Automobile Double Cooling Effect

Dipak Jagdhane

Shram Sadhana Bombay Trust's College of Engineering and Technology
Jalgaon, India

Abstract: **Refrigeration and Air conditioning is a system which consumes more energy to produce cooling effect. In Automobile, Engine cooling system is necessary for proper work of Engine. Human Being give's a market to the comfort system, so need an air conditioning in the vehicle with minimum energy consumption. Automobile Engine produces a big amount of heat which has to liberate in the atmosphere. Again it should be proper to get better work of engine. By using an ammonia water vapour absorption system there is a double cooling effect. Heat produced in the system get liberated from condenser which give's engine cooling effect. Again vapours of ammonia get compressed in generator and produce high pressure. Evaporator produces cooling effect in the vehicle. Such a way production of double cooling effect in vehicle is efficient system. Ultimately by using engine surface as a heat Generator for vapour absorption system energy consumption takes place. This increases overall Engine efficiency.**

1. INTRODUCTION

Vapour absorption system is system which produces a cooling effect when heat applied to the water ammonia solution. By using wasted heat energy, refrigeration effect get produced in vehicle. In automobile, engine temperature must have to maintain within certain limit. There is need of separate cooling system, which takes space and energy for proper cooling effect. Also if air conditioning is required then it consumes space as well as energy. To reduce both disadvantages of a system, combination of a system give a better effect. Heat required to compress ammonia is taken from engine surface. At the time of heat generation some heat supplied to the condenser by ammonia vapour which consider as a cooling of engine. Air conditioning is again part of vehicle those produced by ammonia vapour after expansion in evaporator. By using an enthalpy concentration chart of water ammonia- solution, required amount of water- ammonia will be design.

2. Vapour Absorption system

2.1 Water ammonia absorption system

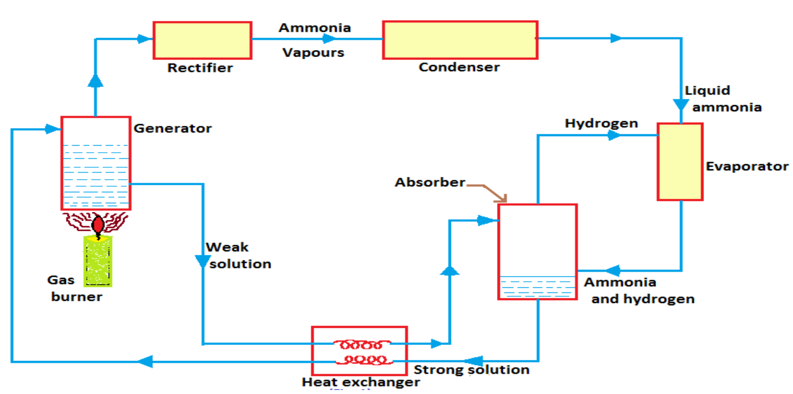

Fig.1 Water ammonia absorption system

Water Ammonia Absorption system is one of the system mostly used to get high refrigeration effect. As shown in figure. In generator formation of pressurized ammonia vapour takes place. Heat supplied to the system may be from any source. Rectifier used to separate water vapour from ammonia vapour. Passing those vapour from condenser it get in the form of liquid. For proper evaporation, hydrogen must have to add before expansion of liquid ammonia in the evaporator. After expansion cooling effect produced surrounding to the evaporator. Due to low weight of Hydrogen it separate from Ammonia. Strong solution again added in generator coming from absorber through Heat exchanger. Continuous operation of system produces cooling effect.

3. Engine cooling system

It is one the complicated system of Automobile. For a required cooling, Radiator and pump system is to be connect, which reduces efficiency of vehicle.

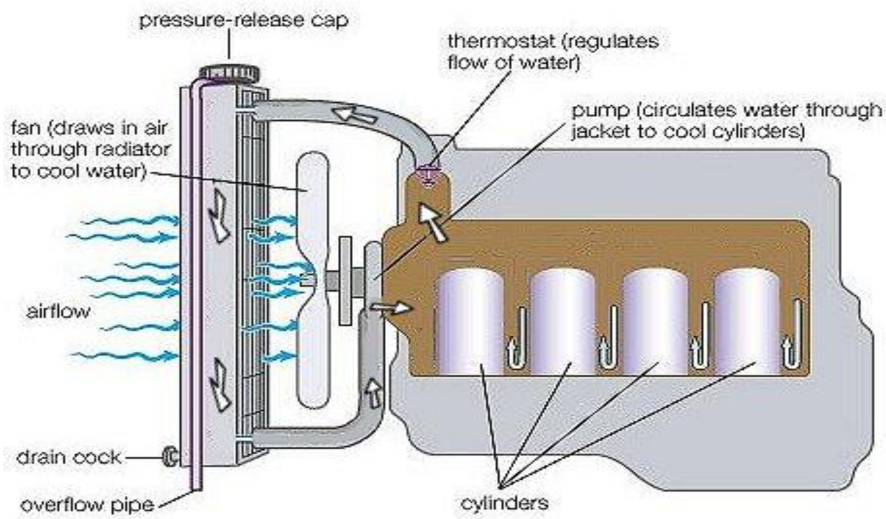

Fig.2 cooling system

As shown in fig. 2 there is need of radiator and pump which reduces efficiency of a vehicle. Also there is no surety to required cooling of an Engine surface. Hence we have to reduce complication and increase efficiency of a system.

3.1 Fourier law of cooling

Conduction is major factor for heat transfer in a plane wall of engine. Heat to be liberated from Engine is again depending on convection takes place from Engine surface. Fourier's law state that heat flux is proportional to the temperature differences per unit length. The proportionality constant is the Thermal conductivity **K**.

$$q_x = -k\frac{dT}{dx}$$

Where,

q- Heat flux in watt per cross sectional area

K- Thermal conductivity in watt per meter Kelvin .

dT- Temperature difference,

dx- Change in length

3.2 Heat transfer in Engine

Conduction heat transfer from engine wall causes reduction in temperature of system. By maintaining atmospheric temperature constant and external cooling, constant heat flux will liberate.

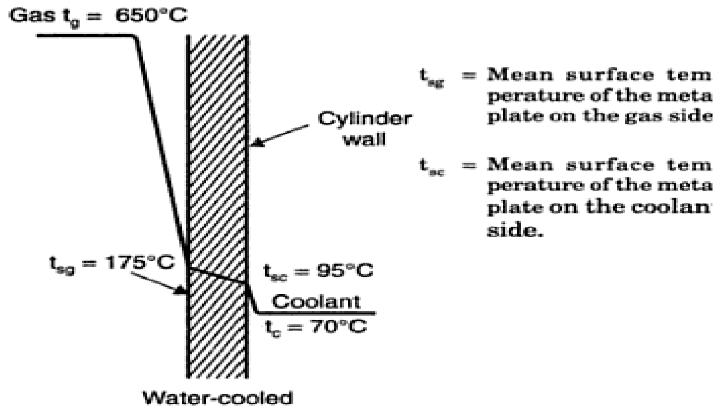

Fig.3 Heat Transfer in Engine

As shown in fig.3 heat conduction in system is constant if we maintain constant surface temperature. As per requirement of Engine surface temperature, water flow will vary. By Fourier's law of heat conduction heat transfer will be calculated.

To maintain constant temperature of Engine surface cool water gets hot. It is a process like a condenser shown in given fig. below

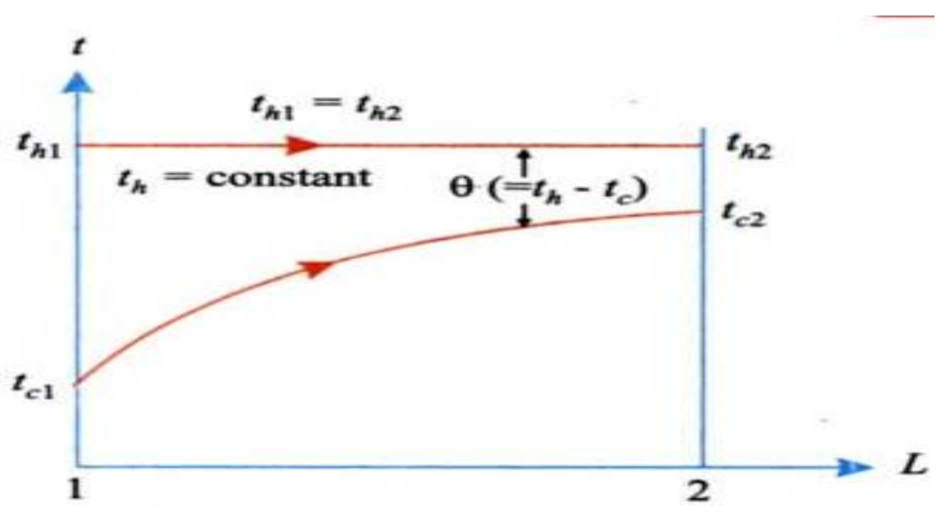

Fig.4 maintain constant temperature

Where,

T_h-surface temperature of Engine

T_{c1}-inlet water temperature

T_{c2}-outlet water temperature

4. Enthalpy concentration chart of Ammonia water solution

At specified pressure and temperature of generator in absorption system we can plot an enthalpy concentration chart. In the design of the system, once the temperature at condenser and evaporator are known, the load is to be taken by system is known, and then we can conclude a circulation of NH_3-water to be used in the system.

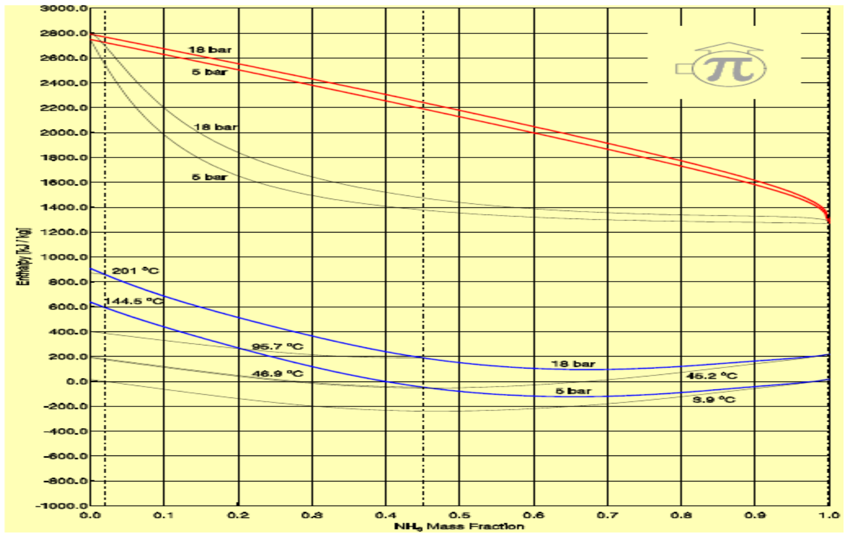

Fig.5 Enthalpy concentration chart

Figure shown above is used to calculate mass of ammonia solution required for system.

4.1 Modified engine cooling and air conditioning system

Heat generated in the generator at the cooling time of engine surface is used to heat solution, to get pressurized ammonia. Pressurized ammonia then condensed in condenser by using cooling water. Heat rejected from there is heat of engine which we have to liberate.

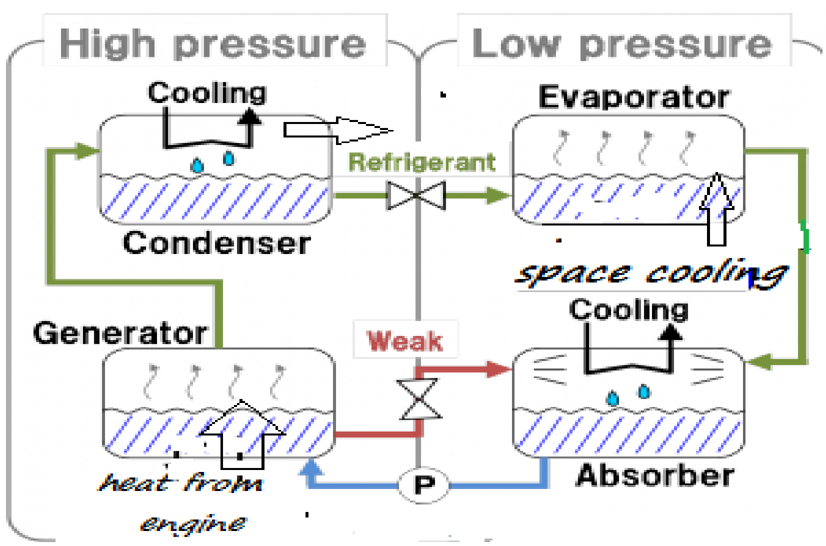

Fig.6 Absorption system, engine as a heat source

Above fig. shows how to combine both air conditioning of vehicle and engine cooling. At evaporator side there is a cooler fan to suck an atmospheric air which get cool as per requirement of space. Comfort will be handling by varying an amount of aqua ammonia solution in the absorption system. From the velocity and temperature of air we have to design temperature of evaporator. h-c chart give all required data to design an absorption system.
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5. Calculation

5.1 Heat from engine

Heat supplied from engine surface is calculated by Fourier's law of heat conduction.

$$Q = K\ (dT/dX)$$

where,

K- Thermal conductivity in watt per meter Kelvin

dT- Temperature difference

dX- Change in length in meter

To keep temperature constant of engine surface we have to design aqua ammonia flow on engine surface. By taking value of heat as a heat capacity of absorption system, enthalpy concentration chart will design mass flow. By using an Enthalpy concentration chart we can design an ammonia water vapour absorption system. Consider system as shown in below fig.7.

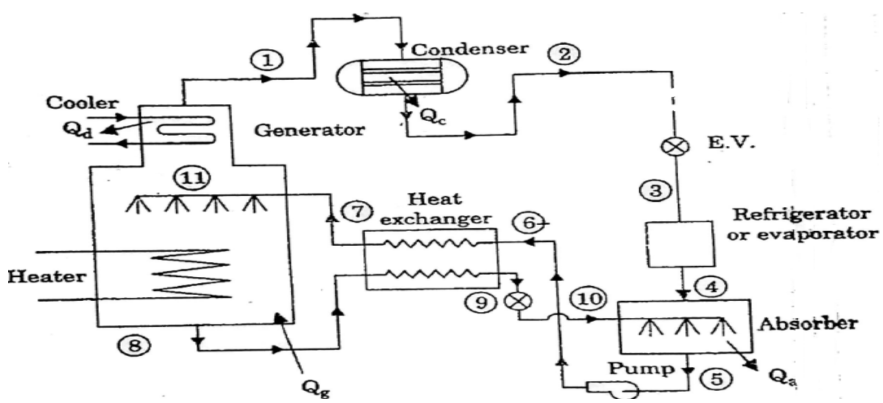

Fig.7 Ammonia water vapours absorption system

At the time of heating of solution in generator some amount of water get evaporate. In evaporator those again form ice which may block a system, hence to avoid this we have to cool NH_3 vapour, to condense water again in the generator. After passing through generator, ammonia get condense in the condenser. In evaporator system it get's evaporate and produces cooling effect to the surrounding. Pump required to pass water from absorber to generator. Heat taken or rejected from system is shown in fig.8.

Consider an Example to get more detail of system.

Example 1

In aqua NH_3 vapour absorption system, the following data is available.

1) Temperature of weak solution in generator=100^oC

2) Temperature of strong solution admitted to generator=82^oC
3) Temperature of condenser = temperature of Absorber=40^oC
4) Temperature in the Evaporator=10^oC
   If 10-tons Refrigeration capacity:

Determine:

(1) Heat required in the Generator in KJ/sec
(2) Heat rejected in the absorber in KJ/sec
(3) Degasing value
(4) Heat rejected in Deflimator in KJ/sec
(5) Heat rejected in condenser in KJ/sec
(6) Mass flow of strong solution handled by the pump
(7) COP of the system

Use following fig.8, and fig.9

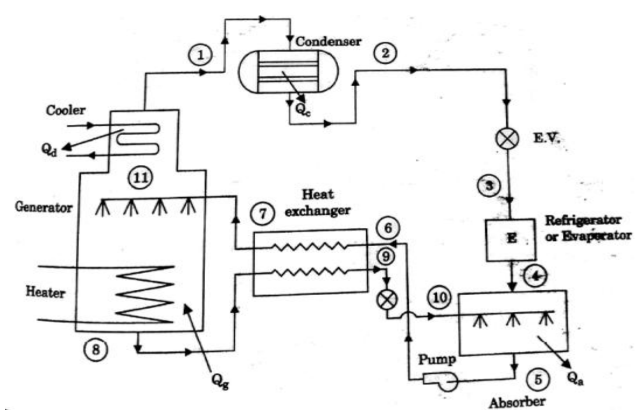

Fig.8 Absorption system

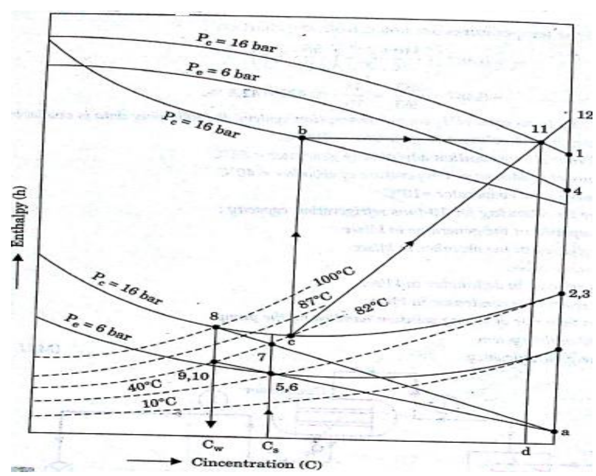

Fig.9 enthalpy concentration chart

Solution:

The pressure in the condenser (P_c) is the pressure corresponding to saturation temperature of NH_3 vapour which is given at 40^oC The P_c can be read as line C=1 and temperature 40^oC line meet each other. P_c=16 bar The pressure in Evaporator (P_e) is the pressure corresponding to the saturation temperature of NH_3 mixture

(vapour + liquid) mixture is given as 10^oC The P_c can be read at C=1 and Temperature 10^oC line meet each other. P_e=6 bar Now locate P_c=16, P_e=6 pressure lines in liquid mixture and pure vapour region and also locate 100^oC, 82^oC, 40^oC and 10^oC line in liquid region as shown in fig. on aqua Ammonia chart also locate 16 bar Auxiliary pressure line. Now, P_c=16 bar, T_c=40^oC and P_e=6 bar, T_c=10^oC

Now locate the point '1' which is saturated ammonia vapour at P_c=6 bar now locate the point '2' which is saturated liquid at P_c=16 bar in the liquid region where ammonia concentration 1 locate the point '3' at point '2' as a h_2=h_3 now locate the point '4' at 6 bar pressure which is saturated vapour in the vapour region. Now locate the point '5' which represent the condition of strong mixture coming out from absorber where it's pressure is 6 bar and temperature is 40^oC and point '6' is falls on point '5' as h_5=h_6 (neglecting pump work given to the ammonia) the aqua coming from heat exchanger is at 82^oC and concentration remains same as point '6' when passing through the heat exchanger. So locate point '7' drawing vertical line through point '6' which cut's 82^oC line. The condition at '7' is sub-cooled because, the saturation temperature at 16 bar pressure and C_5=C_7=0.46 is 87^oC (from chart)

Locate the point '8' as its pressure is 16 bar and temperature is 100^oC now joint point '8' and '7' and extent till it cuts at point 'a' as shown in fig. The weak and hot solution coming out at condition '8' is passed through exchanger which gives its latent heat to the strong solution and its enthalpy decreases but it's concentration remains same. Therefore the point '9' lies on vertical line passing through point '8'. To locate point '9', joint point 'a' and '5' and extend till it cuts to the vertical line passing through '8'. The point '10' lies on point '9' as $h_{10}=h_9$

Read the following values from chart,

h_1=1630KJ/kgK, $h_2=h_3$=535 KJ/kgK, h_4=1600 KJ/kgK, $h_5=h_6$=70 KJ/kgK, h_7=260 KJ/kgK, h_a= -425 KJ/kgK, h_8=350 KJ/kgK, $h_9=h_{10}$=120 KJ/kgK

$C_s=C_7$=0.46 (strong solution) and $C_w=C_8$=(weak solution) =0.4

Now locate the point 'c' where the pressure is 16 bar and temperature is 82^{o}Cthen draw a vertical line through point 'c', till it cut the auxiliary pressure line 16 bar and locate point 'b' then draw a horizontal line through point 'b' till it cuts the 16 bar pressure line in the vapour region and locate the point '11'. Joint the point 'c' and '11'and extend till it cuts the vertical line of concentration =1 and locate point '12'

Draw a vertical line through point '11' which cuts the horizontal concentration line at point 'd' the point 'd' gives the concentration of vapour generated in the generator and entering in to the cooler. Now read the following values from the chart

h_{12}= 1840 KJ/kgK, C_{11}=0.982 = C_d

Mass flow of evaporator = (35/1065)=0.033 kg/sec

Heat supplied per kg of NH_3 in the generator =$h_{12}-h_a$=1840-(-425)=2265 kg/kg of NH_3

1) Q_g(KJ/sec)=0.33×2265=24.75 KJ/sec
2) $Q_a= m_r (h_4-h_a)$ =0.33(1600+425)=66.835 KJ/sec
3) Degassing =$C_s-C_w=C_7-C_8$=0.46-0.4=0.06kg/kg of aqua
4) heat rejected in deflimator (cooler after generator) =$m_r(h_{12}-h_1)$=0.33(1840-1630)=210 KJ/sec
5) heat rejected in condenser $Q_c=m_r(h_1-h_2)$ 0.033(1630-535)=36.15 KJ/sec
6) Consider the enthalpy balance across the heat exchanger, we can write
   Heat loss by weak solution=heat gain by strong solution
   $m_w (h_8-h_9) = m_s(h_7-h_6)$
   1kg of NH_3entering in to condenser, m_w kg of weak solution entering, then
   $m_s = m_w+1$
   $m_w (h_8-h_9) = (m_w+1)(h_7-h_6)$

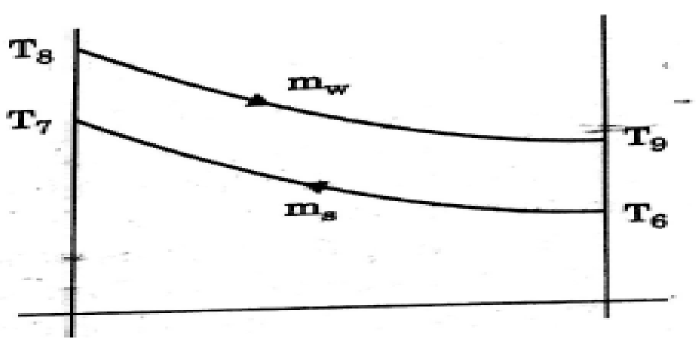

Fig.10

$40m_w$=190 therefore, m_w=4.75 kg/kg of NH_3

Strong solution handled by the pump=4.75+1=5.75kg/kg of NH_3 and 0.189kg/sec

7) COP=Q_e/Q_g=0.4

6. Conclusion

By using vapour absorption system in Automobile there is a double cooling effect. Cooling of engine surface takes at constant required surface temperature of engine. To cool an engine in normal present system there is need of water pump to cool engine also water pump required to cool radiator. Again to cool vehicle inner body there is need of extra air conditioning system. Which again consume power, so reduction in vehicle efficiency takes place. By combining both systems, energy required to engine cooling is completely getting reduced. Only providing a pump for aqua solution circulation and to condenser water circulation we can run air conditioning system with free of cost. By relating heat rejected from engine surface, to the heat absorb in generator system, calculation of aqua solution required at given Evaporator temperature, Condenser temperature, Absorber temperature and Generator temperature is possible.

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