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# FABRICATION OF AIR CONDITIONING SYSTEM USING ENGINE EXHAUST GAS

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**Abstract:**

The project deals with the fabrication of automobile exhaust air conditioning system. It is well known that an IC engine has an efficiency of about 35-40%, which means that only one-third of the energy in the fuel is converted into useful work and about 60-65% is wasted to environment. In which about 28-30% is lost by cooling water and lubrication losses, around 30-32% is lost in the form of exhaust gases and remaining by radiation, etc. In this air conditioning System, a physicochemical process replaces the mechanical process of the Vapour Compression System by using energy in the form of heat rather than mechanical work. The heat required for running this type of air conditioning System can be obtained from that which is wasted into the atmosphere from an IC engine

**Introduction:**

Air conditioning is the process of removing heat from an enclosed or controlled space or from a substance and moving it to a place where it is unobjectionable. The primary purpose of air conditioning is lowering the temperature of the enclosed space or substance and then maintaining that lower temperature as compared to the surroundings. Cold is the absence of heat, hence in order to decrease a temperature, one should "remove heat", rather than "adding cold." The basic objective of developing a vapour absorption refrigerant system for cars is to cool the space inside the car by utilizing waste heat and exhaust gases from engine. The air conditioning system of cars in today's world uses "Vapour Compression Refrigerant System" (VCRS) which absorbs and removes heat from the interior of the car which is the space to be cooled and further rejects the heat to be elsewhere. Now to increase an efficiency of car beyond a certain limit vapour compression refrigerant system resists it as it cannot make use of the exhaust gases from the engine. In vapour compression refrigerant system, the system utilizes power from engine shaft as the input power to drive the compressor of the refrigerant system. Hence the engine has to produce extra work to run the compressor of the air conditioning system thus utilizing extra amount of fuel. This loss of power of the vehicle for air conditioning can be neglected by implementing this type of air conditioning system.

**Literature Review:**

According to Palm, Corberan et al., Domanski and Yashar, most HFC refrigerants have a relatively high global warming potential (GWP) which is also being regulated by the Kyoto Protocol. They have cited thatrecent passage of legislation in the European Community requires the use of refrigerants with GWPs of less than 150 in all new-type vehicles starting in 2011 and in all new vehicles by 2017.Work done by Angelo Cantoni, Rome, Italy This invention comprises a vapour generator member connected to a condenser which is itself connected, by way of a pressure reduction valve, to an evaporator connected to an absorber which receives the liquid present in the lower zone of the generator and from which liquid is fed to the upper zone of the generator, there being provided in the generator a heat exchanger through which the engine cooling liquid flows. Hence it uses heat of the cooling water as the source of heat for the generator. Work done by I Horuz, Bursa, Turkey. The work done by I Horuz consists of using exhaust heat of the automobile as the heat source for the generator. He used two heat exchangers one with insulation and the other without insulation for transferring heat to the solution of the absorption system. He plotted the results obtained after conducting various performance tests on the engine under different running conditions.

**Vapor Absorption Refrigeration in Road Transport Vehicles, J. Engine Energy Engrg. Volume 125, Issue 2, PP. 48-58 (August 1999):**

This study includes an experimental investigation into the use of vapor absorption refrigeration (VAR) systems in road transport vehicles using the waste heat in the exhaust gases of the main propulsion unit as the engine energy source. This would provide an alternative to the conventional vapor compression refrigeration system and its associated internal combustion engine. The performance of a VAR system fired by natural gas is compared with that of the same system driven by engine exhaust gases. This showed that the exhaust-gas-driven system produced the same performance characteristics as the gas-fired system. It also suggested that, with careful design, inserting the VAR system generator into the main engine exhaust system need not impair the performance of the vehicle propulsion unit. A comparison of the capital and running costs of the conventional and proposed alternative system is made.

**International Journal of Refrigeration (Volume 31, Issue 4, June 2008, Pages 545-551 Refrigeration with Ammonia And Hydrocarbons) by Andy Pearson, Star Refrigeration Ltd., Glasgow G46 8JW, UK:**

Ammonia is widely used as a refrigerant in industrial systems for food refrigeration, distribution warehousing and process cooling. It has more recently been proposed for use in applications such as water chilling for air-conditioning systems but has not yet received widespread acceptance in this field. This review paper assesses the reasons why ammonia is so popular in industrial systems, the reasons why it is deemed less suitable for other applications and the possible benefits at local, national and international levels that might be gained by more general acceptance of ammonia as a refrigerant. The paper also considers other possible applications which might benefit from the use of ammonia as refrigerant.

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**Components and Description:**

The major components used in this project are,

- Condenser,
- Evaporator,
- Heat exchanger
- IC engine.
- Battery
- Frame

**Condenser:**

The condenser is an important device, used in the high pressure side of a refrigeration system. Its function is to remove heat of the vapour refrigerant discharged from the compressor. The hot vapour refrigerant consists of the heat absorbed by the evaporator and the heat of compression added by the mechanical engine energy of the compressor motor. The heat form the hot vapour refrigerant in a condenser is removed first by transferring it to walls of the condenser tubes and then form the tubes to the condensing or cooling medium.

**Classification of Condensers:**

The common forms of condensers may be broadly classified on the basis of the cooling medium as,

- Water cooled condenser.
- Air cooled condenser.
- Evaporative (air and water cooled) condenser.
- In the work Fin and Tube condenser (air cooled) is used.

**Fin and Tube Condenser:**

The fin and tube condenser is one in which the removal of heat is done by air. It consists of steel or copper tubing through which the refrigerant flows. The size of tube usually ranges from 6mm to 18mm outside diameter, depending upon of the size of the condenser. Generally copper tubes are used because of its excellent heat transfer ability. The tubes are usually provided with plate type fins to increase the surface area for heat transfer. The fins are usually made from aluminium because of its light weight. The condensers with the single row of tubing provide the most efficient heat transfer. This is because the air temperature rises as it passes through each row of tubing. The temperature difference between the air and the vapour refrigerant decreases in each row of tubing and therefore each row becomes low effective. However single row condensers required more space than multi row condensers.

**Evaporator:**

The evaporator is an important device used in the low pressure side of a refrigeration system. The liquid refrigerant from the expansion vale enters into evaporator where it boils and changes into vapour. The function of and evaporator is to absorb heat form the surrounding location or medium which is to be cooled, by means of the refrigerant. The temperature of the boiling refrigerant in the evaporator must always be less than that of the surrounding medium so that heat flows to the refrigerant. The evaporator becomes cold and remains cold due to the following reasons,

- The temperature of the evaporator coil is low due to low temperature of the refrigerant inside the coil.
- The low temperature of the refrigerant remains unchanged because any heat it absorbs is converted to latent heat as boiling proceeds.

**Classification of Evaporators:**

The common forms of evaporators can be classified as follows,

- According to the type of construction,
  - Bare tube coil evaporator.
  - Finned tube evaporator.
  - Plate evaporator.
  - Shell and tube evaporator.
  - Shell and coil evaporator.
  - Tube – in – tube evaporator.
- According to the manner in which liquid refrigerant is fed,
  - Flooded evaporator.
  - Dry expansion evaporator.
- According to the mode of heat transfer,
  - Natural convection evaporator.
  - Forced convection evaporator.
- According to operating conditions,
  - Frosting evaporator.
  - Non-frosting evaporator.
  - Defrosting evaporator.

**Shell and Coil Evaporator (Cold Tank):**

The shell and coil evaporators are generally dry expansion evaporators to chill water. The cooling coil is continuous tube that can be in the form of a single or double spiral. The shell may be sealed or open. The sealed shells are usually found in shell and coil evaporators used to cool drinking water. The evaporators having flanged shells are often used to chilled water in

secondary systems. The capacity of the cold tank used in the work is 15 litres. The dimensions of the tank are of 300 mm diameter and 450mm height.

**IC Engine Construction:**

In this project we use Spark Ignition engine of the type two stroke single cylinder of Cubic capacity 75 cc. Engine has a piston that moves up and down in cylinder. A cylinder is a long round air pocket somewhat like a tin can with a bottom cut out. Cylinder has a piston which is slightly smaller in size than the cylinder the piston is a metal plug that slides up and down in the cylinder Bore diameter and stroke length of the engine are 50mm and 49mm respectively.

**I.C Engine:**

Internal combustion engines are those heat engines that burn their fuel inside the engine cylinder. In internal combustion engine the chemical engine energy stored in their operation. The heat engine energy is converted in to mechanical engine energy by the expansion of gases against the piston attached to the crankshaft that can rotate.

**Petrol Engine:**

The engine which gives power to propel the automobile vehicle is a petrol burning internal combustion engine. Petrol is a liquid fuel and is called by the name gasoline in America. The ability of petrol to furnish power rests on the two basic principles;

- Burning or combustions always accomplished by the production of heat.
- When a gas is heated, it expands. If the volume remains constant, the pressure rises according to Charlie's law.

**Working:**

There are only two strokes involved namely the compression stroke and the power stroke; they are usually called as upward stroke and downward stroke respectively.

**Upward Stroke:**

During this stroke, the piston moves from bottom dead center to top dead center, compressing the charge-air petrol mixture in combustion chamber of the cylinder. At the time the inlet port is uncovered and the exhaust, transfer ports are covered. The compressed charge is ignited in the combustion chamber by a spark given by spark plug.

**Downward Stroke:**

The charge is ignited the hot gases compress the piston moves downwards, during this stroke the inlet port is covered by the piston and the new charge is compressed in the crankcase, further downward movement of the piston uncovers first exhaust port and then transfer port and hence the exhaust starts through the exhaust port. As soon as the transfer port open the charge through it is forced in to the cylinder, the cycle is then repeated.

**Frame:**

This is made of mild steel material. The whole parts are mounted on this frame structure with the suitable arrangement. Boring of bearing sizes and open bores done in one setting so as to align the bearings properly while assembling. Provisions are made to cover the bearings with grease.

**Batteries:**

In isolated systems away from the grid, batteries are used for storage of excess solar energy converted into electrical energy. The only exceptions are isolated sunshine load such as irrigation pumps or drinking water supplies for storage. In fact for small units with output less than one kilowatt. Batteries seem to be the only technically and economically available storage means. Since both the photo-voltaic system and batteries are high in capital costs. It is necessary that the overall system be optimized with respect to available energy and local demand pattern. To be economically attractive the storage of solar electricity requires a battery with a particular combination of properties:

- Low cost
- Long life
- High reliability
- High overall efficiency
- Low discharge
- Minimum maintenance
    - Ampere hour efficiency
    - Watt hour efficiency

We use lead acid battery for storing the electrical energy from the solar panel for lighting the street and so about the lead acid cells are explained below.

**Lead-Acid Wet Cell:**

Where high values of load current are necessary, the lead-acid cell is the type most commonly used. The electrolyte is a dilute solution of sulfuric acid ($H_2SO_4$). In the application of battery power to start the engine in an auto mobile, for example, the load current to the starter motor is typically 200 to 400A. One cell has a nominal output of 2.1V, but lead-acid cells are often used in a series combination of three for a 6-V battery and six for a 12-V battery. The lead acid cell type is a secondary cell or storage cell, which can be recharged. The charge and discharge cycle can be repeated many times to restore the output voltage, as long as the cell is in good physical condition. However, heat with excessive charge and discharge currents shortens the useful life to about 3 to 5 years for an automobile battery.

**Working Principle:**

For this system we have considered vapor absorption system. This system is more useful and applicable to our system. The machine is to provide 40 liters capacity of air conditioning with the components. The air conditioning system obtained was modified in order to accommodate the waste heat fixing the generator tube to the exhaust pipe. The pipe coming from engine

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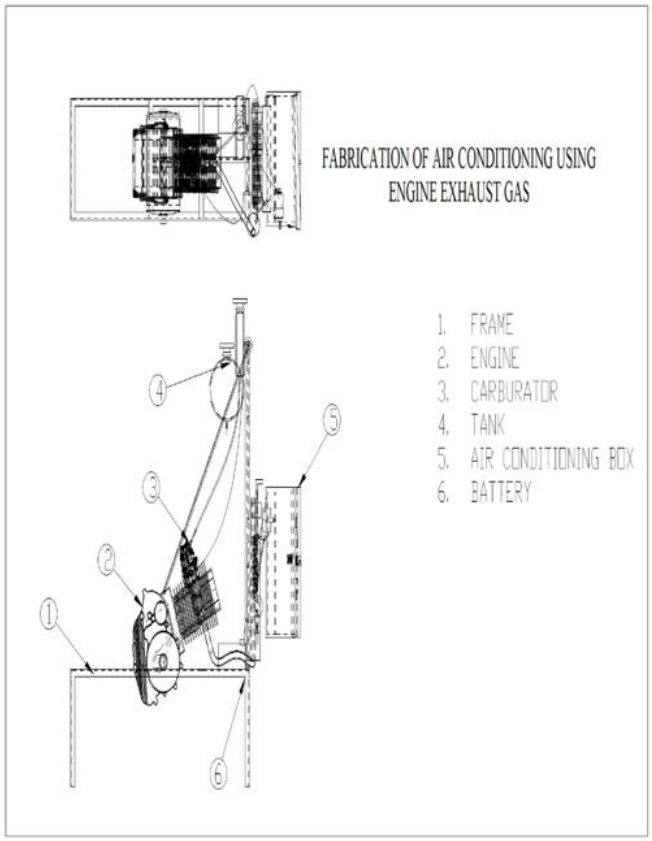
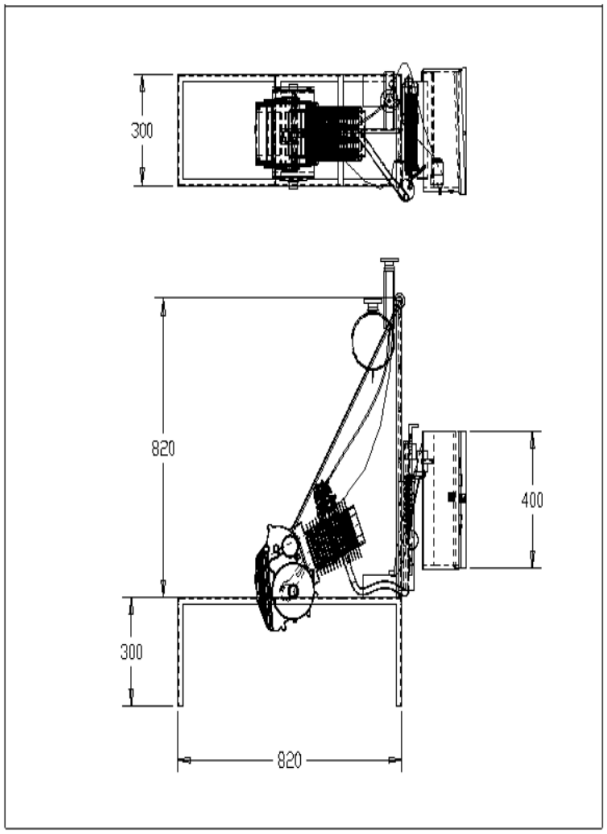
exhaust is connected to the one end of the generator tube and the other end of the generator tube is free to atmosphere. When the engine starts working the exhaust gases are madeto pass through the generator where the heat is recovered, which later escapes in to atmosphere.




**List of Materials:**

| S.No | Parts | Qty | Material |
|---|---|---|---|
| 1. | Engine | 1 | 4 Stroke |
| 2. | Air conditioning setup | 1 | Ms |
| 3. | Blower fan | 1 | Aluminum |
| 4. | Generator | 1 | Silver |
| 5. | Heat exchanger | 1 | Copper |
| 6. | Fuel tank | 1 | Plastic |
| 7. | Frame | 1 | Mild Steel |
| 8. | Battery | 1 | 12v |

**Advantages:**

- The coefficient of performance is quite high as the working cycle of this system is near the Carnot cycle.
- Among the refrigerant circulated is less per ton of refrigeration than air refrigeration system because the heat carried away by the refrigerant is the latent heat. As a result of this, the size of evaporator is smaller for the same refrigerating effect.
- This system can be employed over a large range of temperatures. By adjusting the expansion valve of the same unit, the required temperature in the evaporator can be achieved.
- The running cost of this system is less than air refrigerating system. The air refrigeration system requires five times more power than a vapour compression refrigeration system of the same capacity.

**Disadvantages:**

- Prevention of leakage of refrigerant in this system is the major problem.
- First investment cost is high than the air refrigeration system

**Applications:**

- The refrigeration effect from the waste heat from the cars has a wide range of applications in the fields like,
- Domestic Applications.
- Commercial vehicles.
- All automobile industries

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