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Doors of Vehicles: An Energy Source

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ABSTRACT: In the pace of automobiles, machines energy requirement is increasing every-day to operate these automobiles and machines. Although there a number of electricity generation sources available but still the researchers, scientists and engineers keep searching new, cost effective and automatic electricity and energy generating sources. In this research paper one such technique for the generation of electricity has been proposed where the electricity has been produced using the piezoelectric fixes on the inner side of door underneath the sealer material lining of the door which also provides cushion to the door while closing the door. Piezoelectric can also be fixed in cushion rubber pads on the inner side of the door of the four wheelers. The electricity produces when the door is slammed because due to the shutting of the door the piezoelectric underneath gets pressed and electricity produces with voltage ranging from 0-100 V depending upon the size, surface area exposing to the force applied, shape and the applied force on/of the piezoelectric which are available in ring, plate, cylindrical, disc shapes. The electricity generated will help the vehicle battery to get charged in less time or this energy can be used for other applications that depends upon the requirement

KEYWORDS: Automobile, Battery, Cushion, Cylindrical, Piezoelectric, Sealer, Alternate energy, Electricity.

I. INTRODUCTION

Piezo is used to define materials which accumulate the charge due to the piezoelectric effect. Piezo materials, including crystals and ceramics generate a voltage due to the application of the mechanical stress. But in the case of inverse effect, when the same materials are applied voltage their shape gets changed either by lengthening or by shortening in response to the applied voltage. The voltage, force and the movements produced by the piezo materials are small and usually require enlargement[1]. For example, by merely changing the thickness of the piezoelectric, these materials can be used in many far reaching applications. These are usually preferred in many applications due to their ability to get tailored to fulfil the specific requirements. Currently, PZT materials are the most abundantly used materials because they offer greater sensitivity and higher operating temperatures than the other ceramics.

The term “piezoelectricity” has been derived from two words which means from press and amber means a source of electricity or it can be said that it refers to the generation of the electricity with the application of latent heat and pressure. Thus whenever a mechanical stress is applied, an electric charge can build up in the solid material, including ceramics, crystals and some biological materials like DNA, bone and certain proteins. Thus the resulting effect is that the type of electricity produced due to the pressure or the heat otherwise known as the piezoelectricity. In 1880, Pierre brothers discovered an uncommon behavior of some crystalline minerals, when they were subjected to the mechanical force, the materials become electrically polarized. Tension and compression generated voltages of opposite polarity in proportion of the applied force. The form of the applied energy can be knocking, squeezing, tapping or may be some other type which pressurizes the material but don't make it to fail. So, the force should be applied with utmost care.

- *Piezo Ceramic Elements*

A traditional piezoelectric ceramic is a mass of perovskite ceramic crystals, each consisting of a small, tetravalent metal ion, usually titanium or zirconium, in a lattice of larger, divalent metal ions, usually lead or barium, and O²⁻ ions[2]. For the manufacturing of a piezoelectric ceramic, fine PZT powders of the component metal oxides are mixed in specific proportions, then heated to form a uniform powder. The piezo powder is mixed with an organic binder and is formed into structural elements having the desired shape (discs, rods, plates, etc.). The elements are heated up to a

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specific time and temperature as programmed, during which the piezo powder particles undergoes the process of sintering and the material attains a fine dense crystalline structure. After that the elements are cooled, shaped or cut to specifications, and electrodes are applied to the appropriate surfaces.

- *What can piezoelectric ceramics do?*

Mechanical compression or tension on a poled piezoelectric ceramic element changes the dipole moment, creating a voltage. Compression along the direction of polarization, or tension in a direction perpendicular to the direction of polarization, generates the voltage of same polarity as the poling voltage[3]. Tension along the direction of polarization, or compression perpendicular to the direction of the polarization, generates a voltage signal having polarity opposite to that of the poling voltage. These actions are generator actions -- the ceramic element converts the mechanical energy of compression or tension into electrical energy. This behavior is used in force-sensing devices, fuel-igniting devices and solid state batteries. Values for the compressive stresses and the voltage generated by applying stress to the piezoelectric ceramic element are linearly proportional to a material-specific stress. It also holds true for applied voltage and generated strain. If a voltage of the same polarity as the poling voltage is applied to a ceramic element, in the direction of the poling voltage, the element will lengthen and its diameter will become smaller. If a voltage of polarity opposite to that of the poling voltage is applied, the element will become shorter and broader[4]. If an alternating voltage is applied, the element will lengthen or shorten cyclically, at the frequency of the applied voltage. This is motor action -- electrical energy is converted into mechanical energy. The principle is adapted to sound or ultrasound generating devices, piezoelectric motors.

II. METHODOLOGY

The production of the electricity depends upon the shape, shape of the piezoelectric and it also depends upon how the piezoelectric has been placed/fixed to the door of vehicle due to which the surface area of the piezoelectric exposing to the force applied varies and the force applied on the piezoelectric also. Suppose for the best placement of the piezoelectric on the door of the piezoelectric is on the inner side where the door slams with the panel of body of the vehicle because the area that comes under the force is the rubber lining on the inner side of the door. Secondly piezoelectric can also be placed on the rubber pad on the lower side of the door which also provide cushion to the door[5]. Depending upon the shape, size, force applied and the surface area of the piezoelectric exposed various calculation can be performed and best shape and size can be chosen. Generally, disc and cylindrical shapes are chosen and the force applied in on thickness wise or the in the radial direction.

III. RESULTS & DISCUSSION

Thus from the above calculations it can be inferred that the maximum value of static voltage is for the ring shape piezoelectric for almost similar dimensions. It is also beneficial to use ring shape piezoelectric because multiple piezoelectric can be placed with decreasing diameter one inside the bigger one so that more amount of current can be obtained in a given space. For a single door suppose there are 20 piezoelectric installed, then the voltage will add up if the connections are in series and the current will add up if the connections are in parallel. For the five door vehicle like car the generated electricity will be in good amount to charge the battery[6]. Ring shape is preferred as per the calculation wise because ring shape produces more voltage than other shapes but depending upon the space and shape of the door available shape of the piezoelectric can be changed so as to fit properly on the door and thus the amount of voltage will vary according to the real situation. Calculations mainly vary with kind of shape installed on the door and the direction of the application of force on the piezoelectric which can be in radial, tensile or thickness wise [7]. So, in real situation actual value may differ from the calculated one depending upon some other factors that may have not been considered while calculating the value of the voltage produced.

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IV. CONCLUSION

Although there are a number of sources available for the generation of electricity in a vehicle but the set up required is voluminous and costly and also requires energy to operate to charge the battery like alternator which is operated by the belt attached with engine pulley. Alternator in itself is very costly component but this setup requires one-time arrangement, design and investment. Door opening, closing is a usual activity that happens in the vehicle to step-in or step-out. For each step-in and step-out everybody will feel strange that there is generation of electricity which is getting stored for the usage in operating the appliances. This energy generated if stored in the main battery unit of the vehicle can be used for the other appliances wherever is required or if the specific batteries are installed for the doors then can be used for the door operation purposes. This research will certainly help to reduce the energy load on the main battery unit and the reduced consumption form the main battery can be utilized for operating other devices installed in vehicles.

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