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Utilization of HDPE for making piezoelectric plastic tiles

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Abstract - *The overall goal of this study article is to help clean up the environment. The specific goal of this work is to develop sustainable plastic tiles from plastic trash. As a result of this technology's usage of waste plastic in the production of tiles, the environment is automatically cleaned up.The current investigation focuses on producing floor tiles from 100% HDPE waste plastic. The study also covered the production of electricity. Piezoelectric flooring is excellent for areas with high foot traffic. Therefore, using waste plastic tile and piezoelectric sensors to generate electricity from footstep energy will assist to minimize pollution and energy demand, resulting in the creation of piezoelectric plastic tiles as the end result.*

Key Words: **Plastic, plastic waste, HDPE, piezoelectricity, tiles, footstep.**

1. INTRODUCTION

Numerous research have examined the possibility of capturing the energy of people strolling through crowded public areas. For nations with dense populations, the technique known as piezoelectricity, which applies human waste energy from foot power, is unquestionably crucial. When pressure is applied, floor sensors catch the electrical energy created by the pressure and convert it to an electrical charge that is then stored and used as a power source.

The usage of a flooring tile made of piezoelectric material makes it appropriate for locations with high foot traffic. a method for effectively using waste plastic in flooring tiles and the potential for electricity production through the use of piezoelectric materials in flooring tiles.

Problem Statement

Plastic waste poses a serious threat to both the environment and human lives. Plastic disposal takes close to 300 years. Additionally, the plastic contains dangerous compounds that, when burned, release deadly fumes. We intend to employ waste plastic from the civil industry as a raw material for the production of tiles in order to lessen this negative impact of plastic on the environment.

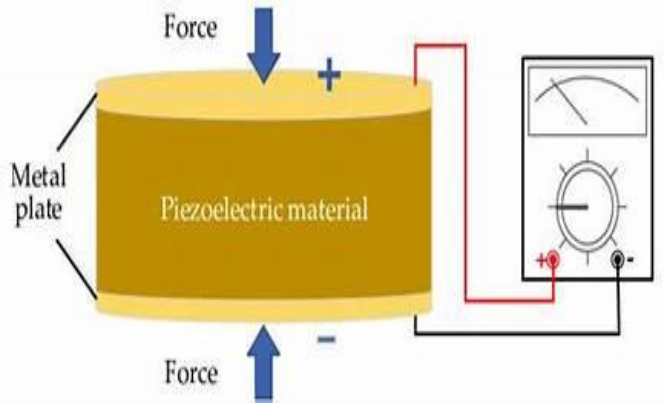
It is past time to consider producing cleaner sources of electricity given the nation's increasing demand for electricity on a regular basis. The Indian power industry has previously launched a number of steps to encourage renewable energy sources including solar, wind, hydro, etc. There are numerous ways to produce electricity as an alternative technique of generating power, and one of these ways, called footstep energy generation, can be a successful way to do it.

Types of Plastic

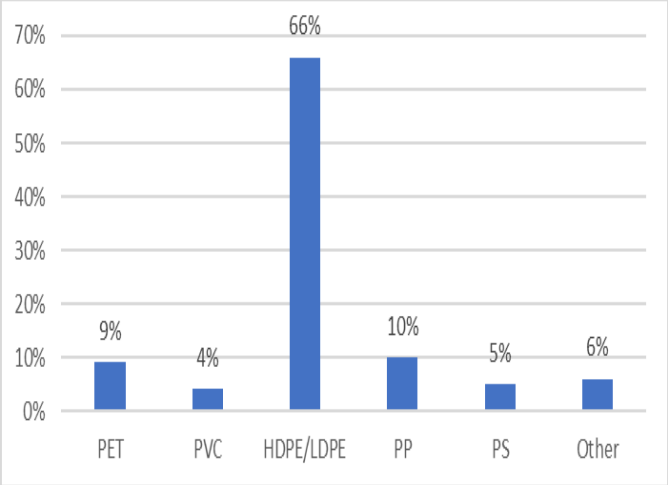
1. Polyethylene Terephthalate.
2. High-Density Polyethylene.
3. Polyvinyl Chloride.
4. Low-Density Polyethylene.
5. Polypropylene.
6. Polystyrene.

Piezoelectric Effect

Two French physicist brothers, Pierre and Paul, discovered the piezoelectric phenomenon in 1880. A piezoelectric sensor is a tool that converts pressure, acceleration, and force into an electrical signal via the piezoelectric effect. Piezoelectric crystals generate electricity when pressure is applied to the crystal lattice.



PW makes up 8% of the waste produced in India. In India, 6137 tonnes of PW run through streets, highways, and beaches per day without being collected. By 2005, PW in MSW had roughly doubled in comparison to 1970, while paper trash production had only climbed slightly more than twice as much. Figure displays the primary types of polymers used in India's PW composition.



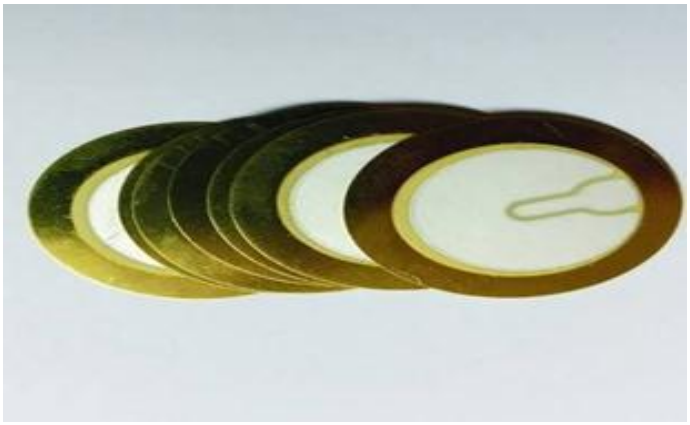
Primary types of polymers used in India's PW composition

Sr no.	Property	
1	Density(g/cm^3)	0.94-0.96
2	Tensile Modulus of elasticity (MPa)	600-1400
3	Yield Stress (MPa)	18-30
4	Melting Temperature(^{0}C)	126-135
5	Water absorption	<0.05

Typical properties of HDPE plastic

2. Methodology

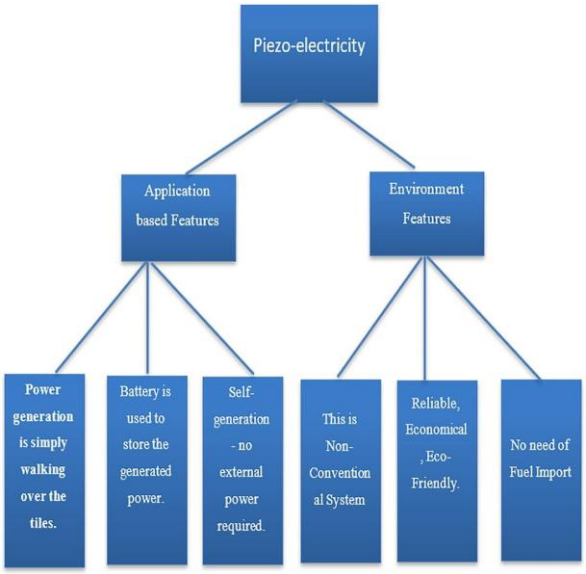
Hdpe-labeled plastic waste was collected from auto garages for recycling. Plastic garbage is physically sorted, shredded, and cut into smaller pieces. The chips were thoroughly cleaned and free of dirt, paper labels, and other product remains. Plastic waste melted at temperatures between 210^{0}C to 300^{0}C when using an injection moulding system. The individual tile measures 150x150x10 mm. A mould was created to give the molten plastic its ultimate shape of the tile. This was created by joining MS plates with welding. Mould should be placed in water to cool immediately after being filled with molten plastic. The tile is taken out of the mould once it has cooled. For proper utilization of piezoelectric sensors sandwiching it in rubber which is placed under tile. So by using above methodology the 0.9mx0.3m tile track is made and 20 piezoelectric sensor were placed.



Typical piezoelectric sensor

Typical characteristics of piezoelectricity

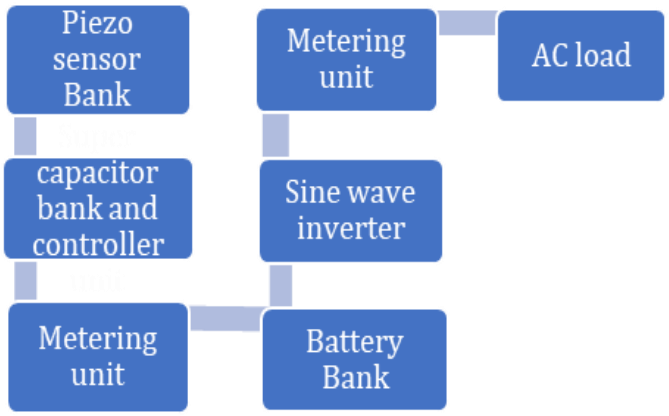
The majority of current energy research is concentrated on creating new energy sources. The search for future renewable energy sources has begun. Due to their peculiar nature and unique and interesting features, piezoelectric materials are being explored more and more. Energy can only be changed from one form to another; it cannot be created or destroyed. In actuality, their materials may be suitable to generate electrical energy from mechanical energy, similar as vibrations, into electricity.



3. Generation of electricity by use of piezoelectric materials

A charge is produced across a piezoelectric material when a force is applied to it. The pressure energy applied to the flooring tiles containing piezoelectric material can be converted into electrical energy. The weight of the persons stepping on it can provide pressure. The output of the piezoelectric material is not constant. This variable voltage can be transformed into a linear voltage with the use of a

bridge circuit. The availability of rechargeable batteries helps with output DC voltage storage. A provision can be made to convert Direct Current (DC) to Alternate Current (AC) loads by providing a battery and connecting an inverter to the battery. Additionally, an LCD display can be used.



Circuit Block Diagram

4. Test

Flexure test

The three-point bending flexural test was used to test the flexure strength of sample.

Sr No	Specimen	Breaking load(N)	Average
1	Specimen 1	1482	1524.67
2	Specimen 2	1594	
3	Specimen 3	1498	

Water Absorption test

The water absorption test has been carried out as per ASTM D570 - 98. The samples are subjected to gradual increase in water absorption at room temperature of 23°C

Sr No.	Specimen	Water Absorption (%)	Average
1	Specimen 1	0.03	0.031
2	Specimen 2	0.013	
3	Specimen 3	0.051	

Compression test

The plastic block has a short curing time. Plastic core can slowly cool over a period of 24 hours in ambient temperatures, but 72 hours is recommended for safety.

Sr No.	Specimen	Load KN	Strength N/mm²	Average
1	Specimen 1	319.30	14.19	13.6
2	Specimen 2	303.12	13.47	
3	Specimen 3	302.05	13.42	

Flash and Fire Point Test

Flash and fire point test was taken using standard procedure by using Pensky Marten apparatus.

Sr No.	Test	Temperature
1	Flash point	230°C
2	Fire point	330°C

5. Result and discussion

An assembly is capable to generate 12 v. A circuit can be prepared to utilize the renewable energy that is generated by piezoelectric tiles and can be connected to an ac load. For example, the average percentage of water absorption by tile is 0.031%. The average breaking load is 1524.67 N. The compressive strength obtained is 13.6 N/mm² and result of flash and fire point test was obtained 230°C as flash point and 330°C as fire point. Form the results it is clear that such tiles can easily use in Indian conditions without much problem of catching of fire at normal operating temperatures. There is no effect of weathering on tile.

6. Conclusion

The study offers a practical and effective solution for getting rid of waste plastic. We have created a system that is most suited for congested regions and can generate energy from staircases, passageways, and many other busy locations like institutional buildings, train stations, etc. These tiles perform better than regular tiles. Because it is made from garbage, a product that has been totally recycled was produced at a very low cost. Unlike ceramic tile, the substance is indestructible. With the use of these techniques, waste plastic and waste human energy both can be utilized.

Piezoelectric plastic tiles arrangement

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