

Q1

The MHD generation or, also known as magneto hydrodynamic power generation is direct conversion system which converts the heat energy directly into electrical energy, without any intermediate mechanical plants. Therefore in this process, substantial fuel economy can be achieved due to elimination of the link producing mechanical energy and then again converting it to electrical energy.

* WORKING PRINCIPLE :-

This effect is a result of Faraday's law of electro magnetic induction. When the conductor moves through a magnetic field, it generates an electric field perpendicular to the magnetic field & direction of conductor.

The induced emf is given by

$$E_{ind} = U \times B$$

where U = velocity of the conductor

B = magnetic field intensity.

The induced current is given by

$$I_{ind} = C \times E_{ind}$$

where C = electric conductivity

The retarding force on the conductor is the Lorentz force given by

$$F_{ind} = I_{ind} \times B$$

As the name implies, the magneto hydro dynamic generator shown below is concerned with the flow of a conducting fluid in the presence of magnetic and electric fields. In conventional generator or alternator the conductor consists of copper windings or strip while in an MHD generator the hot ionized gas or conducting fluid replaces the solid conductor.

The conducting fluid flow is forced between the plates with a kinetic energy and pressure differential sufficient to overcome the magnetic induction force. An ionized gas is employed as the conducting fluid.

Ionization is produced either by thermal means i.e by an elevated temperature or by seeding with substance like cesium or potassium vapours which ionizes at relatively low temperature.

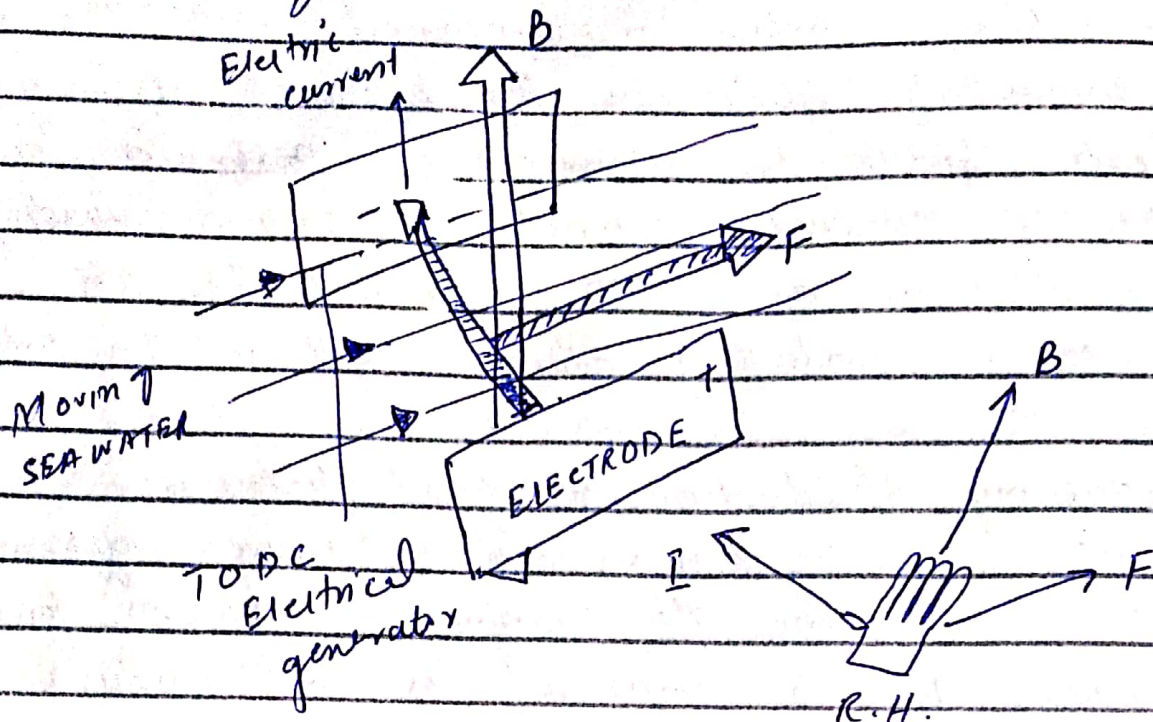
Pair of electrodes are located on the channel walls at right angle to the magnetic field and connected through an external circuit to deliver power to a load connected to it. electrodes in MHD generator perform the same function as brushes in a conventional DC generator.

The power generated by the MHD system is given as

$$P = \sigma B^2 v^2 K(1-K) \text{ W/m}^3$$

- where σ is the specific electrical conductivity of gas in siemens/metre,
- B is magnetic field strength in Tesla (wb/m^2)
- v is the velocity of gas in m/s
- K is the ratio of external load voltage to open

Circuit voltage.



Advantages of MHD generation over the conventional methods of generation are given below.

- 1- In MHD the thermal pollution of water is eliminated.
- 2- Use of MHD plant operating in conjunction with a gas turbine power plant might not require to reject any heat to cooling water.
- 3- These are less complicated than the conventional methods.
- 4- There are no moving parts which reduces the energy loss.
- 5- These plants have the potential to raise the conversion efficiency upto 55-60%.
- 6- It is applicable with all kind of heat source like nuclear, thermal, thermonuclear plants etc.

Q2

Thermo electricity refers to a class of phenomena in which a temperature difference creates an electric potential.

Thermo generator is a device that converts the heat energy into electrical energy based on the principle of Seebeck effect.

Following are different effects involved in the technology that determines the output power of thermos-electric generator.

SEEBECK EFFECT :-

When the junctions of two different materials or metals are maintained at different temperature, the emf is produced in the circuit. This is known as Seebeck effect.

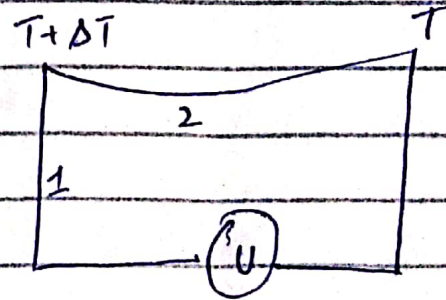
If one junction is open but the temperature difference is maintained, current no longer flows in the legs but a voltage can be measured across the open circuit.

This generated voltage (V) is the Seebeck voltage & is related to the difference in temperature (ΔT) between the heated junction

and the open junction by a proportionality factor (α) called the Seebeck coefficient,

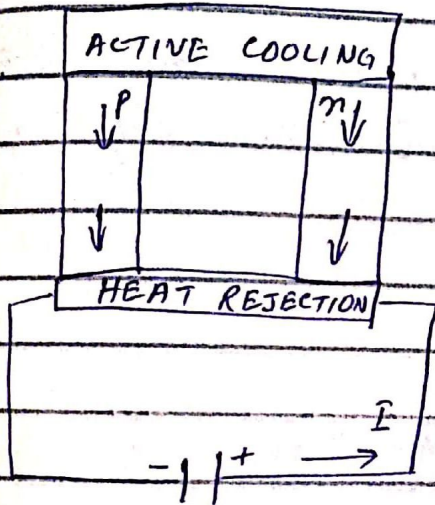
$$\text{or } V = \alpha \Delta T.$$

The value for α is dependent on the types of material at junction.

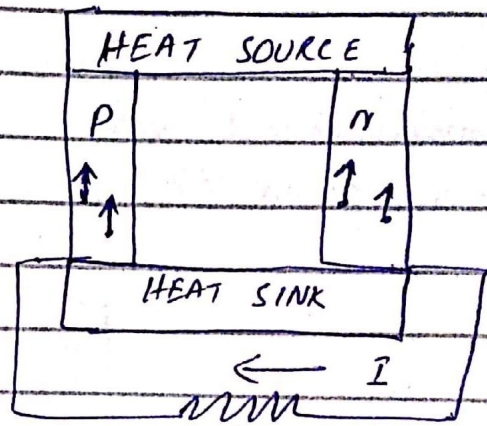


PELTIER EFFECT :-

when ever the current passes through the circuit of two dissimilar conductors, depending on the current direction, either heat is absorbed or released at the junction of the two conductors. This is known as peltier effect.



Refrigeration mode



Power generation mode

JOULE EFFECT :-

Irreversible conversion of electrical energy into heat when a current I flows through a resistance R .

$$Q_j = I^2 R$$

THOMSON EFFECT :-

Heat is observed or produced when current flows in material with a certain temperature gradient. The heat is produced which is proportional to both the electric current and the temperature

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The power produced is given as

$$\text{Power } P = I^2 R_L$$

$$V = IR, \quad I = V/R$$

$$P = \frac{(d_{512} \Delta T)^2}{(R + R_L)} R_L$$

$$P_{\text{max}} \text{ (when } R = R_L) = \frac{1}{4} \frac{(d_{512}^2 \Delta T^2)}{R}$$

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in the space between the emitter and collector to provide a plasma with a relatively neutral space charge. Because of this a liberated electron encounters little electrostatic resistance force in passing from the emitter to the collector.

Alkali metals are used to produce readily ionizable vapour. Cesium is used in the more efficient converters because of its low ionization potential of about 3.89 electron volts.

The vapour pressure is normally on the order of 100 pascals. Contact occurs when the ionization potential is less than the work of function of the emitter material.

The efficiency is far higher than the vacuum converter. It has a lifetime nearly 600 hours which is best than the former.

The only problem is efficient sealing and corrosive nature of cesium.

After looking to the efficiency, lifetime and construction of the two types of converters it is concluded that cesium gas filled converters are more efficient, has more lifetime and are easily to construct and operate.

Q4

COMMON PRINCIPLE:-

Both the thermo-electric and thermionic are Direct energy converters which has convert heat energy into electrical energy.

⇒ DIFFERENCES (TEG)

THEMIONIC GENERATORS.

- 1- Uses the principle of seebeck effect, peltier effect and thomson effect.
- 2- two junctions of different materials are used.
- 3- TEG devices typically uses special semiconductor materials.
- 4- Three major types are available.
 - a- Fossil Fuel generators
 - b- Solar Source generators
 - c- Nuclear Fuel generators.
- 5- Easy maintenance.
- 6- Environment friendly
- 7- Compact and less weight
- 8- high reliability
- 9- No Noise.
- 10- Convenient Power suply.
- 11- used Fore Home power station with thermo electric generator, LED lighting and TEG system.

- 1- consists of one or more of these converters coupled to give desired power.
- 2- Thermionic generator can be operated from any primary heat source.
- 3- For low power level 3KW or less solar Energy can be used
- 4- For high Power level 50KW or more nuclear heat source can be used.
- 5- consists of two Electrodes placed near one another in vacuum.
- 6- classified accordinge space charge are
 - Vacuum close-spaced.
 - cesium Gas filled.
- 7- Has lifetime of 40 hours to 600 hours.
- 8- Rotating components are not employed.
- 9- liquid-vapour phase problems do not exist.

12- The thermo electric generators are less efficient but useful

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| Over a much wider range of temperature gradients. | 10- Separators for fuel fluids are not required. |
| 13- Works in atmosphere. | 11- Frictional losses due to bearings not present. |
| 14- Requires constantly heat source. | 12- individual converters are low voltage, high current devices |
| 15- Solid state construction, no moving parts, no vibration. | 13- A large number of converters must be sequentially arranged to obtain useful voltage. |
| 16- Available 24 hours a day. | 14- Power losses in converters can seriously cut useful power output. |
| 17- Convenient power supply | 15- Used in space and military applications. |
| 18- Stabilize temp of devices. | |
| 19- Performance output highly scalable. | |
| 20- waste heat - Electricity. | |

QsMAIN PROBLEMS OF THERMO-NUCLEAR FUSION.HOT PLASMA CONFINEMENT:-

One solution to this dilemma is to keep the hot plasma out of contact with the walls of the container by keeping it moving in circular or helical paths by means of the magnetic force on charge particles.

MAGNETIC CONFINEMENT :-INERTIAL

1. Laser beams or laser-produced X-rays rapidly heat the surface of the fusion target, forming a surrounding plasma envelope.

2- Fuel is compressed by the rocket like blow-off of the hot surface material.

3- During the final part of the capsule implosion, the fuel core reaches 20 times the density of lead and ignites at $100,000,000 \text{ } ^\circ\text{C}$.

4- Thermonuclear burn spreads rapidly through the compressed fuel yielding many times the input energy.

In the inertial confinement fusion method a very large plasma density is attained at the expense of the energy confinement time.

In the magnetic confinement method an energy confinement time longer than one second is attained in very low density plasmas.

MAGNETIC FIELD CONFINEMENT :-

In the absence of magnetic field heated particles will move in

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straight lines in random directions, quickly striking the walls of the container. When a uniform magnetic field is applied the charged particles will follow spiral paths encircling the magnetic lines of force. The motion of the particles across the magnetic field lines is restricted and so is the access to the walls of the container.

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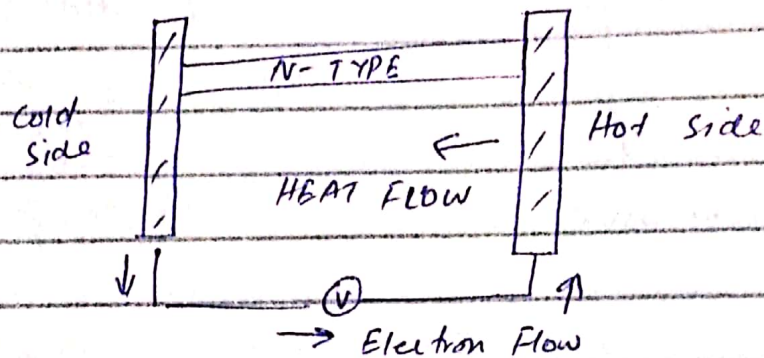
gradient. This is called Thomson effect.

THERMO ELECTRIC EFFECT :-

The thermo electric effect is the direct conversion of heat differentials to electric voltage and vice versa.

:-

When the two sides of a semiconductor are maintained with different temperature, the emf is flows across the output circuit.



As the heat moves from hot side to cold side, the charge carrier moves in the semiconductor materials & hence the potential difference is created.

The electrons are the charge carriers in the case of N type semiconductor and hole are in P-type semiconductors.

In a stack, number of P-type and N-type semiconductors is connected.

A single PN junction can produce a seebeck voltage of 40mV.

The heat source such as natural gas or propane are used for remote power generation.

Thermionic generator has two main types.
These two parts are explained below.

VACUUM CONVERTER :-

The available power and the efficiency of a thermionic converter can be severely limited by buildup of space charge between the electrodes. The vacuum type of thermionic converter uses a very small gap between its emitter and collector electrodes, typically 0.025 to 0.038 mm in order to minimize the effects of this electronic space charge. At a temperature range of 1100 K i.e. about 800°C the electric power converted is 0.1 to 1 watt per square centimeter of emitter surface. Converters with such small spacings are difficult to manufacture through as a result, the vacuum converter has had only limited practical applications. The vacuum close-spaced converter has a lifetime of only 40 hours which is too low for long duration operations.

It also suffers from the presence of vacuum, space charge and large work function.

CESIUM GAS CONVERTER :-

These devices are designed so that positively charged ions are continuously generated and mixed with negatively charged electrons.