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Refrigeration from Low Grade Energy for Cabin Cooling of a Vehicle

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ABSTRACT:

The rise in civilization is closely related to the improvement is transportation. In the development of transportation, internal combustion engine play an important role of petrol and diesel engine. This problem is increasing day by day with increasing pollution, & urbanization air pollution has been identified as one of the potential source of air pollution. The Petrol and diesel engine power automobile achieve symbol of our modern technological society but in recent time. The I.C. engine powered vehicle has come under heavy attack due to various problems created by them. One of the various problems is air pollution and this pollution problem facing the developing countries. First of all we know about pure air means it is a mixture of nitrogen and oxygen with some rare gases argon, neon etc. Now air pollution is defined as the addition of any material which will have a dangerous effect of our planet to our atmosphere.

This pollution of air problem is very serious such than a one metrologies predicted recently that air could put an end to life on this planet within century. Out of all the available sources, the internal combustion engines are the major consumers of fossil fuel around the globe. Carbon dioxide coming out of every car's tailpipe is a greenhouse gas .Recently, the total heat energy supplied to the engine in the form of combustible fuel, approximately, 35% to 40% is converted into productive mechanical work; the remaining energy in the form of heat is expelled by the exhaust gases and engine cooling systems, resulting in the rise of entropy and serious environmental pollution, thus there is a demand to utilize this waste heat from the vehicle into useful work output. The refrigerating units which are being currently employed in the vehicle are of Vapor Compression Refrigeration system (VCRS). The main drawback of this system is that it uses power directly from the engine shaft to power and run the drive of the compressor of the refrigeration system; hence the engine has to produce extra power to run the compressor of the unit, thus utilizing fuel.

The energy loss from the vehicle can be utilized to operate the Vapor Absorption Refrigeration System (VARS), hence reducing the excessive work done by the engine. Keeping this in mind, this paper explores the possibilities of utilizing the VARS in moving vehicles.

INTRODUCTION:

Refrigeration is a process of moving heat from one location to another in controlled conditions. The work of heat transport is traditionally driven by mechanical work, but can also be driven by heat. The basic need of introducing the concept of Refrigeration is to get comfort conditions for human and it generally mean that lowering the temperatures when compare to atmospheric temperature. Generally we use vapor compression refrigeration system to get cooling effect, it is a high grade energy which uses electric power. In VCR system a refrigerant is used to get lower temperature , refrigerants such as R-11,R-13, Ammonia etc. They are polluting the atmosphere.

The concept of introducing vapor absorption refrigeration system to use the energy that absorbs from exhaust gases of a vehicle. The basic objective of developing a vapor absorption refrigerant system for automobiles is to lower the temperature of a small space inside the vehicle by utilizing waste heat and exhaust gases from engine. It is a well known factor that an IC engine has an efficiency of about 35%-40%, which means that only one-third of the energy produced by the combustion of the fuel is converted into useful work done i.e. into mechanical output and about 60-65% of the energy in the form of heat is lost to environment. In which about 28%-30% is lost by coolant and lubrication losses, around 30%-32% is lost thorough exhaust gases from the exhaust pipes and remainder of the energy is lost by radiation and convection.

VAPOR COMPRESSION REFRIGERATION SYSTEM: The figure shows the detailed process with T-s diagram

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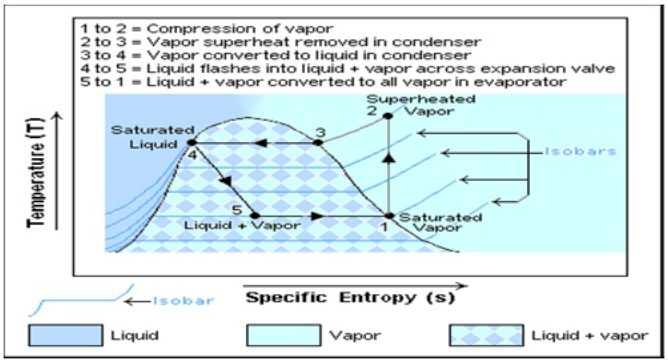
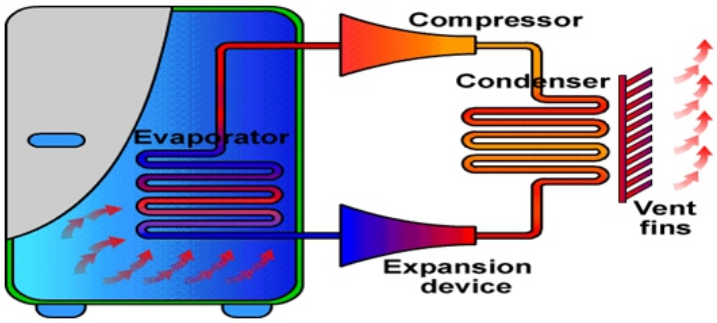


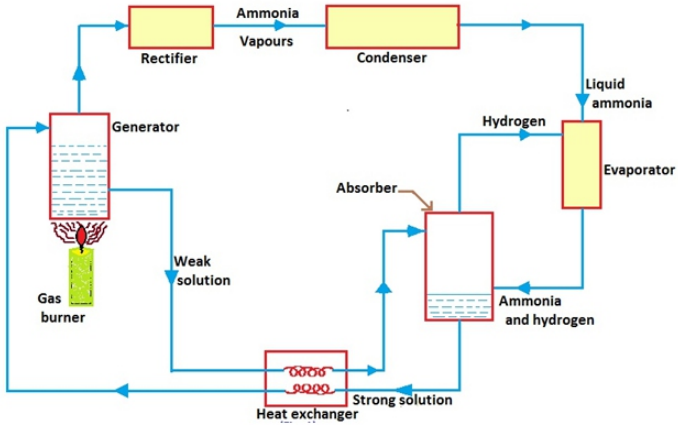
The figure shows the schematic view of VARS system



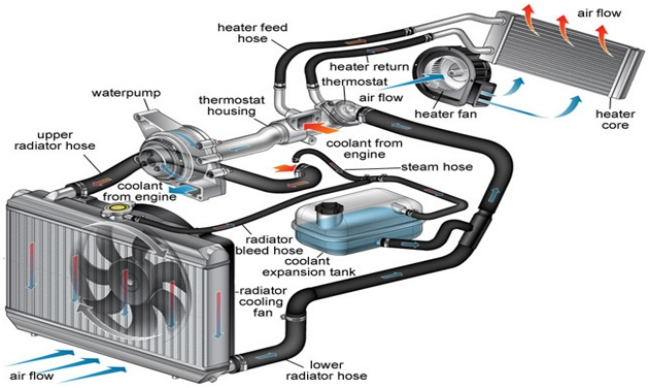
VAPOR ABSORPTION REFRIGERATION SYSTEM:

An absorption refrigerator is a refrigerator that uses a heat source (e.g., solar energy, a fossil-fueled flame, waste heat from factories, or district heating systems) which provides the energy needed to drive the cooling process. Some liquids like water have great affinity for absorbing large quantities of certain vapors (NH3) and reduce the total volume greatly. The absorption refrigeration system differs fundamentally from vapor compression system only in the method of compressing the refrigerant. An absorber, generator and pump in the absorption refrigerating system replace the compressor of a vapor compression system. Figure shows the schematic diagram of a vapor absorption system. Ammonia vapor is produced in the generator at high pressure from the strong solution of NH3 by an external heating source. The water vapor carried with ammonia is removed in the rectifier and only the dehydrated ammonia gas enters into the condenser. High pressure NH3 vapor is condensed in the condenser. The cooled NH3 solution is passed through a throttle valve and the pressure and temperature of the refrigerant are reduced below the Refrigeration Cycles. The low temperature refrigerant enters the evaporator and absorbs the required heat from the evaporator and leaves the evaporator as saturated vapor.

Slightly superheated, low pressure NH3 vapor is absorbed by the weak solution of NH3 which is sprayed in the absorber as shown in figure. Weak NH3 solution (aqua–ammonia) entering the absorber becomes strong solution after absorbing NH3 vapor and then it is pumped to the generator through the heat exchanger. The pump increases the pressure of the strong solution to generator pressure. The strong NH3 solution coming from the absorber absorbs heat form high temperature weak NH3 solution in the heat exchanger. The solution in the generator becomes weak as NH3 vapor comes out of it. The weak high temperature ammonia solution from the generator is passed to the heat exchanger through the throttle valve. The pressure of the liquid is reduced to the absorber pressure by the throttle valve.



Actual refrigeration system in vehicles



DISADVANTAGES OF EXISTING AUTOMOBILE AIR CONDITIONING SYSTEM:

Reduce the efficiency of automobile air conditioner
(1) High cost of refrigerant.
(2) Total equipment quite heavy.
(3) System runs noisily.

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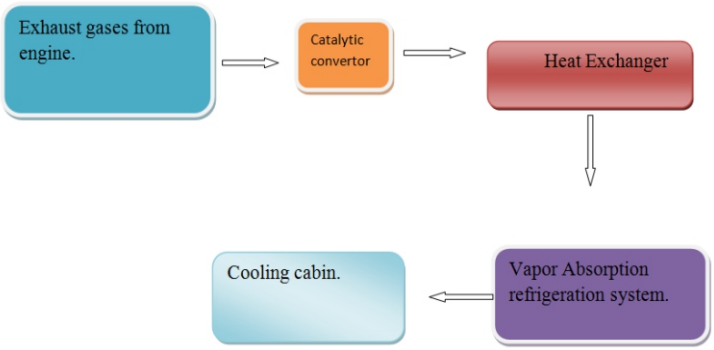
(4) Over loading and overheating of the system take place.
(5) Leakage problem of refrigerant which damage the ozone layer.

ADVANTAGES OF USING VARS:

The use of a Vapor Absorption Refrigeration System in the vehicles used on roads. Transport vehicles have the following advantages:

1.No dedicated IC engine is required for the working of the refrigerating unit.
2. No refrigerant compressor is required.
3. No extra work is required for the working of the refrigerating unit
4. Reduction in capital cost.
5. Reduction in fuel cost.
6. Reduced atmospheric pollution.
7.. Reduced maintenance.
8. Reduced noise pollution.

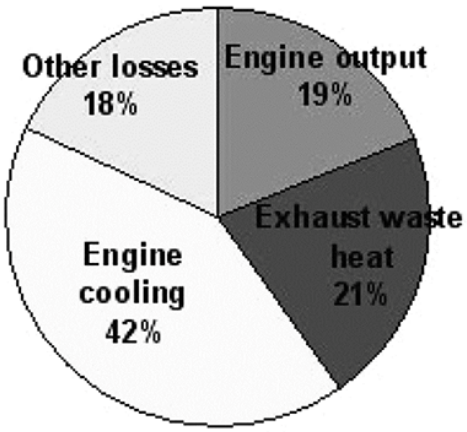
SCHEMATIC VIEW FOR USING VARS SYSTEM FOR VEHICLES:



POTENTIAL OF HEAT RECOVERY FROM THE ENGINE OF THE VEHICLE:

Waste heat, which is generated by fuel combustion in the engine, and is then dissipated into the environment even though it could still be reused for some useful and economic purpose. This heat depends on the temperature of the waste heat gases and mass flow rate of exhaust gas. Waste heat losses arise both from equipment inefficiencies and from thermodynamic limitations on equipment. Considering the internal combustion engine approximately 35% to 40% of heat energy is converted into useful mechanical work.

The remaining heat from the engine is expelled into the atmosphere by exhaust gases and engine cooling systems. It means approximately 60%-65 % energy losses as a waste heat through exhaust. Exhaust gases immediately leaving the engine can have temperatures as high as 842-1112°F [450-600°C]. Thus the high content of heat from the exhaust can easily be redirected and reused to provide useful work.



CONCLUSION:

The possibility to design a refrigeration unit inside an automobile using the waste heat from the engine of the vehicle based on Vapor Absorption Refrigeration System is realistic. Also keeping in mind the Environmental safety view, this system is Eco-friendly as it involves the use of Ammonia (a natural gas) as a refrigerant and is not responsible for Green House effect and OZONE layer depletion. In this way we can conclude, that out of the total heat supplied to the engine in the form of fuel combustion, approximately, 35% to 40% is converted into useful mechanical work; the remaining heat is categorized under the waste heat and expelled out of the system, resulting in the rise of entropy, so it is required to utilize this waste heat into useful work. Possible methods to recover the waste heat from internal combustion engine through the study on the performance and emissions of the internal combustion engine are discussed upon and can be designed. Waste heat recovery system is the best way to recover waste heat and saving the fuel.

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