International Journal of Research in Engineering, Science and Management
Volume-2, Issue-4, April-2019
www.ijresm.com | ISSN (Online): 2581-5792

Design and Fabrication of Air Conditioning using Engine Exhaust Gas

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***Abstract*: This 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, et. 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.**

***Keywords*: Air conditioning exhaust gas, exhaust gas utilization, design of air conditioning.**

1. 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

2. Methodology

The vapour absorption system we are using here is having four main sections. i. Evaporator ii. Absorber iii. Generator iv. Condenser In this project we are mainly making design modifications at the generator section. Normally in a vapour absorption system in the generator section the refrigerant and the absorbent is separated by supplying the heat. The heat supplied here is produced by means of a heating coil. For this usually we have to find another power source. But in our project we can use the waste exhaust energy available at the exhaust section of the vehicle. Hence, the heat exchanger is designed to install in between the exhaust manifold and flexible joint of exhaust system. Ammonia vapor is extracted from the NH3 strong solution at high pressure in the generator by an external heat source. In the receiver the water vapor which carried with ammonia is removed and dried ammonia gas enters into the condenser and it is condensed. The pressure and temperature of cooled NH3 is then reducing by throttle valve below the temperature of the evaporator. Then NH3 at low temperature enters to the evaporator and absorbed the required heat from passenger compartment and leaves as saturated vapor out from the evaporator. The low pressure NH3 vapor is then passed to the absorber, where it absorbs by the NH3 weak solution. After absorbing NH3 vapor by weak NH3 solution (aqua- ammonia), the weak NH3 solution becomes strong solution and then it to pump to generator through heat exchanger. Heat is supplied to the generator from the exhaust system, which generates ammonia gas from a liquid water ammonia mixture. Ammonia gas flows to the condenser allows the ammonia gas to dissipate its thermal energy and condenses into liquid. The liquid ammonia flows to evaporator via the expansion valve, it is vaporized and cooling load generated by absorbing the heat from the vehicle's passenger compartment. The cooling effect can be feel at the evaporator section since the heat is absorbed by the refrigerant at this section. We are using ammonia as the refrigerant and water as the absorbent. These two compounds are easily available and there won't be much problem in collecting and filling in our exhaust gas assisted air cooling system. In case of leakage of any compounds in the apparatus get, it can be easily detected by adding some color giving ingredients in the compounds.

3. Materials and methods

The materials and method used for the manufacturing of the component is discussed and the main components used in the design are condenser, evaporator, heat exchanger, IC engine, battery, and frame.

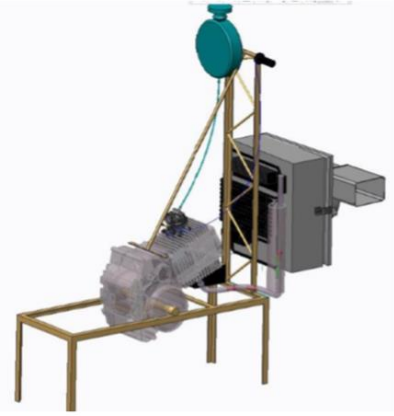

Fig. 1. Conceptual design

The major components used i. Condenser ii. Evaporator iii. Heat exchanger iv. IC engine. Battery vi. Frame

A. 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. The common forms of condensers may be broadly classified on the basis of the cooling medium as, i. Water cooled condenser. ii. Air cooled condenser. iii. Evaporative (air and water cooled) condenser. iv. 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 aluminum 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.

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

Classifications of evaporators:

The common forms of evaporators can be classified as follows, i. According to the type of construction, a) Bare tube coil evaporator. b) Finned tube evaporator. c) Plate evaporator. d) Shell and tube evaporator. e) Shell and coil evaporator. f) Tube – in – tube evaporator. ii. According to the manner in which liquid refrigerant is fed, a) Flooded evaporator. b) Dry expansion evaporator. iii. According to the mode of heat transfer, a) Natural convection evaporator. b) Forced convection evaporator. iv. According to operating conditions, a) Frosting evaporator. b) Non-frosting evaporator. c) Defrosting evaporator.

Shell and coil evaporator:

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.

Fig. 2. Prototype

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. 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; i. Burning or combustions always accomplished by the production of heat. ii. 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. 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.

Battery: 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: i. Low cost ii. Long life iii. High reliability iv. High overall efficiency v. Low discharge vi. Minimum maintenance a) Ampere hour efficiency b) 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.

Product description 3.2.1 Engine i. CC: 100 ii. HORSE POWER: 7BHP iii. TYPE: 4 STOKE

DC generator: i. VOLT: 12V ii. TYPE: PMDC iii. RPM: 100 RPM.

Conditioner box: i. Capacity: 40 liters

Blower fan: i. SIZE: 10" X 2" ii. MATERIAL: ALUMINIUM

Battery: i. Material: Lead-Acid Free maintenance Battery ii. Output Voltage: 12 V D.C iii. Output Power: 40 Ampere-Hour.

Need of Mild steel: The term 'mild steel' is also applied commercially to carbon steels not covered by standard specifications. Carbon content of this steel may vary from quite low levels up to approximately 0.3%. Generally, commercial 'mild steer' can be expected to be readily weld able and have reasonable cold bending properties but to specify 'mild steel' is technically inappropriate and should not be used as a term in the most widely used steel which is not brittle and cheap in price. Mild steel is not readily tempered or hardened but possesses enough strength.

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 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 made to pass through the generator where the heat is recovered, which later escapes in to atmosphere.

4. Conclusion

We have completed the work with the limited time successfully. The air conditioning using engine exhaust system is working with satisfactory conditions. We can able to understand the difficulties in maintaining the tolerances and also the quality. We have done to our ability and skill making maximum use of available facilities.

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