Method of Generating Maximum Power Generation from Piezoelectric System

Anjali Gupta, Surya Deo Chaudhary

Abstract—The piezoelectric system converts mechanical energy into kinetic energy and the kinetic energy is converted into electricity by applying pressure on the piezoelectric crystal. The less power is generated in case of parallel configuration of piezoelectric crystal. Therefore, this paper deals with the method of generating maximum power from piezoelectric system by striking weight from different height and comparing the result at different height. It is observed that the generation of current from piezoelectric crystal varies from height to height. Thus, it is required to determine the critical height from which the maximum power is generated by striking weight on it.

Keywords- piezoelectric system, maximum power generation, critical strike rates.

I. INTRODUCTION

In modern world of globalization, the rate of power consumption increases from 40% to 80% due to increment of customer loads and population [1]. The energy demand is growing day by day as the people shifts from rural areas to modern towns and metropolis cities. Since the rate of power consumption is higher than the rate of power generation due to which the utility fails to fulfil the energy demand and as a result of which there is a voltage collapse and power failure [2] . During peak time the load gets overloaded which causes very bad impact on the electrical power component. Due to overloading condition the power system component gets heated and dissipated power in the form of heat. Sometimes there occurs a severe fault due to the overloading and voltage instability condition, so for eliminating these faults and overheating the utility system performs the load shedding by cutting of the power of customers during peak times. The load shedding leads to discontinuity of power and utility system has to suffer from high economic losses [3].

Therefore, to eliminate or reduce the losses caused by load shedding and overloading this paper proposes a novel method that can be employed during the peak load duration. The proposed method is cost effective, reliable, easy in construction and does not require any special component. In this proposed method a series number of piezoelectric crystals is connected and by striking weight from different height the reading is calculated to achieve maximum power from the piezoelectric crystal. It is assumed that during the partial striking condition in the parallel configuration the current generated is very low so it is required to shift from these conventional piezoelectric generation methods to novel method in which the maximum power is generated simply by changing the height of the striking weight that is strike on the piezo electric crystals [4],[5],[6].

II. LITERATURE SURVEY

In past years, various researches have been carried out in the field and use of piezoelectric material for different types of applications. some of them are discussed below:

1) Generating energy using piezo electric material (2009) [7]

This paper discloses about generating electricity by the use of piezoelectric material. In this method a single film of piezo electric is capable of generating electricity and that energy is stored in the rechargeable battery[8]. The main drawback of this method is that it generates very little amount of energy or it can be said that its efficiency is very low.

2) Piezoelectric and electromagnetic energy harvesting system (2009) [9]

This paper reveals the study of piezo electric crystal for harvesting the energy and converting into electricity. It combines the electromagnets and piezo crystal together to produce the electricity. During this experiment it is found that this method serves the purpose of generating the electricity but undergoes to several losses and as a result of which the current produced from this method is of only few micro amperes.

Therefore, it is required to develop a method or device that is capable of generating electricity in most efficient manner and is more reliable then the existing prior arts.

III. PROPOSED METHODOLOGY

There are several configurations in which the piezoelectric crystals can be configured in a system to efficiently fulfil the desired load power requirements. In a general system, arrays are connected in series, parallel, and series-parallel. The main aim of this dissertation is to configure the piezoelectric crystals in the system in various topologies to enhance power generation under the partial vibration condition.

In this dissertation the piezoelectric crystals are configured in the entire above-mentioned configuration under both unvarying and partial vibration condition. The main aim is to configure the piezoelectric crystals in such a way that the power generated under partial vibration condition is enhanced.

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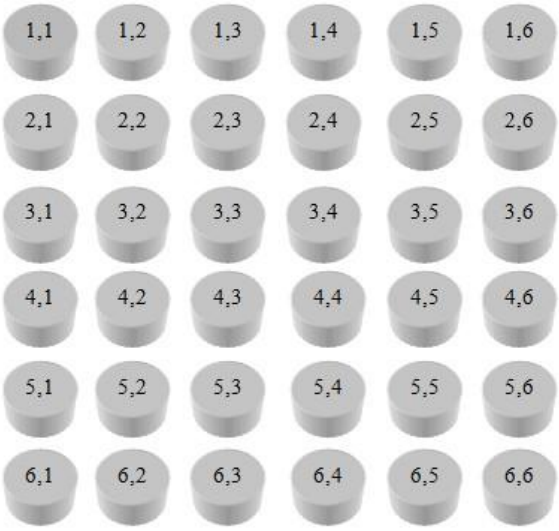

Fig.1 Configuration of piezoelectric crystal

i) Constant vibration condition

The vibration is said to be a constant vibration if and only if all the piezoelectric crystal connected must have uniform vibration throughout the system. This condition is non as ideal condition but in practical no such configuration can be designed. For a large system ideally, it is not possible to have a uniform vibration.

ii) Partial Vibration condition

Practically it is not possible to have a uniform or constant vibration in the whole system. There is an undistributed vibration in the system as the strike on each piezoelectric crystal is not similar, this unequal distribution of vibration is known as partial vibration. The value of partial vibration depends on the height at which the weight gets strikes.

Fig.2 Pattern 1 of Partial vibration

In the proposed method the weight is strike from different heights on the large number of piezoelectric crystals to generate a vibration. It is assumed at on striking weight from different height the value of generated current also varies. It is also observed that the value of current increases on increasing the height of striking but up to the certain limit.

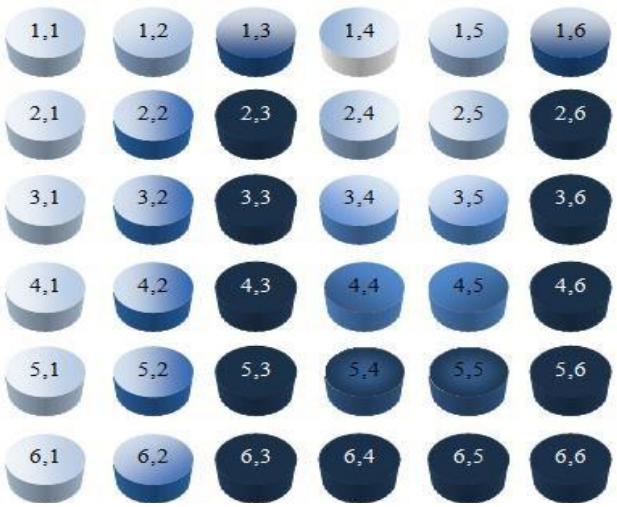

Fig.3 Pattern 2 of partial vibration

IV. RESULT AND DISCUSSION

The piezoelectric crystals are connected in series and the weight is strike from different height. It is observred that the output current and voltage increases on increasing the height of striking but upto some extent. After particular height of vibration the value of generated current and voltage start decreasing, this is known as critical height. Hence from this experiment the maximum energy is produced by determing the critical point at which maximumcurrent and voltage is developed. It is noted that the results from series connected confriguration gives the better result than series- parellel and parellel-parellel combination.

Fig.4 represent the output voltage waveform obtained from partial vibration whereas fig.5 and 6 shows the output current and power of different configuration during partial vibration. Out of all confriguration it is assumed that the series connected confriguration is best that generates maximum output power.

The voltage, current and power is measured and observed in oscilloscope and the reading is shown in table below:

Table 1: Power, Voltage and Current for various topologies during partial vibration pattern 1.

Topologies	Trial 1			Trial 2			Trial 3		
	P(W)	V(V)	I(A)	P(W)	V(V)	I(A)	P(W)	V(V)	I(A)
Simple Series	98.894× 10-6	1.97	50.2× 10-6	117.104× 10-6	2.08	56.3× 10-6	129.549× 10-6	2.17	59.7× 10-6
Simple Parallel	91.988× 10-6	0.58	158.6× 10-6	101.618× 10-6	0.62	163.9× 10-6	131.128× 10-6	0.74	177.2× 10-6
Series-Parallel	258.192× 10-6	1.98	130.4× 10-6	292.248× 10-6	1.98	147.6× 10-6	306.030× 10-6	2.02	151.5× 10-6
BL	335.236× 10-6	2.09	160.4× 10-6	369.364× 10-6	2.14	172.6× 10-6	391.353× 10-6	2.19	178.7× 10-6
HC	419.679× 10-6	2.21	189.9× 10-6	439.222× 10-6	2.29	191.8× 10-6	452.991× 10-6	2.31	196.1× 10-6
TCT	481.712× 10-6	2.38	202.4× 10-6	501.762× 10-6	2.41	208.2× 10-6	526.851× 10-6	2.47	213.3× 10-6
Su Do Ku	649.446× 10-6	2.94	220.9× 10-6	733.566× 10-6	3.09	237.4× 10-6	784.421× 10-6	3.19	245.9× 10-6
Best Topology	Su Do Ku			Su Do Ku			Su Do Ku		

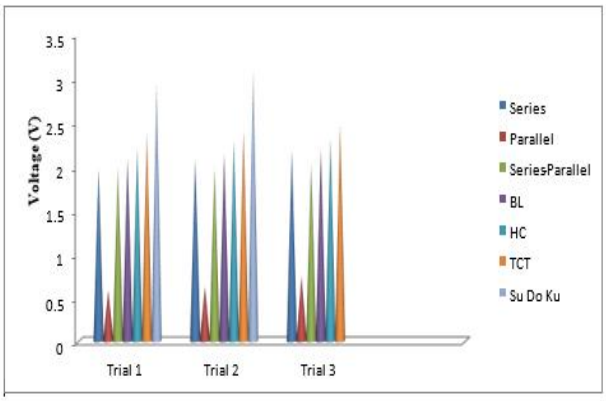

Fig 4: Voltage output during Partial Vibration Condition 1

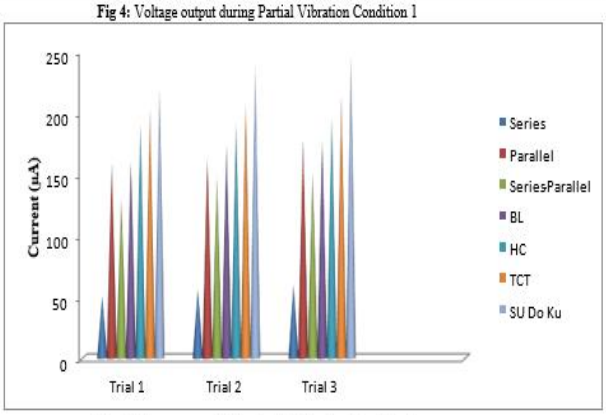

Fig 5: Current output during Partial Vibration Condition 1

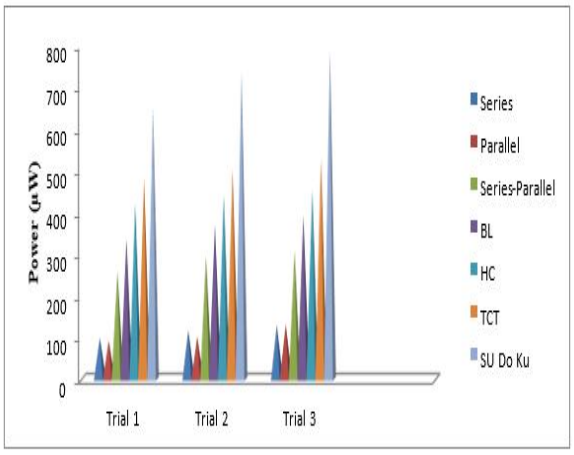

Fig 6: Power output during Partial Vibration Condition 1

V. CONCLUSION

In this experiment the maximum power is achieved by designing the series connected configuration of piezoelectric crystal. This paper concludes that during partial vibration the Su-Do-Ku puzzle based TCT configuration gives enhanced power output followed by TCT configuration under partial vibration condition. Also due to larger number of parallel connections, the reliability of the Su-Do-Ku puzzle based and TCT configured system is more than the others. To improve the power output number of crystals could be increased and the implementation of converters can also be done to boost the overall output to desired value. The use of filter could be done to improve the power quality.

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