Electricity Power Generation by Using Thermal Plant

***Dhobale Swapnil Haridas, *Surve Nayan Maruti,**Prof.Bhadke.D.B.**

**B. Tech Students, **Assistant Professor*
Department Of Electrical Engineering
Shakar Maharshi Shankarro Mohite-Patil Institute of Technology &Research
Akluj, Solapur, Maharashtra, (India)

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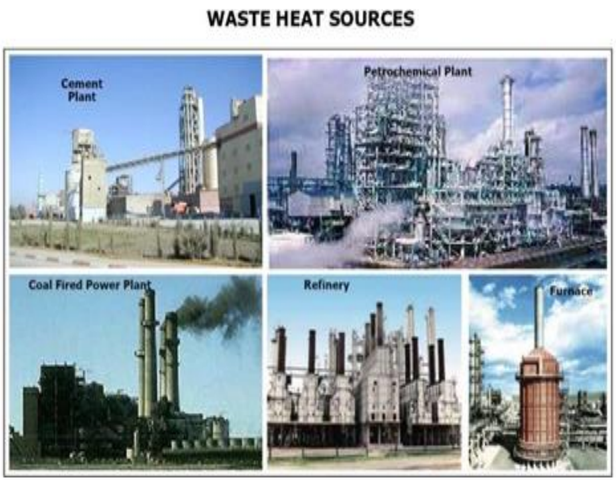
ABSTRACT

Pollution, population, electricity, traffic, these are the words that everyone talks about every day, that they are facing this or that problem, but we need to know that we create the problem from within ourselves. In recent years, growing concerns about environmental emissions, in particular global warming and energy constraints have prompted in-depth research on new power generation technologies. Thermoelectric power generation is emerging as a promising alternative green technology due to its distinct advantages such as environmental friendliness, lower production costs, etc. The generation of thermoelectric energy offers potential applications in the direct conversion of waste heat into electricity, where heat costs do not have to be taken into account. Applying this alternative green technology to convert waste heat directly into electricity can also improve the overall efficiency of the energy conversion system. This article discusses basic thermoelectric ideas, including their importance and appropriate applications for waste heat, noise/vibration.

Keywords: *Thermoelectric, Vibration, Waste-heat recovery, Thermal power plant, Environmental issue.*

INTRODUCTION:

Thermoelectric generation (also known as thermoelectric) offers a promising technology for the direct conversion of low-quality thermal energy, such as waste heat energy, into electricity. The generation of thermoelectric energy offers possible applications in the direct conversion of waste heat into electricity. When "electrons" move, we have an electric current (i.e. charge per unit time per unit area) and an electric voltage ("pressure") is usually the driving force. But other forces like temperature difference and thus heat flow or heat flow can control electrons! You see, Beck (1822) discovered this. The N-type is doped with silicon-phosphorus (creating additional free electrons). The P-type is mixed with silicon boron (creating additional hollow holes). Thermoelectric power plants (TEG) typically use special semiconductor materials that are optimized for the Seebeck effect. The current thermoelectric conversion efficiency is too low to compete with stand-alone dynamic technologies. But TE technology has valuable features.



Technologies for Waste Heat Recovery Power generation:-

- ➢ Commercial Technologies
- – Single Fluid Rankin Cycle
- • Steam cycle
- • Hydrocarbons
- • Ammonia
- – Binary/Mixed Fluid Cycle
- • Ammonia/water absorption cycle
- • Mixed-hydrocarbon cycle
- ➢ Emerging Technologies

- Supercritical CO Brayton Cycle
- Thermoelectric energy conversion
- Combined Cycles

ENVIRONMENTAL ISSUES

Environmental issues in thermal power plant mainly include the following:

- Air emissions
- Energy efficiency and Greenhouse Gas emissions
- Water consumption and aquatic habitat alteration
- Effluents
- Solid wastes
- Hazardous materials and oil
- Noise

Thermal Discharges- A thermal power plant consists of a steam generator and an individual cooling system that uses large amounts of water to cool and condenses the steam to return to the boiler. Hot water is usually discharged back into a water source (i.e. river, lake or ocean) or a nearby surface water body. In principle, the thermal discharge should be designed so that the water outlet temperature outside the scientifically defined mixing zone does not exceed the ambient temperature standard relevant to water quality. The mixing zone is usually defined as the zone where the initial dilution of the discharge occurs, where the relevant water quality temperature standards are allowed to be exceeded, and takes into account the cumulative effects of seasonal variations, ambient and water quality, receptor potential and assimilation capacity among other considerations.

Noise – The main sources of noise in thermal power plants include turbo generators and auxiliary equipment; boilers and auxiliary equipment such as coal sprayers; reciprocating machines; fans and ducts; Pump; compressor; capacitor; separators including shakers and plate shakers; pipes and valves; machine; transformers; circuit breaker; and cooling towers. Thermal power plants used for base load operation can operate continuously, whereas smaller power plants may operate less frequently but are still a significant source of noise when located in urban areas.

It's not possible to reduce a lot of noise, but these sounds create vibrations and can be used to generate electricity using piezoelectric generating technology. Piezoelectric generators work thanks to the piezoelectric effect.

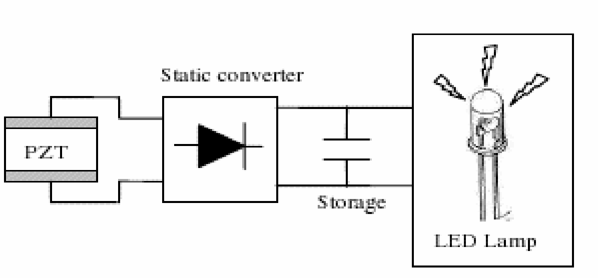


Figure 2- Circuit arrangement for piezoelectric

This is the ability of certain materials to create electric potential when responding to mechanical changes. To put it more simply, when compressed or expanded or changing shape a piezoelectric material, will some voltage.

THERMOELECTRIC POWER GENERATION MATERIALS

To make a good thermoelectric it is required that

$$ZT = \frac{\alpha^2}{\rho\lambda} * T \;\ldots.\; (1)$$

Where, α = see beck coefficient –large
ρ = Resistivity –small
λ = Thermal conductivity – small

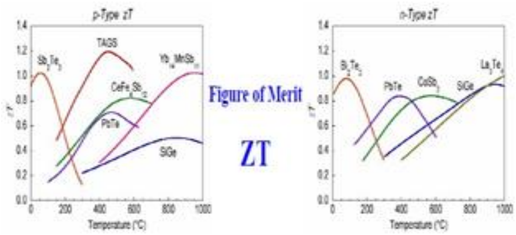


Figure 3- Figure of merit ZT

Some special and interesting materials which are related to power factor to highly doped semiconductors. For almost all typical thermoelectric materials, namely low gap semiconductors, if doping is increase, the electrical conductivity increment but the see beck coefficient is reduce.

$$Pf = \frac{\alpha^2}{\rho} \;\ldots\ldots\; (2)$$

Nanotechnology in thermoelectricity:-
(2D quantum wells, 1D nano wires, 0D quantum dots)

$$ZT = (S^2\sigma T)/K \;\ldots\ldots\; (3)$$

ZT ~ 3 for desired goal
Where, S = see beck coefficient
σ = Conductivity T = Temperature
K = Thermal conductivity
A limit to Z is rapidly obtained in conventional materials So far, best bulk material ($Bi_{0.5}Sb_{1.5}Te_3$) has ZT ~ 1 at 300 K

LOW DIMENSIONAL PHYSICS GIVES EXTRA CONTROL:

(1) Increased density of states due to quantum confinement effects
⇒Increase *S* without reducing s
(2)Boundary scattering at interfaces can reduce k >s.
*(3)*Possibility of materials engineering to further improve *ZT*

LOW DIMENSIONALITY- IMPACT ON THERMO POWER, THERMO CONDUCTIVITY:

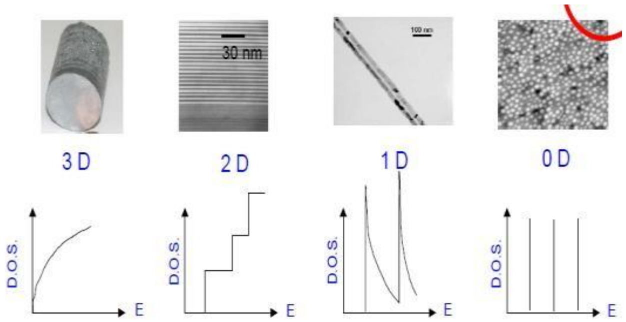


Figure 4- Dimensional view of material

- (D.O.S.) more favorable (stronger dependence of DOS on E) increase of a without increasing *ρ*
- Additional degree of freedom (size) for tailoring of the transport
- Possibility to explore the anisotropy of transport properties
- Chance to decrease lattice due to phonon scattering on interfaces
- ZT0D > ZT1D > ZT2D > ZT3D

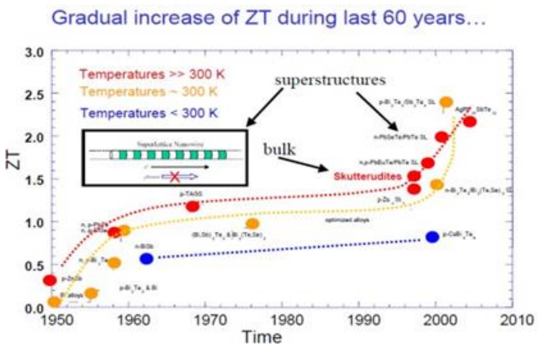


Figure 5- Graph of increment in ZT

IV.THERMOELECTRIC EFFECT IN POWER GENERATION

The thermoelectric effect is the direct conversion of a temperature difference into an electric voltage and vice versa. A thermoelectric device generates a voltage when there is a different temperature on each side. If, on the other hand, a voltage is applied, a temperature difference appears. At the atomic level, the applied temperature gradient causes the charge carriers in the material to diffuse from the hot side to the cold side. This effect can be used to generate electricity, measure temperature, or change the temperature of objects. Since the heating and cooling directions are determined by the polarity of the applied voltage, a thermoelectric component can be used as a temperature controller.

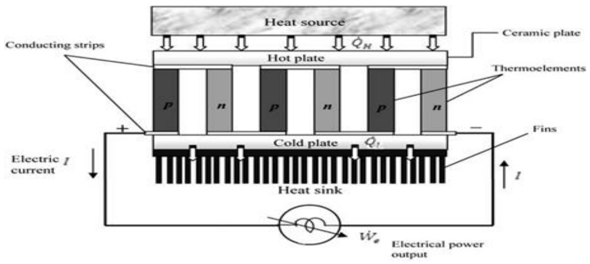


Figure 6- Thermoelectric effect

THERMOELECTRIC POWERGENERATOR

The basic principle of thermoelectric work is related to the Seebeck effect. The Seebeck effect describes a thermoelectric phenomenon in which the temperature difference between two dissimilar metals in a chain is converted into an electric current. Discovered in 1821, the See-Beck effect is one of three reversible phenomena that describe similar processes related to thermoelectricity, conductivity, and temperature. The Peltier effect was first observed in 1834 and the Thomson effect was first described in 1851. The Seebeck effect is named after the East Prussian scientist Thomas Johann Seebeck (1770-1831). In 1821, Seebeck discovered that a circuit of two dissimilar metals would conduct electricity if the two points where the metals met were held at different temperatures. Seebeck placed the compass near the chain he had made and saw the arrows stray. He found that the size of the deviation increased in proportion to the increase in the temperature difference. His experiments also found that the temperature distribution in metal wires did not affect the compass. However, changing the type of metal it uses changes the size of the needle deflection. The Seebeck coefficient is a number that describes the voltage produced between two points on a wire where there is a uniform temperature difference of 1 degree Kelvin between the points. The metal in See Beck's experiment responds to temperature, creating current loops in the circuit and a magnetic field.
The basic theory and operation of thermoelectric systems has been developed over the years. The generation of thermoelectric energy is based on a phenomenon called the "See-Beck effect". When a temperature difference is detected between the hot and cold junctions of two different materials (metals or semiconductors), a voltage is generated, i.e. Seebeck stress. In fact, this phenomenon applies to thermocouples, which are widely used to measure temperature. Based on this See-Beck effect, a thermoelectric device can act as an electric generator. Schematic

representation of a simple thermoelectric power plant based on the See-Beck effect. Heat is transferred at rate H from the high temperature heat source maintained at TH to the hot junction and transferred at rate LQ to the low temperature absorber maintained at TL from the cold junction. Based on the See-Beck effect, heat applied to a thermal device causes an electric current to flow in a circuit and generate electricity. Using the first law of thermodynamics (law of conservation of energy), the difference between H and LQ is the electrical power output e W. It should be noted that this power cycle is very similar to the power cycle of a heat engine (Carnot engine), where a thermoelectric generator can be considered in this respect as a unique heat engine.

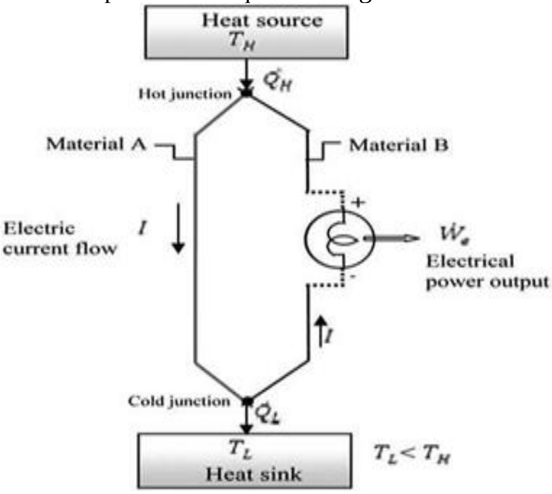


Figure 7- Circuitry of thermoelectric power

ADVANTAGES AND DISADVANTAGE OF THERMOELECTRIC POWER

Advantages:

1) Environmentally friendly
2) Recycles wasted heat energy
3) Scalability, meaning that the device can be applied to any size heat source from a water heater to a manufacturer's equipment
4) Reliable source of energy
5) Lowers production cost

Disadvantages:

1) Low energy conversion efficiency rate
2) Slow technology Progression
3) Limited Applications
4) Requires relatively constant heat source
5) Lack of customer/industry training on thermoelectric generators

CONCLUSION

In thermal power plants, environmental problems are increasing every day and now the need to reduce is that even though we use this waste source as noise from various machines which also generate vibrations, but this vibration can be used to generate energy when we see that the other party is experiencing a loss. Heat loss in thermal power plants, so this waste heat can also be used to generate electricity. Thermoelectric is a very suitable and better way to extract energy from these sources. When these sources turn to consumption, environmental problems will be reduced and their impact on human health, to some extent, will continue to be reduced. On the other hand, electricity production will also increase; the supply-demand curve will meet to meet.

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