

INTRODUCING PIEZOELECTRIC TILE'S USAGE IN PUBLIC PLACES TO CONSERVE ENERGY

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ABSTRACT

Since the demonstration with help of an electric bulb at Calcutta in 1879, by Kilburn & company, Electricity has been commercialised for modern use since. With ever so growing consumption to support modern appliances, our reliance on this form of energy has surpassed the usage of petrol and diesel.

To help provide for this growing need India generates over 375,322.74 MW of electricity through 22 nuclear reactors plus other installations like solar, hydro, thermal and wind based electricity generation plants throughout the country.

It has been noticed that large public spaces like Malls, Airport, Railstation and even Metro stations operate throughout the day on a daily basis, consuming an excessive amount of electricity in India in comparison to residential areas and factories.

Where a medium sized mall within Delhi can consume anything between 6 - 10 MW of power daily, ample to light up nearly 2000 houses for a day. International Airports like Indra Gandhi Airport in Delhi, demanding 24 hours of air conditioning and lighting can consume over 200 million units of electricity within a year.

In this paper our research aims to verify if using Piezo-Gen technology as a viable source of energy generation for such public spaces. We are going to look into the matter from a cost effective and use per case point of view by analyzing available data on the technology.

INTRODUCTION

Piezo- generation of electricity a modern concept, initially introduced by Jacques & Pierre Curie in 1880, creating pressure energy using crystals like quartz to create electricity.

Piezoelectric tiles are ceramic tiles, which has taken the piezo- generation process, mixing it with modern technology to help harvest energy with the help of footsteps walking over these tiles. This concept has an opportunity to not only reduce the grid based energy consumption but also give back to the grid if combined with other forms of renewable energy like Wind and Solar

energy.

The objective of this report would be to look into the feasibility of such a concept, verifying use cases as piezoelectric modules are known to easily break apart under pressure, and their ability to work under different climatic conditions. We shall also consider the existing manufacturing sector and import sector of the technology within the country, its cost and implication on the end consumer.

We shall be relying on available data to carry out a secondary research on the product.

Literature Review

- Piezo-Gen - An Approach to Generate Electricity from Vibrations: this paper looks into the various use cases of the technology, and shall help us realise where all and how the technology can be used
- Designing and manufacturing a piezoelectric tile for harvesting energy from footsteps: This paper looks into various aspects of Piezoelectric tiles along with the manufacturing process and drawbacks.
- PPM Report: Using Renewable Solar Energy Use for The Aviation Industry; part of the Airport Carbon Accreditation (ACA) scheme - this report helped us understand the consumption of electricity within the Airports
- AIP Publishing: The paper is an analysis of the Kuala Lumpur International Airport and how their analysis on adoption of piezoelectric tiles within its infrastructure.
- Piezoelectric energy generation in India: an empirical investigation: The paper is an analysis of the piezoelectric energy market within India
- IOP Publishing: There paper looks into Piezoelectric tiles being a sustainable approach for designing interior spaces and creating self-sustaining projects
- Paris Process on Mobility and Climate: Their research on using various sustainable technologies within the Aviation Industry
- Materials Today: their articles on PZT and its impact on sustainable CSR Activities worldwide.
- Financial Express: Their review on the power cuts in india and the reason behind them

RESEARCH METHODOLOGY

While there are many various forms of research methods that can be used to provide insight to the situation smaller sports are in. I have used the Secondary Research approach considering the amount of data available and the lockdown throughout the various states.

Secondary Research is a systematic analytical investigation where I would rely on the data available on the subject. As I shall be using Data available online, I have ensured that I use data presented by reliable sources and media channels only.

This format of research is not only cost & time effective, gathering data from reliable sources ensures the authenticity of the data. Using this form of research also allows me an opportunity to identify any knowledge gaps which could be used to serve as the basis of further systematic investigation.

While I may have reduced the possibility of questionability of data by using only reliable sources, I still need to consider many other factors that come with secondary data. As the data is freely available to all, the information presented in secondary data is going to be common through and may not present any unique advantage, thus It would solely depend on my analysis and interpretation of the data that shall bring uniqueness to this paper. Also as information may be generic i would have to identify relevant data, specific to this paper and discard the others. Though the chance of the data being outdated may be less, I still need to be aware of newly updated data and information available in context to this paper.

This paper focuses on analysing the cost effectiveness of using piezoelectric tiles for generating power through vibration caused due to walking to light up public places with high number of people.

Hypothesis

However understanding technology is being used alongside ceramic, we can consider them to be highly costly and needing expertise for installation. Also assuming the tiles would be walked upon, we need to also consider wear and tear and the cost associated to.

ANALYSIS

Analysis of the piezoelectric tiles

India is largely dependent on fossil fuel imports as a source for its electricity. About 80% of India's electricity generation is from fossil fuels. The country's peak electricity demand fell after commercial and industrial power demand decreased as factories shut down during the lockdown

during the spread of the pandemic. However, the domestic consumption of electricity, which is comparatively generated less, has risen as everyone has been pushed to stay indoors.

Piezoelectric flooring is ideal for places that receive heavy foot traffic. It can be placed at tourist attractions, dance floors or town halls, schools, stadiums,. In fact, the hard Energy Floors has a product called the Sustainable Dance Floor especially designed for clubs. Piezoelectric tiles can also be placed in other busy places such as subway stations, airports, universities, and malls. The cost per one piezoelectric tile is 40,000.

Advantages of piezoelectric material

- They can operate at any temperature conditions
- They can be reused
- They have a low carbon footprint making them the best alternative for fossil fuels
- Unused energy lost in the form of vibrations can be tapped to generate green energy
- Characteristics of these materials make them the best energy harvesters

Limitations of piezoelectric material

- While working with vibrations these devices are prone to pick up unwanted vibrations also
- The amount of research done on them till date is not sufficient to exploit full usage of these devices
- Resistance and durability apply limits to devices when used to tap energy and from roads and pavements
- The mismatch between piezoelectric material and pavement material

Sparkler Ceramics registered in 1990 as a Pvt. Ltd. Company under the Indian Companies Act, 1956. Started its Commercial Production in 1994; Sparkler Ceramics Pvt. Ltd. is now the largest manufacturer of piezoelectric elements in South Asia. Central Electronics Limited (CEL) is a pioneer in manufacturing of different types of PZT elements since 1976 in India. Some global vendors of these materials are AC International, ACC Technologies, Arkema, Cedrat Technologies, Kyocera, Solvay, etc.

Piezoelectric tile output

If we have to install the tiles in a public place, for example a mall, we will first have to know its

size. An average mall is around 4000 square feet and has 2-3 floors. The average size of one tile is 2.5 feet. Since these tiles are expensive, we would prefer installing 1 in every 25 tiles. The average number of people that visit the mall on a weekday is 150 (including employees) and the number of steps on a tile per person is around 300 steps. Assuming that the tile gets 3-5 hits per person in a day, the number of hits will be $5 \times 300 = 1,500$ hits. The energy generated per step by the tile is 5×4 piezoelectric crystals = 20j. Hence, the total energy generated in a day by one tile will be $1,500 \times 20 \text{ j} = 30,000 \text{ j}$ and total energy generated per year will be $30,000 \text{ j} \times 365 = 1,09,50,000 \text{ j} = 3.04167 \text{ kWh}$. The durability of these tiles is 15 years.

COMPARISON

Solar Panels

Solar panels are used to convert the light from the sun, which is composed of particles of energy called “photons”, into electricity that can be used to power electrical loads. The panels collect clean renewable energy in the form of sunlight and convert that light into electricity which can be used to provide power to different sources.

Piezoelectric Tiles Vs Solar Panel

The cost for installation of 1 panel is Rs.75,000-1,00,000 whereas the cost of installing 1 tile is Rs.12,000. The number of units produced by a panel in a year (considering its capacity utilization factor 20%) is 1700 units. The number of units produced by one tile in a year is 3.04167 units. In the long run, the piezoelectric tile is cheaper than the solar panel. It is more practical to install the tiles than the solar panel.

21% of the people say that there are frequent power cuts in their area. 96% of the people have the habit of switching off the appliances when not required to save electricity. Nearly 40% of the people pay the electricity bills in a range of Rs.3–5 and above Rs.5 per unit of electricity consumption a month. 77% of the people get above Rs.1000 as their overall electricity consumption a month, 18% pay above Rs.500 per month and the remaining get their electricity bill below Rs.500. Around 80% of the people are having the willingness to produce their own electricity by walking. 86% of the consumers are interested in producing power of their own that can be consumed by them as per their own requirements. Hence, these tiles will be successful if commercialized and implemented.

Size of the market

The global piezoelectric materials market size was valued at USD 1.17 billion in 2015. It was then estimated at USD 2.31 billion in 2019 and was expected to reach USD 2.46 million in 2020.

As we know, there are frequent power cuts in our country. Most power cuts happen during rain because lightning strikes and heavy winds can damage lines and cause power surges. The power cuts may be caused due to several incidents such as earthquakes, floods, accidents near power lines, fallen trees, equipment failure, weather conditions, etc. Another reason for it can also be the high energy demand from the area. Since there are many sources that are using the energy, it can be overloaded and may cause a power cut in the region. However, this problem can be solved. There can be usage of piezoelectric tiles in areas experiencing frequent power cuts. The energy can be generated and stored and later used during the power cuts. This way, all the important business or household work can be completed and we won't have to wait for the power to return.

CONCLUSION

There are a lot of households in India that suffer due to inefficient electricity. In some areas, there are frequent power cuts while in the others there is very less energy generation. The solution to all this is the introduction and implementation of piezoelectric tiles.

These tiles can also be used in places like slum areas where there is a lot of population and shortage of resources. The tiles can produce and store electricity and be used as per the convenience of the people. Although the cost of these tiles may be a problem as not everyone can afford it, its introduction in markets of India is very productive.

The companies in India should invest in this as it is a growing market and it is very accessible and valuable even in the future. These tiles can help solve numerous problems during power cuts, insufficient generation of energy and wastage of energy. Places like malls, airports, railway stations, etc. can store excess electricity generated and prevent wastage while the regions having fewer resources like slum areas can generate sufficient energy which can be used by them whenever they want.

There are so many different ways in which these tiles can be valuable in different situations. If we know the places which are best suited for their installation, the problem of electricity within our country can be improved. These tiles may not be very known and popular in every region of the world, but they are one step towards a sustainable environment. There is a constant depletion of non-renewable resources and if energy is not conserved, soon there may not be many resources for our future generation. When we consume less power, we reduce the amount of toxic fumes released by power plants, conserve earth's natural resources and protect the ecosystem from destruction.

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