EXPERIMENTAL INVESTIGATIONS ON THERMO ELECTRIC POWER GENERATION FROM WASTAGE

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ABSTRACT

Truly stating that this is a wonderful system, the entire process right from collecting the garbage, transporting to the dumping yard, dumping in to the hot chamber, generating electricity, converting in to single phase supply, etc. every process is automated, human involvement is not required and hence it can be said as magnificent mechanism. Every device is automated and connected in to the loop such that the mechanism itself carries the garbage to the dumping yard, delivers in to the hot chamber automatically where the garbage will be burned and the garbage collecting rail will be reached to its home position. Here in the dumping yard with the help of a unique furnace designed with TEG modules, heat energy will be converted in to electric energy and again this energy will be converted in to 230V AC, the process repeats continuously.

Keywords—TEG modules; electric power generation; wastage; recycling

I. INTRODUCTION

The Recycling mechanism described in this project work is very useful for the department of Municipal corporations where every day lot of trucks that contains full of garbage usually transported to the City outskirts dumping yards. Since 100's of trucks are engaged to this activity, here transporting rail is designed by which huge quantity of garbage is transported single time. The garbage transporting mechanism designed here is very useful for metro cities where 1000 of tones of waste is produced every day, presently waste carrying trucks are in use and hundreds of such trucks are in use for collecting the junk from various parts of the city. Really this very painful activity and lot of man power is involved in it to make clean city, in addition lot of fuel is consumed every day. To avoid all these problems, we are suggesting the concern department to implement the concept presented here by which lot of man power will be saved, fuel consumption can be minimized and huge quantity of waste can be transported at a time. To prove the concept practically, here a prototype module is constructed for live demonstration which is designed as automatic and driver less. Major building blocks: Mechanical structure of Furnace with smoke pipe, TEG modules, 7.5AH battery, PWM chip, MOSFET's, Main output transformer, Simulation of rail track with aluminum channels, Axle mechanism, chassis mechanism, Dumping mechanism, slotted metal wheels, Micro Controller, DC Motors, Magnetic switches, Battery and its charger, H Bridge IC, etc.

II. Waste burning furnace that generate 230v AC

Since the furnace constructed here performs major function of burning garbage and generating electricity, it is to be described separately and there by separate introduction chapter is created. Here the furnace designed can be called as unique one, because it is aimed to burn the garbage and to generate the electric energy. This furnace solves two major issues, the major issue of vanishing or clearing the garbage will be solved and in addition the waste heat produced by the burning furnace will be converted in to the electric energy. Waste to Energy or Energy from the waste is the process of generating electricity, and the mechanism used to convert the heat energy in to electric energy used in waste dumping yards can be known as recycling mechanism. The power system (Inverter) designed here can be utilized to drive a maximum load of 80Watts. But for the demonstration purpose 20watts tube light or any other light source can be connected at the output of inverter. The prototype module of inverter contains all required devices including 7AH battery. In order to generate 230V ac from 12V battery for the inverter application, the best method of inverter with higher efficiency technique is to be evolved which shall be high efficient, less power consumption, easy interface, and modular design. For this purpose an IC 3524 based (pulse width modulator) circuit is designed which can work on a 12V sealed maintenance free battery there by it can provide an un-interruptible power supply. The main function of this power system is to provide power to the low power home appliances like fan, light, etc., because the power system designed here can generate less power. As long as the

furnace is burning, electric energy will be generated by the TEG modules and it is utilized to charge the battery. Once the battery is charged fully and depending up on the load applied to the output of inverter, back-up time will be calculated, and the detailed description of back-up time and charging time will be explained in Power source chapter. Initially the ac pulses at 50Hz in the form of square waves are generated from the inverter chip; this device generates duel inverted outputs. The output of the oscillator is amplified in terms of voltage and current, the drive circuit is designed with power mosfets & main output transformer, & it is configured as push-pull amplifier. With the help of a duty cycle control circuit interfaced with 3524 chip, output voltage is can be controlled linearly.

Functional Description of Garbage Dumping Rail

There are many ways to transport the garbage from towns to their dumping yards, mainly trucks, tractor trolleys, tippers, etc are used, but nowhere in the world rails are used, there by this innovative idea is presented here to transport huge quantity of garbage through wagons. To prove the concept practically, a prototype module with one autonomous dumping wagon is designed for live demonstration. Entire system is designed to operate at 12V DC, for this purpose 12V, 4.5AH rechargeable lead acid sealed battery is used, this is a heavy duty battery and used for long back-up time. The motors required 12v dc, so this voltage as it is used to run the motors through H Bridge IC, where as for control circuit and horn circuit different DC levels are required. Since the control circuit is designed with microcontroller IC, 5V regulated supply source is essential and there by using 7805, 5v regulator, stable supply is derived, similarly for horn circuit using 7809, 9v regulated supply source is created. In addition the battery is charged with 13v unregulated power source which is not accommodated over the chassis of train.

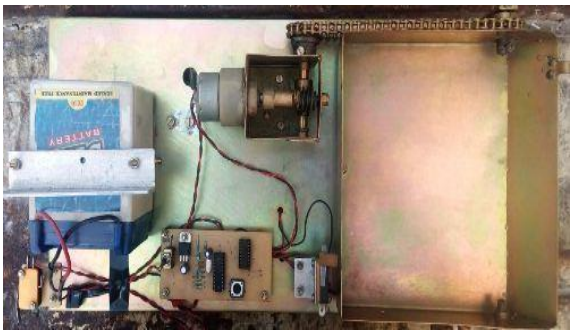

Fig.1Dumping Rail

Fig.2 Track

III. FUNCTIONAL DESCRIPTION OF FURNACE

The function or process begins with the array of TEG modules connected in series, a Thermo-electric generator or TEG is a solid state device that converts heat directly into electrical energy through a phenomenon called the Seebeck effect (a form of thermoelectric effect). Thermo-electric generators function like heat engines, but are less bulky and have no moving parts. However, TEGs are typically more expensive and less efficient. Here in this project work, this kind of thermo-electric generators are used and are attached to the body of burning chamber at one side of the furnace which is constructed with aluminum plate. Since it is a prototype module very few TEG modules are used, but for real time applications all sides of the furnace can be constructed with Aluminum plates and N number of TEG modules can be attached to the hot body to generate required voltage and current.

The mechanical construction of a hot chamber must be designed specifically such that heat energy transfers to the TEG modules through aluminum heat sinks. As these modules must be placed between hot body and cold body, for better results, lot of care must be taken at cold side body while fabricating the chamber. In general the outer body must be attached to a huge heat sink for radiating heat in to space, the other technique is to cool the outer body with small water tubs made of aluminum and attached to the other side of TEG module. The affect of electric energy produced by the TEG modules depends up on the temperature difference between the outer body and inner body. The furnace is constructed with 1.6mm thick mild steel sheets, except one side all 5 sides are covered with these sheets. The dimensions of the furnace will be around 500mm X 250mm X 250mm, since it is a prototype module mini furnace is constructed for the demo purpose. For real time applications huge furnace can be constructed. One side of the furnace is constructed with 2mm thick aluminum sheet, the idea of using aluminum sheet is to grab the waste heat delivered form the hot chamber. Now the TEG modules are attached to this aluminum sheet, here 5 or six TEG modules are used to generate sufficient voltage to charge the battery.

The starting point, where the waste is collected, here the carrier will be halted and surrounding people must put their waste bags in to the container. Once the container is filled, some one has to activate the start button, by which the vehicle moves in forward direction and reaches to the dumping yard. Here with the help of a limit switch fixed with moving mechanism, the vehicle will be stopped in dumping yard just adjacent to the burning furnace and it will be positioned parallel to the hot chamber input and garbage will be unloaded automatically in to the burning chamber. After completing

this process, the vehicle moves in reverse direction and reaches to its destination automatically. Here in the home position with the help of another limit switch, home position will be identified. DC motors are used to create movements in the mechanisms and control circuit is designed with micro controller chip, this is the main processing unit. Two more Limit switches are used to restrict the movements of dumping mechanism

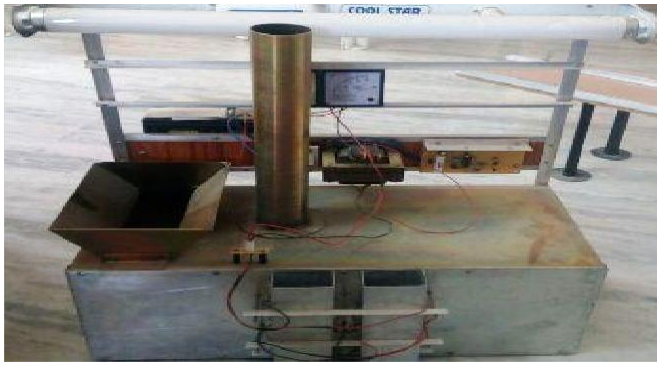

Fig. 3FURNACE

IV. Functional Description of TEG modules

Thermo-Electric Generator (TEG) is a solid state device that converts heat (temperature differences) directly into electrical energy through a phenomenon called the Seebeck effect (a form of thermo electric effect). Thermo-electric materials show the thermoelectric effect in a strong or convenient form. The thermo-electric effect refers to phenomena by which either a temperature difference creates an electric potential or an electric potential creates a temperature difference. These phenomena are known more specifically as the Seebeck effect (converting temperature to current), Peltier effect (converting current to temperature), and Thomson effect (conductor heating/cooling). While all materials have a nonzero thermo-electric effect, in most materials it is too small to be useful. However, low-cost materials that have a sufficiently strong thermo-electric effect (and other required properties) could be used in applications including power generation and refrigeration. Thermo-electric materials are used in thermo-electric systems for cooling or heating applications, and are being studied as a way to regenerate electricity from waste heat. Here TEG modules are used for generating electricity.

The Seebeck effect is a phenomenon in which a temperature difference between two dissimilar electrical conductors or semiconductors produces a voltage difference between the two substances. The Seebeck coefficient (also known as thermo-power, thermo-electric power, and thermo-electric sensitivity) of a material is a measure of the magnitude of an induced thermo-electric voltage in response to a temperature difference across that material, as induced by the Seebeck effect. The Peltier effect is the phenomenon that a potential difference applied across a thermocouple causes a temperature difference between the junctions of the different materials in the thermocouple. This effect is the opposite of the Seebeck effect (named after the scientist who discovered it in 1821).

The array of TEG modules attached to the hot body of Furnace is designed to deliver a maximum voltage of 15-18 at no load condition, when the output is connected to the battery for charging, the voltage may fall down according to the condition of the battery. As per the ratings specified by power source, if the battery consumes more than 300milliamps, the voltage may fall down by less than 12V, as the battery is charging slowly, the terminal voltage level boosts & charging current will be reduced gradually. As the charging current reduced, battery terminal voltage will be increased, when the battery terminal voltage reaches to 13.5V, the battery will be charged with this constant voltage.

As described above, the output of the power source is not stable, it varies based on many factors, the first reason is that at what degrees the TEG module is heated, the second and most important reason is that weather the temperature difference between hot and cold bodies of the TEG modules are maintained or not. Power source is depended based on these two reasons, if the temperature difference is maintained properly and modules hot bodies are heated at specified ratings, than maximum output can be obtained from the power source.

The battery used here is rated for 12V at 7AH (Ampere Hour), since low power source is used, the battery will take lot of time to charge fully. As the TEG modules all together generates 0.3Amps under above said conditions, the charging time is defined as, battery rating, i.e. 7AH / charging current, i.e. 0.3Amps = 23.3 hours approximately. If the battery is charged with high power source, charging time can be reduced. Power source can be increased by increasing the no. of TEG modules connected in series and parallel combination. In real time operation, it is recommended to use high power TEG panels for charging the battery in less time.

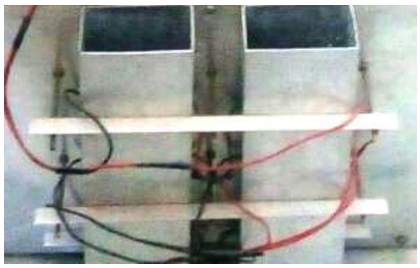

Fig.4 TEG modules

V. Functional Description of 12V DC to 230V AC Inverter

The power system that generates 230V AC from 12V DC is designed with SGS3524, this is a PWM chip generally used to construct inverters and converters. When compared with power system configurations, the battery used in the demo module can be said as low power battery, in general high power inverters contains high power batteries of 60Ah and above ratings are preferred for long back-up time. The application aimed to implement here requires more high power battery, therefore the battery should able provide long back-up time. Though the furnace is not burned for one or two days, the battery should able to generate required power, at least the inverter should able to keep energize a low wattage lamp for minimum 10 hours. Accordingly the battery back-up time must be calculated & implemented. As it is a prototype module, here less power battery is used because of the less power source. The power 'P' produced by the source can be calculated easily, initially the battery that consumes energy from the power source for storing in to it is denoted as product of the voltage & current (E & I). Thus P = E X I watts, if E is in volts and I in amperes, and the voltage across the battery terminals can be measured with a volt meter, similarly current can be measured with an ammeter connected in series with the load. Finally the power is calculated in watts by multiplying voltage & currents produced by the panel. If the value of the load resistance (battery terminal resistance) RL is known in ohms, power in watts can also be calculated by use of the formula $P = I^2 RL$ or $P = E^2 / RL$.

Conclusions

The project work "Thermo Electric Generation from Garbage Dumping Yard" is completed successfully and results are found to be satisfactory. During our trail runs we found that, when the furnace is burning, all 6 TEG modules connected in series are generating nearly 13.5v DC.

- As per the specifications mentioned by the manufacturers of these TEG modules, each TEG modules is supposed to generate 4.5V 150^0C Temperature, but in fact they are not up to the mark and generating less voltage and there by 6 TEG modules are used and are connected in series. All modules attached to the hot body of furnace will be heated up equally when the hot chamber is burnt with full of flames.
- The current output of each module is also suppose to give 600 milliamps, but it is not giving, we found that each module is giving only 300 milliamps at 2v, when devices are connected in series, only voltage will be increased but whereas current remains same and therefore finally we are getting 300 milliamps current at 13v DC.
- The concept presented here is very useful for waste yards where every day lot many tones of garbage is burnt to maintain clean environment.
- The concept presented here is the latest one, by adopting this type recycling mechanisms everywhere in waste yards, lot of electric energy can be generated and it can be coupled to the main grid. Since it is new concept and availability of TEG modules in our country is very difficult, the costs of these devices are very high because we have to import these devices from Europe, very few countries are manufacturing these devices. In coming days cost of these devices may reduce.

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