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Waste heat recovery system Using T.E.G

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Abstract: -- the possibilities of thermoelectric systems' contribution to "green" technologies, specifically for waste heat recovery from automobile exhaust system and industry exhausting flue gases or smoke passing through chimney. Recent research shows that TEG as a waste heat harvesting method is useful. Due to distinct benefits of thermoelectric generators, they have become a promising alternative green technology. Thermoelectric generator direct converts waste-heat energy into electrical power where it is unnecessary to consider the cost of the thermal energy input. The application of this technology can also improve the overall efficiency the of energy conversion systems and reduce pollution. Thermoelectric revolves around modern day thermocouples and their application in power generation. The phenomenon involving an inter conversion of heat and electrical energy is termed as thermoelectric effect. The concept of thermoelectric effect was brought forward by a German scientist Thomas Joham Seebeck in 1821. According to this, a voltage is produced at the junction of two different materials. If a closed path is provided a current will flow in the circuit. This is the direct conversion of temperature difference to electric voltage and vice-versa. Below figure shows the illustration of seebeck effect.With the increase in population the energy consumption has also increased. Human race is in search of new technology for different energy sources to meet the present demand. Thermoelectric generation is one such emerging technology. This technology uses the waste heat carried away in flue gas or smoke passing through chimney, automobiles, exhaust etc. which is let into the environment to extract electric power. The conversion from heat to electric potential is done with the help of a device called TEG.

Keywords: Thermo electric generator, seebeck effect, waste heat recovery.

I. WORKING PRINCIPLE OF TEG

When the junction of two different metals are maintained at different temperature, emf is produced in the circuit. this is known as seebeck effect.Whenever current passes through a circuit of two dissimilar conductor, depending on the current direction either heat is absorbed or released at the junction of two conductors. This known as peltier effect. The most common thermoelectric conductors materials today are alloys of chalcogenides (materials with a chalcogen or IUPAC group 16 anion). Specifically these materials are either based on bismuth telluride (Bi2Te3) or lead telluride (PbTe). Bi2Te3 can be alloyed with Bi2Se3 to form n-type Bi2Te3-xSex and with Sb2Te3 to form p-type BixSb2-xTe3. PbTe can be alloyed with PbSe to form p-type PbTe1-xSex and with SnTe to form n-type Pb1-xSnxTe. PbTe has been used successfully by NASA as radioisotope thermoelectric generators.

A TEG is a device which uses the temperature gradient present between the hot surface of the TEG and the environment to convert waste heat into electricity. TEG is usually a two different semiconductor material or alloy or metal connected electrically in series. As the junction gets heated the valence electrons in the warmer part of the TEG start moving towards the colder part of TEG. These electrons are sole responsible for the production of electricity. The device was targeting a power output of 330W, being supplied with heat from the exhaust and cooled by the conventional coolant circuit. Efficiencies of the electronic device converting the electrically generated TEG saw figures in the order of 80-90%. The maximum amount of electricity created was 140 W to 225 W, with different types of configurations. Temperatures of 973 K or more, the temperature difference between exhaust gas on the hot side and coolant on the cold side is close to 373 K. This temperature difference is capable of generating 100-500W of electricity. In the power plants and other industries chimneys the temperature of flue gases would be around 373K which is the hot junction & the ambient air is cold junction having temperature 308 K. So there is temperature difference of 353 K. Applying the same technique to this it will gives output of 4.583 mV for one.

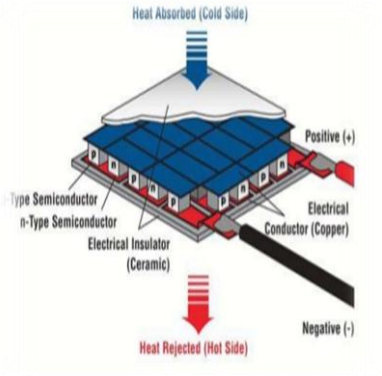

Fig 1: Thermo Electric Generator

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II. PROBLEM STATEMENT

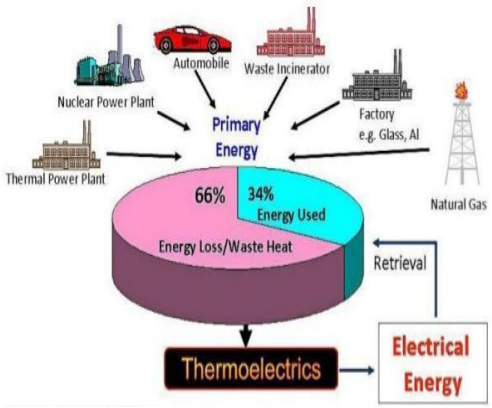

Fig 2: Sources for generating electricity using TEG

In recent years, global warming and the limitations in use of energy resources increase environmental issues of emissions. The possibilities of thermoelectric systems' contribution to "green" technologies, specifically for waste heat recovery from industry and others waste heat source like automobile exhaust system etc.

The main problems are energy crises, increased rate in pollution and population, tremendous amount of waste heat energy and constant uninterrupted power supply constant uninterrupted power supply.

III. APPLICATIONS OF TEG

RECENTLY, applications of thermoelectric technology have been extensively studied due to the increasing emphasis on energy savings and carbon reduction. Thermoelectric generators (TEGs) have potential application for the conversion of low-level thermal energy into electrical power. For waste heat recovery, it is unnecessary to consider the cost of the thermal energy input. In general, a TEG consists of a number of semiconductor pairs that are connected electrically in series and thermally in parallel. Each pair includes a p-type and an n-type element. The working principle of a TEG is based on the Seebeck effect which induces an electromotive force in semiconductor materials due to temperature gradients. In recent years, there has been growing interest in using various heat sources for TEGs, including combustion waste, geothermal energy, power plants, and other industrial heat generating processes. Current technology can be cost- effective when the thermoelectric system adds value beyond electricity production, as is the case in generation for wireless sensor networks. TEGs combined with wireless sensor network nodes can add value to by allowing sensing and automation without the need for wire runs or batteries that require checking and replacement. Additionally, remote industrial facilities with abundant waste heat and expensive electricity—in the oil and gas industry, for example—might stand to benefit from current thermoelectric technology. DOE could encourage adoption of waste heat recovery in manufacturing (using TEGs or other technologies), by pushing for higher efficiency standards for manufacturing facilities. These could drive the adoption of high efficiency manufacturing technologies in the same way that CAFE standards do for automobiles.

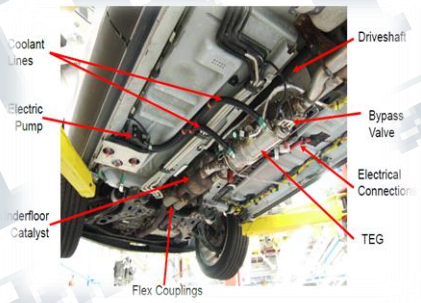

Fig 3: Thermo Electric Generator installed in exhaust system of an automobile

Fig 4: closeup view of TEG in Exhaust system

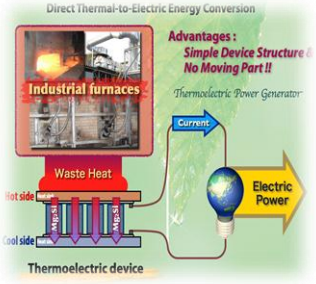

Fig 5: TEG concept in industrial waste heat recovery

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Fig 6: domestic application of TEG

Fig 7: TEG in refrigerator

Fig 8: TEG in wrist watch

Fig 10: TEG in remote areas

IV. ADVANTAGES

1. Solid state construction, no moving part, no vibration.
2. Low noise and less maintenance.
3. Increased operation life under all environments.
4. Light weight and small size.
5. Convenient power supply.
6. Space and military application.
7. Direct conversion from waste heat to electricity
8. Portable and controllable by voltage
9. Space requirement is 1/20th of solar cell

V. DISADVANTAGES

1. Low efficiency.
2. High cost
3. High output resistance.
4. Adverse thermal condition

VI. CONCLUSION AND FUTURE SCOPE

When an experiment is done on model chimney and diesel generator chimney, we are successful in getting a considerable amount of voltage. The voltage so produced was utilized to

Numerous advantages over disadvantage

- Charge a mobile battery of 3.7 volts
- Glow an LED of 3.8 volts and
- To run a small dc motor which operates at (3V-9V) volts.

Use Thermoelectric to generate electricity for powering auto components (lights, pumps, occupant comfort, stability control, computer systems, electronic braking, drive by wire, radiator fan, GPS, audio and video systems etc.).Reduce size of alternator (target: 1/3rd reduction in size) Improve fuel economy (targets: 5% to 6%).Reduce Regulated Emissions and Greenhouse Gases. waste heat conversion to useful energy beneficial.TEG to supply low power electronics devices. Generate electricity without introducing any additional carbon into The atmosphere. variety of application field. Development in future will lead to interesting applications.

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