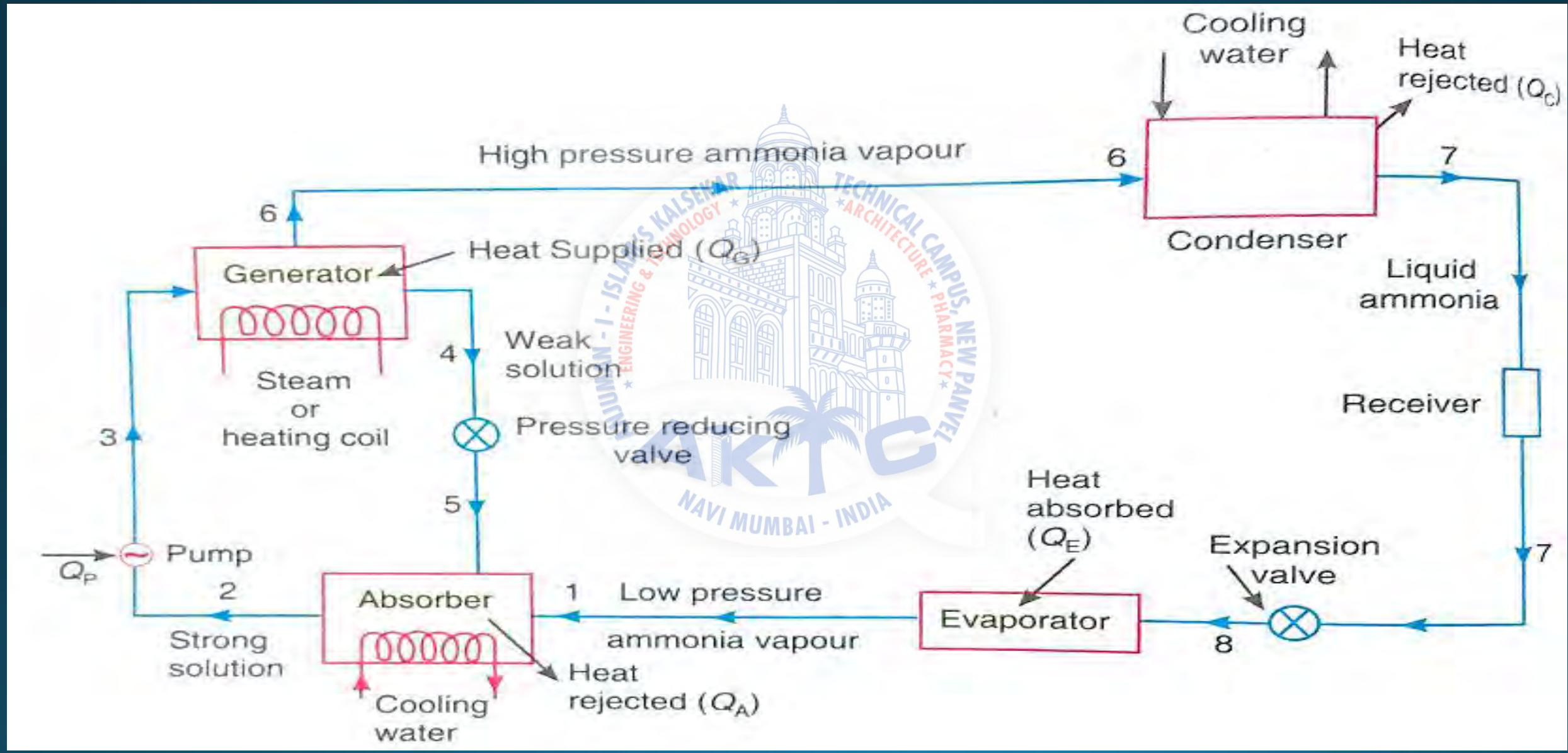
Vapour Absorption Refrigeration System

Simple Vapour Absorption Refrigeration System

- 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 refrigeration 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.
- In vapour absorption system the compressor is replaced by an absorber, pump, generator and a pressure reducing valve.
- These component in vapour absorption system perform the same function as that of a compressor in vapour compression system.

Simple Vapour Absorption Refrigeration System



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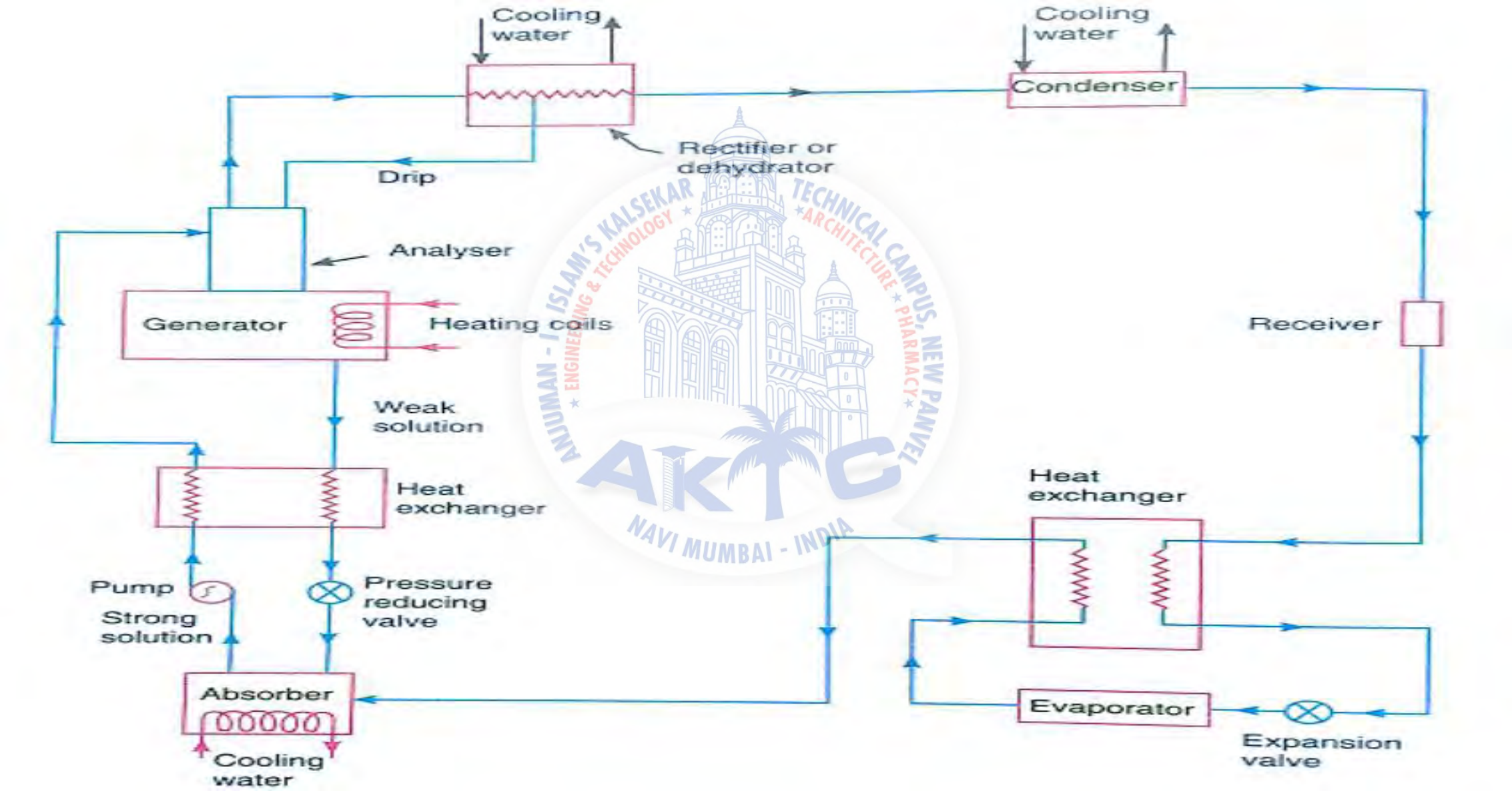
- The other component of the system are condenser, receiver, expansion valve and evaporator.
- In this system the low pressure ammonia vapour refrigerant from the evaporator is drawn into an absorber where it is absorbed by the cold water in the absorber forming solution known as aqua-ammonia (strong solution). The absorption of ammonia vapour in water lowers the pressure of the absorber which in turn draws more ammonia vapour from evaporator and thus raises the temperature of solution.
- Cooling arrangement usually water cooling is employed in the absorber to remove the heat of solution evolved. This is necessary in order to increase the absorption capacity of water because at higher temperature water absorbs less ammonia vapour.
- This strong solution is pumped to generator where it is heated by some external source. The pump increases the pressure of the solution up to 10 bar.

Simple Vapour Absorption Refrigeration System

- The strong solution of ammonia in the generator is heated by some external source such as gas or steam.
- During the heating process the vapour refrigerant is take off from the solution at high pressure leaving behind the hot weak ammonia solution in the generator.
- This weak ammonia solution flows back to the absorber at low pressure after passing through the pressure reducing valve.
- The high pressure ammonia vapour from the generator is condensed in the condenser to a high pressure liquid ammonia.
- This liquid ammonia is passed to the expansion valve through the receiver and then to the evaporator thus cycle is completed.

Practical Vapour Absorption Refrigeration System



Practical Vapour Absorption Refrigeration System

- In practical vapour absorption system accessories such as analyser, rectifier and two heat exchanger are used.
- When ammonia is vaporised in generator some water is also vaporised and will flow into the condenser along with the ammonia vapours in simple system.
- If these unwanted water particles are not removed before entering into the condenser they will enter into the expansion valve where they freeze and choke the pipeline.
- The analyser may be built as an integral part of the generator or made as a separate piece of equipment.
- The analyser consist of a series of trays mounted above generator. The strong solution from the absorber and aqua from the rectifier are introduced at the top of the analyser and flow downward over the trays and into the generator.

Practical Vapour Absorption Refrigeration System

- In this way considerable liquid surface area is exposed to the vapour rising from the generator.
- The vapour are cooled and most of the water vapour condenses. Mainly ammonia vapour (approximately 99%) leaves the top of the analyser. Since the aqua is heated by vapour less external heat is require in the generator.
- In case the water vapour are not completely removed in analyser a closed type vapour cooler called rectifier also known as dehydrator is used. It is generally water cooled.
- Its function is to cool further the ammonia vapour leaving the analyser so that the remaining water vapour are condensed. Thus only dry ammonia vapour flow through the condenser.
- The condensate from the rectifier is return to top of the analyser by a drip return pipe.

Practical Vapour Absorption Refrigeration System

- The heat exchanger provided between the pump and the generator is used to cool the weak hot solution returning from the generator to the absorber.
- The heat removed from the weak solution raises the temperature of the strong solution raises the temperature of the strong solution leaving the pump and going to analyser and generator.
- This operation reduces the heat supplied to the generator and the amount of cooling for the absorber. Thus the economy of the plant increases.
- The heat exchanger provided between the condenser and the evaporator is called liquid sub-cooler.
- In this heat exchange, the liquid refrigerant leaving the condenser is sub-cooled by the low temperature ammonia vapour from the evaporator.
- This sub-cooled liquid is now passed to the expansion valve and then to the evaporator.

Practical Vapour Absorption Refrigeration System

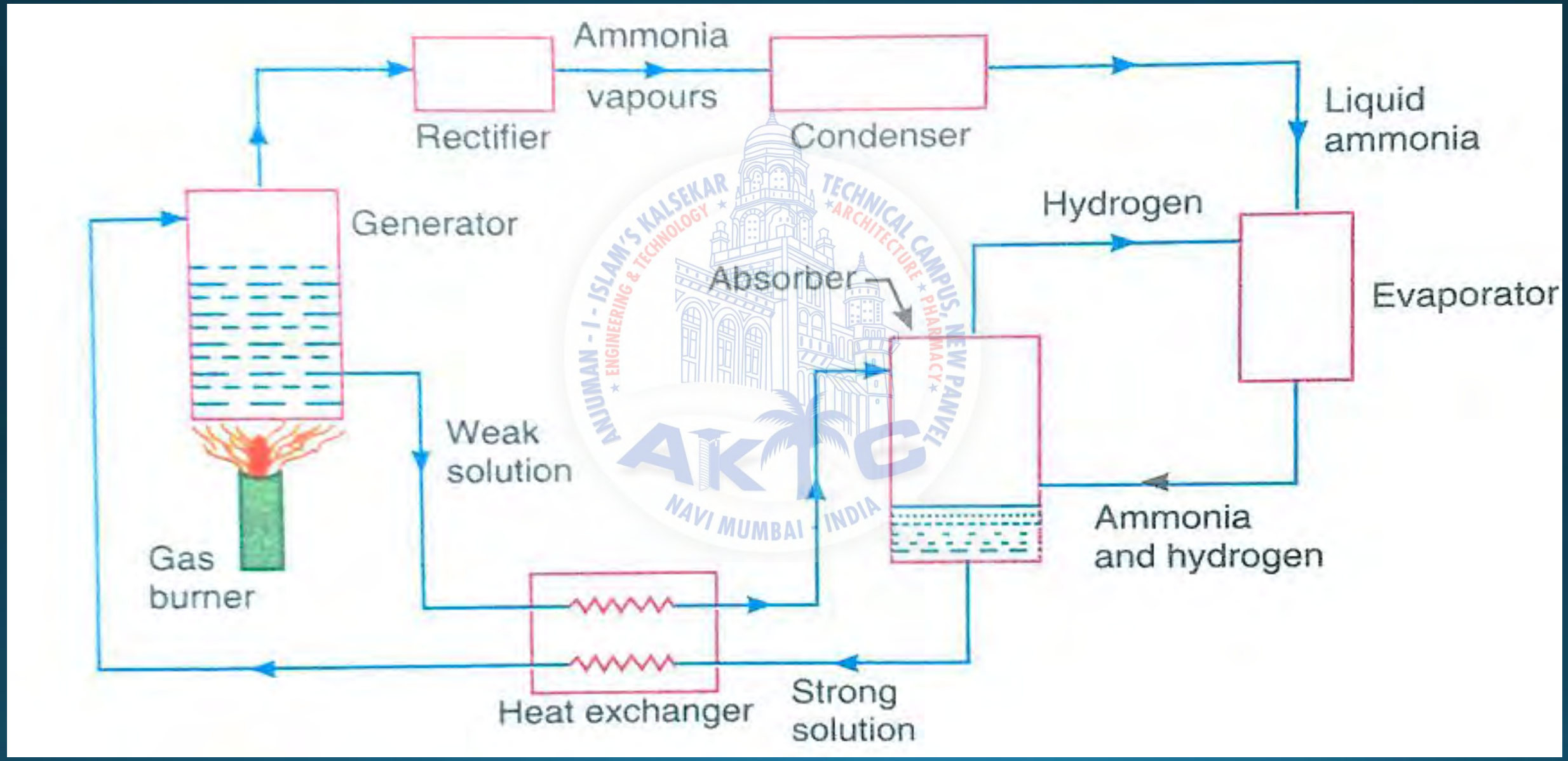
- The net refrigerating effect is the heat absorbed by the refrigerant in the evaporator.
- Total energy supplied to the system is the sum of work done by the pump and the heat supplied in the generator. Therefore the coefficient of performance of the system is given by

$$C.O.P = \frac{Heat\ absorbed\ in\ evaporator}{Work\ done\ by\ pump + Heat\ supplied\ in\ generator}$$

Domestic Electrolux (ammonia Hydrogen)Refrigerator

- The domestic absorption type refrigerator was invented by Swedish engineers Carl Munters and Baltzer Von Platan in 1925 while they were studying for their undergraduate course of Royal Institute of technology in Stockholm.
- The idea was first develop by the Electrolux company of Luton England.
- This type of refrigerator are also known as three fluid absorbing system.
- The main purpose of this system is to eliminate the pump so that there is no moving part and machine become noiseless.
- The three fluid used are ammonia, hydrogen and water.
- The strong ammonia solution from the absorber through heat exchanger is heated in the generator by applying heat from an external source usually a gas burner.
- During heating process the ammonia vapour are removed from the solution and passed to the condenser.

Domestic Electrolux (ammonia Hydrogen)Refrigerator



Domestic Electrolux (ammonia Hydrogen)Refrigerator

- A rectifier or a water separator fitted before the condenser removes water vapour carried with the ammonia vapour so that dry ammonia vapour are supplied to the condenser.
- The hot weak solution left behind in the generator flows to the absorber through heat exchanger. This hot weak solution while passing through the heat exchanger is cooled. The heat removed by the weak solution is utilised in raising the temperature of strong solution passing through the heat exchanger.
- Ammonia vapour in the condenser are condensed by using external cooling source. The liquid refrigerant leaving the condenser flow under the gravity to the evaporator where it meets the hydrogen gas.
- The hydrogen gas which is being fed to the evaporator permit the liquid ammonia to evaporate at low pressure and temperature.
- During the process of evaporation the ammonia absorb latent heat from the refrigerated space and thus produce cooling effect.

Domestic Electrolux (ammonia Hydrogen)Refrigerator

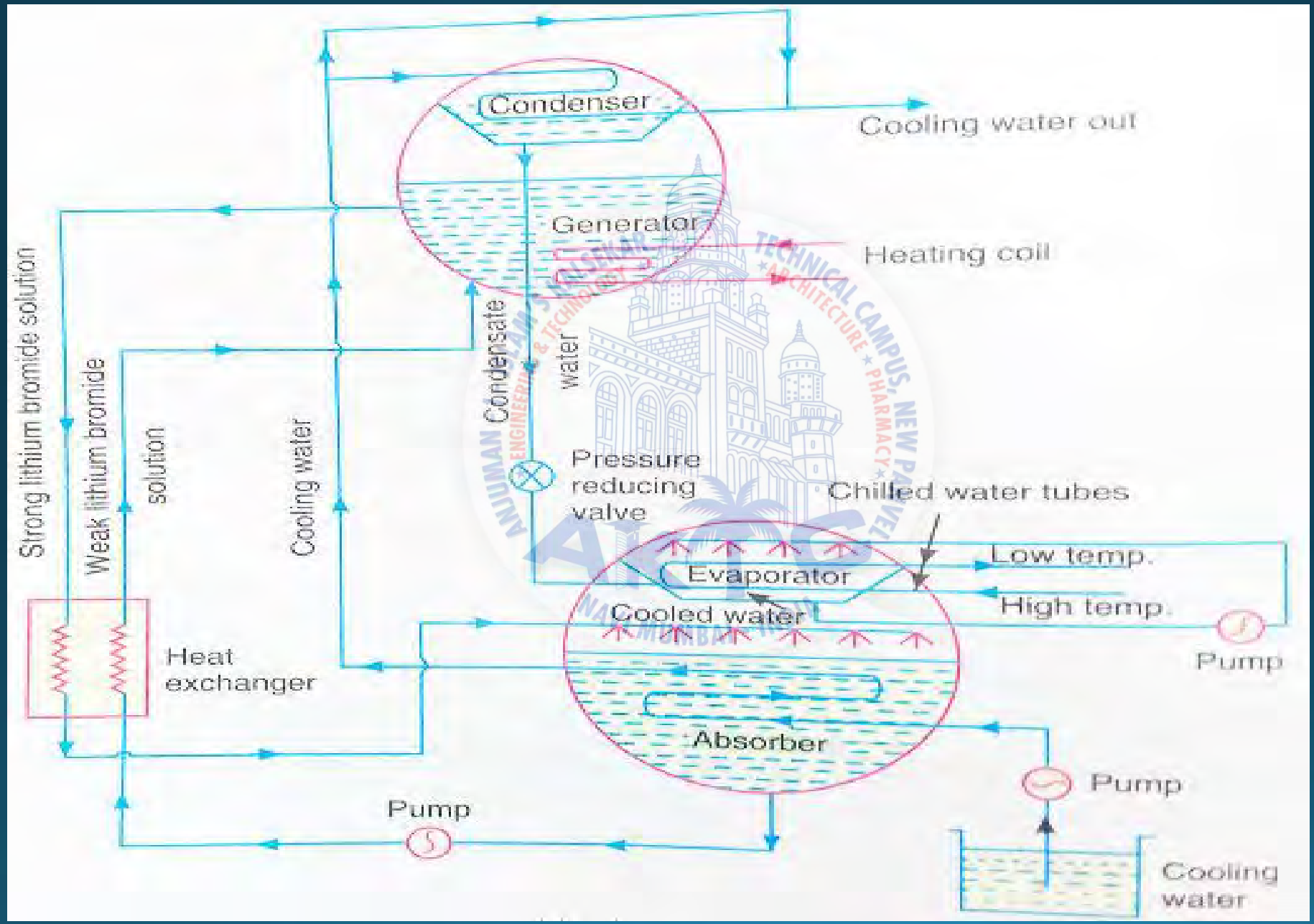
- The mixture of ammonia vapour and hydrogen is passed to the absorber where ammonia is absorbed in water while the hydrogen rises to top and flow back to the evaporator. This complete the cycle.

$$C.O.P = \frac{Heat\ absorbed\ in\ the\ evaporator}{Heat\ supplied\ in\ the\ generator}$$

Lithium Bromide absorption refrigeration System

- The lithium bromide absorption refrigeration system uses a solution of lithium bromide in water.
- Water is used as a refrigerant whereas lithium bromide is used as a absorbent. The lithium bromide solution has a strong affinity for water vapour because of its very low vapour pressure.
- Since lithium bromide solution is corrosive therefore inhibitors should be added in order to protect the metal part of the system against corrosive.
- Lithium chromate is often used as a corrosive inhibitor.
- This system is very popular for air-conditioning in which low refrigeration temperature (not below 0^0C) are required.
- Figure shows a lithium bromide vapour absorption system.
- The absorber and the evaporator are placed in one shell which operate at the same low pressure of the system.

Lithium Bromide absorption refrigeration System



Lithium Bromide absorption refrigeration System

- The generator and condenser are placed in another shell which operates at same high pressure of the system.
- The water for air condition coil is chilled as it is pumped through the chilled water tubes in the evaporator by giving up heat to the refrigerant water sprayed over the tubes.
- Since the pressure inside the evaporator is maintained very low therefore the refrigerant water evaporates.
- The water vapour thus formed will be absorbed by strong lithium bromide solution which is sprayed in the absorber.
- In absorbing the water vapour the lithium bromide help in maintaining very low pressure (high vacuum) needed in the evaporator and the solution becomes weak.
- This weak solution is pumped by a pump to the generator where it is heated up by using steam or hot water in the heating coils.
- A portion of water is evaporated by the heat and the solution now become more

Lithium Bromide absorption refrigeration System

- This strong solution is passed through the heat exchanger and then sprayed in the absorber as discussed above.
- The weak solution of the lithium bromide from the absorber to the generator is also passed through the heat exchanger.
- This weak solution gets heat from the strong solution in the heat exchanger thus reducing the quantity of steam required to heat the weak solution in the generator.
- The refrigerant water vapours formed in the generator due to heating of solution are passed to the condenser where they are cooled and condensed by the cooling water flowing through the condenser water tubes.
- The cooling water for condensing is pumped from the cooling water pond or tower. This cooling water first enters the absorber where it takes away the heat of condensation and dilution .

Lithium Bromide absorption refrigeration System

- The condensate from the condenser is supplied to the evaporator to compensate the water vapour formed in the evaporator.
- The pressure reducing valve the pressure of condensate from the condenser pressure to the evaporator pressure.
- The cooled water from the evaporator is pumped and sprayed in the evaporator in order to cool the water for air-conditioning flowing through the chilled tubes. This completes the cycle.