Experimental Investigations on Vehicle Suspension to Produce Power for Running Air Conditioning Systems

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Abstract: In automobile the suspension system is essential to absorb shocks, vibration and bumps etc. Vehicle is run on different type road conditions such as even, uneven, rough etc. The automobile frame and body are mounted on front and rear axle through springs and shock absorbers. This is essential to damp out road shocks transmitted to the frame by the wheels when they roll over uneven road. This creates discomfort to the passengers and produces stresses in the frame and other parts of the automobile. The passenger experiences the jolts by the forward movement of the vehicle and jerks due to uneven road conditions. Even under good road condition the passenger are also subjected to bounce and roll when cornering and pitch when the front wheels are suddenly lifted or dropped in relation to rear wheels that means suspension system work continuously. Due to varying conditions of heating, ventilating, cooling and dehumidification in the atmosphere at various places, the air conditioning of automobiles is very essential. To maintain human comfort and improve internal atmosphere in an enclosed space, proper control of freshness, temperature, humidity and cleanliness of the air is required. So, in this project we are using renewable energy of suspension system to produce air conditioning effect in automobile.

Index Terms **– Vehicle Suspension, AC System, Heat Exchangers, Pump, Blower.**

I. INTRODUCTION

Due to varying conditions of heating, ventilating, cooling and dehumidification in the atmosphere at various places, the air conditioning of automobiles is very essential. To maintain human comfort and improve internal atmosphere in an enclosed space, proper control of freshness, temperature, humidity and cleanliness of the air is required. So, in this project we are using renewable energy of suspension system to produce air conditioning effect in automobile. Energy is necessary for daily survival. Future development crucially depends on its long-term availability in increasing quantities from sources that are dependable, safe, and environmentally sound. At present, no single source or mix of sources is at hand to meet this future need. Concern about a dependable future for energy is only natural since energy provides 'essential services' for human life - heat for warmth, cooking. In many countries worldwide, a lot of primary energy is wasted because of the inefficient design or running of the equipment used convert it into the services required; though there is an encouraging growth in awareness of energy conservation and efficiency.

II. LITERATURE REVIEW

S.Vigneswari, V.Vinodhini,(1) Deals about collecting air from the cylinder and store this energy to the compressor tank as non-conventional method by simply driving the vehicle. Non-conventional energy system is very essential at this time to our nation. Compressed air production using vehicle suspensor needs no fuel input power to produce the output of the air. For this project the conversion of the force energy in to air. The control mechanism carries the air cylinder (vehicle suspensor), quick exhaust valve, Non-return valve and spring arrangement. Borse.S.H,Satpute.A.G.,(2) about air conditioning system by using vehicle suspension. When vehicle is run on bumpy road or uneven road then suspension spring move continuously up and down. The pneumatic cylinder is installed below this spring arrangement. This pushing power is supplied to pneumatic piston and cylinder arrangement which compresses the air. This compressed air is supplied to air tank through non return valve. By the placement of non return valve stops the back flow of pressurized air into cylinder again. That high pressurized compressed air is stored in air tank. When we want to turn on A.C. system the pressurized compressed air is supplied to parallel flow heat exchanger through pipe by using knob. Gaurang Tiwari, Dr. R.K. Saxena ,.,(3) research deals with revolves around the energy dissipated by the vehicle suspensions and factors affecting the energy harvested from vehicle suspension. The main idea proposed in this paper is that system depends on recovering this dissipated power by suspension and converts it into regulated power using the applications of power electronics and then uses it in battery charging or feeding some vehicle electric loads directly. The operating principle is derived from the Lenz law that states the change in flux in a coil produces an EMF. The paper has also discussed assembly of the suspension system. The challenges for this system are deterioration of magnetic strength, complexity in circuit and irregularities in the voltage profile.

III. TYPES OF SUSPENSION SYSTEMS

3.1. LEAF SPRING

A leaf spring is a simple form of spring used for suspension in vehicles. Originally spring, sometimes referred to as a semi-elliptical spring or cart spring, it is one of the oldest forms of springing, dating back to medieval times. A leaf spring takes the form of a slender arc-shaped length of spring steel of rectangular cross-section. In the most common configuration, the center of the arc provides location for the axle, while tie holes are provided at either end for attaching to the vehicle body. For very heavy vehicles, a leaf spring can be made from several leaves stacked on top of each other in several layers, often with progressively shorter leaves. Leaf springs can serve locating and to some extent damping as well as springing functions. While the interleaf friction provides a damping action, it is not well controlled and results in stiction in the motion of the suspension. For this reason some manufacturers have used mono-leaf springs.

A leaf spring can either be attached directly to the frame at both ends or attached directly at one end, usually the front, with the other end attached through a shackle, a short swinging arm. The shackle takes up the tendency of the leaf spring to elongate when compressed and thus makes for softer springiness. Some springs terminated in a concave end, called a spoon end (seldom used now), to carry a swivelling member

3.2. TORSION BEAM SUSPENSION

A torsion bar suspension, also known as a torsion spring suspension (but not to be confused with torsion beam rear suspension), is a general term for any vehicle suspension that uses a torsion bar as its main weight bearing spring. One end of a long metal bar is attached firmly to the vehicle chassis; the opposite end terminates in a lever, the torsion key, mounted perpendicular to the bar, that is attached to a suspension arm, a spindle, or the axle. Vertical motion of the wheel causes the bar to twist around its axis and is resisted by the bar's torsion resistance. The effective spring rate of the bar is determined by its length, cross section, shape, material, and manufacturing process.

3.3 COIL SPRING

A coil spring, also known as a helical spring, is a mechanical device which is typically used to store energy and subsequently release it, to absorb shock, or to maintain a force between contacting surfaces. They are made of an elastic material formed into the shape of a helix which returns to its natural length when unloaded. Under tension or compression, the material (wire) of a coil spring undergoes torsion. The spring characteristics therefore depend on the shear modulus, not Young's Modulus.

4. HEAT EXCHANGER

Heat exchangers are devices whose primary responsibility is the transfer (exchange) of heat, typically from one fluid to another. However, they are not only used in heating applications, such as space heaters, but are also used in cooling applications, such as refrigerators and air conditioners. Many types of heat exchangers can be distinguished from on another based on the direction the liquids flow. In such applications, the heat exchangers can be and be parallel-flow, cross-flow, or countercurrent. In parallel-flow heat exchangers, both fluid involved move in the same direction, entering and exiting the exchanger side by side. In cross-flow heat exchangers, the fluid paths run perpendicular to one another. In countercurrent heat exchangers, the fluid paths flow in opposite directions, with each exiting where the other enters. Countercurrent heat exchangers tend to be more effective than others.

Aside from classifying heat exchangers based on fluid direction, there are types that vary mainly in their composition. Some heat exchangers are comprised of multiple tubes, whereas others consist of hot plates with room for fluid to flow between them. It's important to keep in mind that not all heat exchangers depend on the transfer of heat from liquid to liquid, but in certain cases use other.

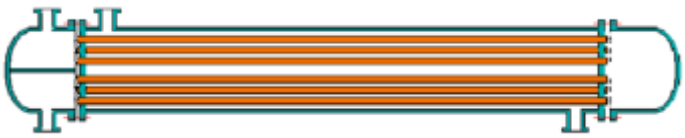

Fig.1. shell and Tube Type Heat Exchanger

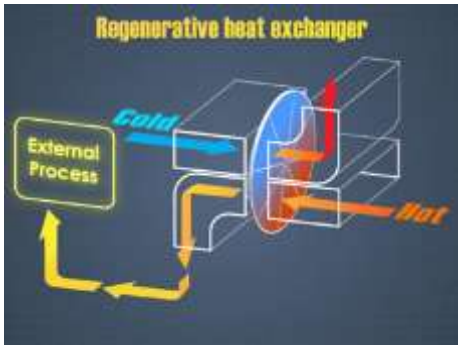

Fig.2. Regenerative Heat Exchanger

V. MATERIALS/COMPONENTS REQUIRED

5.1. SINGLE ACTING CYLINDER

The single-acting piston-type cylinder is similar in design and operation to the single-acting ram-type cylinder. The single-acting piston-type cylinder uses fluid pressure to provide the force in one direction, and spring tension, gravity, compressed air, or nitrogen is used to provide the force in the opposite direction. Single-acting, spring-loaded, piston-type actuating cylinder. In this cylinder the spring is located on the rod side of the piston. In some spring-loaded cylinders the spring is located on the blank side, and the fluid port is on the rod side of the cylinder. A three-way directional control valve is normally used to control the operation of the single-acting piston-type cylinder. To extend the piston rod, fluid under pressure is directed through the port into the cylinder.

5.2. SPRING

Spring is elastic object used to store mechanical energy .The system will have two helical compression springs. We are using spring to store kinetic energy, which is not used by existing suspension system. We are using steel as material for spring. In this system we are using helical compression system which is generally used to store energy due to resilience and subsequently release it. Force applied by helical compression spring is directly proportional to its length. When vehicle is running on bumpy roads, then shocks and vibrations transmitted to persons, which is very uncomfortable that's why we use shock absorber to absorb shocks and vibrations to become comfort. Shock absorber is nothing but a spring. In this we have used coil spring because this spring absorbs more shocks rather than other type.

5.3. AIR TANK

Air tank is a closed container designed to hold fluids at pressure other than atmospheric pressure. Air receiver is used to provide compressed air to tank. They are dangerous to handle hence regulated time to time. The system will have the cylinder made up of mild steel and it will have two holes which may be used to pass input and output air.

5.4 HEAT EXCHANGER

Heat exchanger is device which provides the heat transfer from one medium to other. These two fluids are generally separated by the solid boundaries to prevent direct contact between them or mixing between them. They are used in many systems like refrigeration, air conditioning, power plants etc.

5.5. BATTERY ELIMINATOR

A battery eliminator is a device powered by an electrical source other than a battery, which then converts the source to a suitable DC voltage that may be used by a second device designed to be powered by batteries. A battery eliminator eliminates the need to replace batteries but may remove the advantage of portability. A battery eliminator is also effective in replacing obsolete battery designs.

5.6 BLOWER

Blowers serve three main functions: heating, cooling and air flow. Although unit designs range from simple and complex, most blowers usually consist of some type of fan-like apparatus. Some blowers also use pressure pumps to move air or gases. The term blower, however, often refers to cooling fans and centrifugal blowers. Blowers used for cooling purposes either send cooler air into a system or facility.

5.7 THERMOMETER

A thermometer is a device that measures temperature or a temperature gradient. A thermometer has two important elements: (1) a temperature sensor (e.g. the bulb of a mercury-in-glass thermometer) in which some physical change occurs with temperature, and (2) some means of converting this physical change into a numerical value (e.g. the visible scale that is marked on a mercury-in-glass thermometer).

5.8. PUMP

A pump is a device that moves fluids (liquids or gases), or sometimes slurries, by mechanical action. Pumps can be classified into three major groups according to the method they use to move the fluid: direct lift, displacement, and gravity pumps. Pumps operate by some mechanism (typically reciprocating or rotary), and consume energy to perform mechanical work by moving the fluid. Pumps operate via many energy sources, including manual operation, electricity, engines, or wind power, come in many sizes, from microscopic for use in medical applications to large industrial pumps.

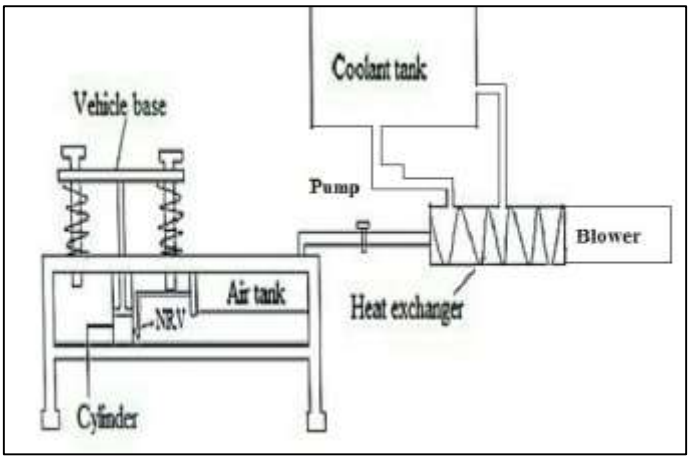

Fig.3. 2D Model of AC system using Suspension

VI. DESIGN CALCULATION

FOR COUNTER FLOW

Entry temperature of air (T_1) = 36ºC
Entry temperature of coolant (t_1) = 32ºC
Exit temperature of coolant (t_2) = 34ºC
Exit temperature of air (T_2) = ?
Specific heat of air (C_{ph}) = 1.005 kj/kg k
Flow rate of air (m_h) = 0.20 m^3/s
Specific heat of coolant (C_{pc}) = 1.67 j/kg k
flow rate of coolant (m_c) = 0.75 kg/s

Heat lost by air = Heat gained by coolant

$Q_h = Q_c$

$M_c(C_{ph})(T_1-T_2) = m_c(C_{pc})(t_2-t_1)$

$0.20\times1.005(36-T2) = 0.75\times1.67(34-32)$

T2 = 27ºC

Heat transferred in cold water

$Q = m_c C_{pc}(t_2-t_1)$

$Q = 0.78\times1.67(34-32)$

Q = 2.505 kJ

Logarithmic Mean Temperature Difference (LMTD)

For counter flow

$(\Delta Tm) = \{(T_1-t_2) - (T_2-t_1)\} \div \ln \{(T_1-t_2) \div (T_2-t_1)\}$

$(\Delta Tm) = \{(36-34) - (27-32) \div \ln \{(36-34) \div (27-32)\}$

(ΔTm) = 7.7ºC

VII. WORKING PRINCIPLE

The vehicle frame is bounce according to suspension of vehicle. In figure the vehicle frame is push by manually this connect the piston rod end and move the piston inside the cylinder mounted on axle of the vehicle and this movement of piston the atmospheric air is suck from piston moves from BDC to TDC and compressed the air from piston moves to TDC to BDC. The outlet port of cylinder is connected to the hoses pipe and supplies the compressed air in air receiver. This air receiver is connected the pressure gage to indicate the pressure inside the receiver. The other side of receiver the regulating valve is fitted to regulate the pressure of air. This valve is connected the hoses and air is supplied to heat exchanger.

The heat exchanger is used in shell and tube type. The air is supplied inside the heat exchanger and cooling liquid is supplied in inside of tube for the purpose to produce cooling effect. We choose counter flow type of heat exchanger because of its high rate of transfer, compact size, and use of gases fluid is possible and large range of temperature difference. This cooling liquid is store in air tank and supply the cooling liquid in inlet port of the heat exchanger. Then hot air is drain to heat exchanger from outlet port and the cool of air also cooling effect is produced. This cooling air is passing to vehicle cabin for the purpose of comfort air conditioning. The cycle is repeated. The Pump which transfers the coolant from the heat exchanger to coolant tank and the cycle is repeated.

The blower which is used to send the cool air from the heat exchanger to outside and main purpose is blower which acts as a fan which pushes the air to the atmosphere at the higher speed rate. The battery eliminator which then converts the source to a suitable DC voltage that may be used by a second device designed to be powered by batteries. Here we have used from power source without battery. It has been attached with 2 Thermometers one shows the reading of current room temperature another one which is fixed where air coming out from blower which shows the outlet temperature of air.

Fig.4. Fabricated model of AC System using suspension

VIII. CONCLUSION

Research focuses on energy saving mechanisms by using vehicle suspension system. This project can be very much useful for Indian conditions because of geographical sites. Taking into consideration other manmade sites like road it is well known fact that we have one of the best as well as worst road conditions available. So this kind of project is well worth regarding Indian context of view. Using of this system in vehicle we are save fuel economy.

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