# IQRA NATIONAL UNIVERSITY


# FINAL ASSIGNMENT

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Program: MS (EL.E)

Subject: Direct Energy Conversions

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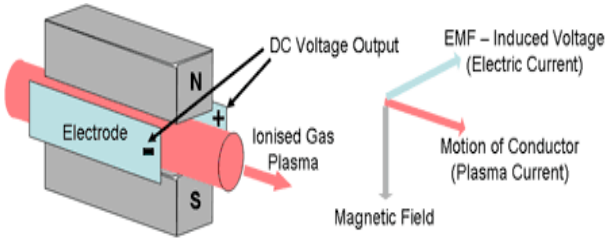
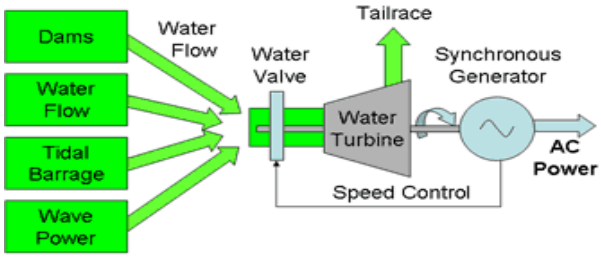
**Q 1: Magneto hydrodynamics (MHD) is a direct energy conversion technique. What are the basic differences in working principle of this system as compared to conventional hydro power systems? How is the output power obtained from this system?**

**ANSWER:**

| MAGNETO HYDRODYNAMICS (MHD): | COVENTIONAL HYDRO POWER |
|---|---|
| An MHD is a device which converts heat energy of a liquid directly into power energy without involvement of electric generator. | Hydro power system is a procedure in which falling water rotates the turbine thus producing electric power |
| Basic principle is Faradays law of electromagnetic induction | Basic principle is potential energy and kinetic energy. |
| An ionized gas is release as a conducting fluid | Water is used to run turbines |
| It is than ionization by mean of elevated temperature or by mixing substance like cesium or potassium vapors. | Water id delivered by mean of penstock and rotate turbine |
| Atoms of added element split of electrons. Negatively charged electrons are present and make the gas an electrical conductor. | Turban rotate generators and produce electricity. |
| 90% conductivity can be achieved with a fairly low degree of ionization of only about 1% | Efficiency increase by head. |
| There is no moving part, so more reliable. | Lots of mechanical parts, more maintenance |
| Simple in design and MHD power generation process is applicable to all kinds of heat sources such as oil, coal, gas, nuclear, solar and thermonuclear fusion | Complicated in design and can only use water as a fluid. |

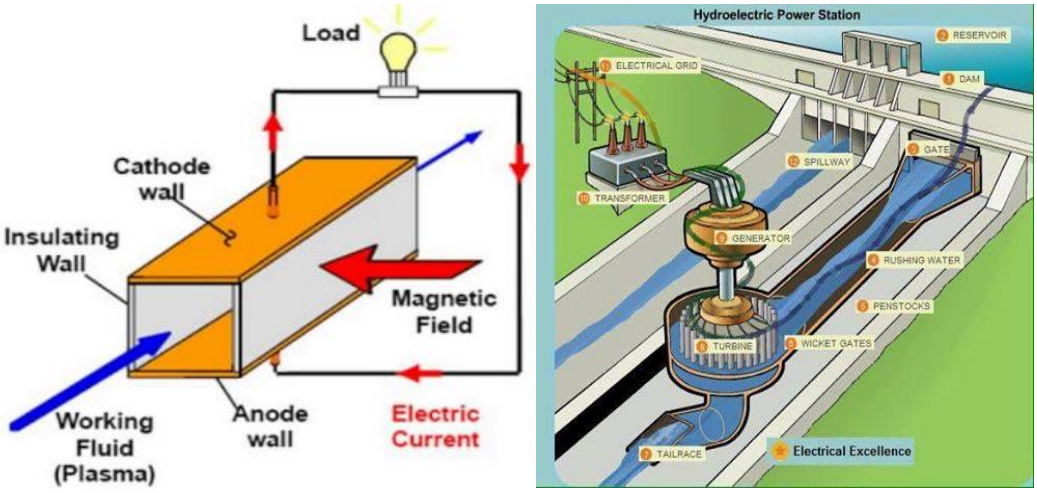



Magnetohydrodynamic Power Generation (Principle)




Hydro Electric Power Generation

## Comparison:




*MHD & Hydro Power GENERTION*

## MHD output power is obtained:

In MHD generator, hot gases are injected into a channel and make pressure by a nozzle. Nearby channel, there is strong magnetic field. In accordance with Faraday's law of induction, an electric field is established that acts in a direction perpendicular to both the gas flow and the magnetic field. Parallel to the magnetic field walls of the channel act as electrodes and generator produces electric power to the load. Generator output power for its channel volume is proportional to the product of the gas conductivity, the square of the gas velocity, and the square of the strength of the magnetic field through which the gas passes.

**POWER EQUATION:**

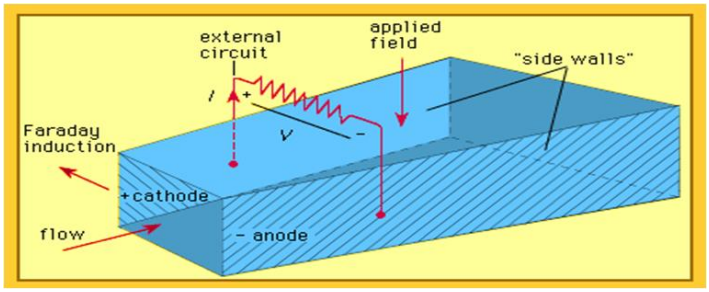
$\rho = \sigma B^2 v^2 K (1 - K)$ W/m$^3$

Where σ is the specific electrical conductivity of gas in siemen/ 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.




*MHD GENERATOR*

**Q 3: The Thermionic generator has two main types (i) Vacuum Convertor and (ii) Cesium Gas Convertor. Explain in detail why which convertor is more efficient, has more life-time and is easier to construct/operate.**

**ANSWER:**

## EFFICIENCY:

Cesium Gas Converter is more efficient as compared to Vacuum Converter because these devices are designed so that positively charged ions are produced and merge with negatively charged electrons that is present between the emitter and the collector as long as 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 a readily ionizable vapor. Cesium is used in the most efficient converters because of its low ionization potential (3.88 electron volts). The vapor pressure is normally on the order of 100 Pascal's. Contact ionization occurs when the ionization potential is less than the work function of the emitter material. While Vacuum Converter available power and the efficiency of a thermionic converter can be severely limited by buildup of space charge between the electrodes.

## CONSTRUCTION/OPERATION:

Vacuum converter is engineering difficult in construction as compared to Cesium gas converter because 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 of 1,200 K (about 900 °C, or 1,600 °F) the electric power produce is 0.2 to 2 watt per square centimeter of emitter surface. Converters with such small spacing's are difficult to manufacture, though. As a result, the vacuum converter has had only limited practical application while cesium gas converter are designed so that positively charged ions are continuously produced and merge with negatively charged electrons that is present between the emitter and the collector as long as a plasma with a relatively neutral space charge. Hence making its construction easier.

## LIFE TIME:

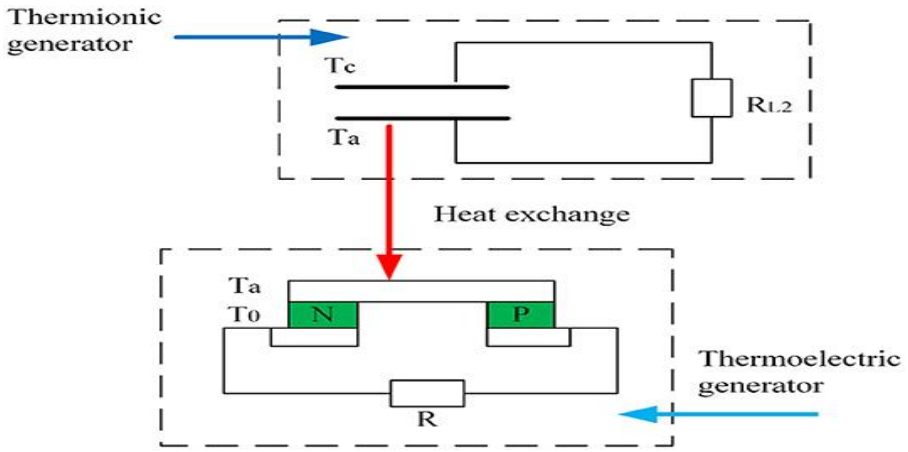
Cesium gas converter has lifespan of 600 hours while vacuum converter is 40 hours because of material and design properties. Converter size of vacuum converters are so small and small gap between its emitter and collector that its lifespan cannot be increase.

**Q 4: Thermo-electric and Thermionic are DEC techniques. What are the common principle in both systems. What are the main differences between both the systems. Explain in detail.**

**Answer:**

## Common Principle:

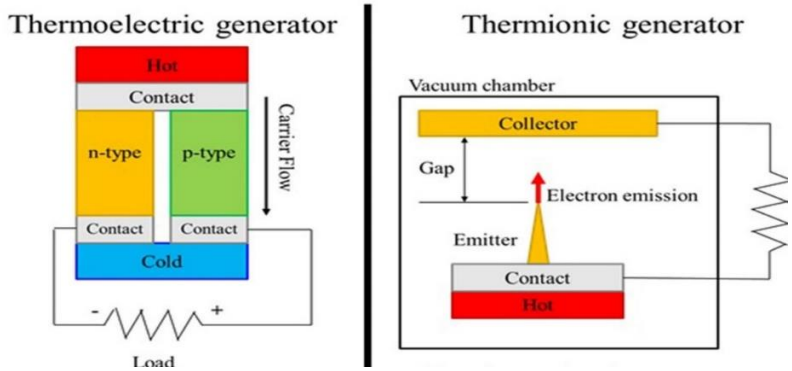
Common principle of both thermionic and thermoelectric generators employ the electron gas as the working fluid.




*THERMIONIC & THERMOELECTRIC PRINCIPLE*

## Difference:

- A thermionic generator based on the ballistic current flow which is highly efficient, and its theoretical efficiency is close to the Carnot efficiency
- A thermoelectric generator have diffusive current due to which it has poor efficiency.
- A thermionic generator has to provide a high temperature heat to produce power.
- A thermoelectric generator can produce power from low quality source.
- Thermionic Power losses in convertors can seriously cut useful power output
- Thermoelectric modules exhibit very high reliability due to their solid-state construction



**Q 5: Thermo-Nuclear fusion has the potential to provide unlimited clean power. But the technology has not been mainstreamed due to technical difficulties. What are the main issues with the system. How can they be solved.**

**Answer**:

**THERMONUCLEAR FUSION:**

Thermonuclear fusion is the process that occurs when two atoms combine to make a larger atom, creating a whole lot of energy.

Two types of thermonuclear fusion: uncontrolled, output energy is produce in an uncontrolled manner, e.g. hydrogen bombs and sun and controlled, output energy in controlled manner for useful purpose.

The main issues with the system is:

## Temperature requirements

Temperature is a measure of the average kinetic energy of particles, so by heating the material it will gain energy. After reaching sufficient temperature, given by the Lawson criterion, the energy of accidental collisions within the plasma is high enough to overcome the Coulomb barrier and the particles may fuse together. But we cannot generate such heat to gain this extremely high temperature needed to initiate nuclear fusion reaction.

### Container Trap:

If we generate such high temperature to power up nuclear fusion reaction, there is no material container which can withstand such temperatures.

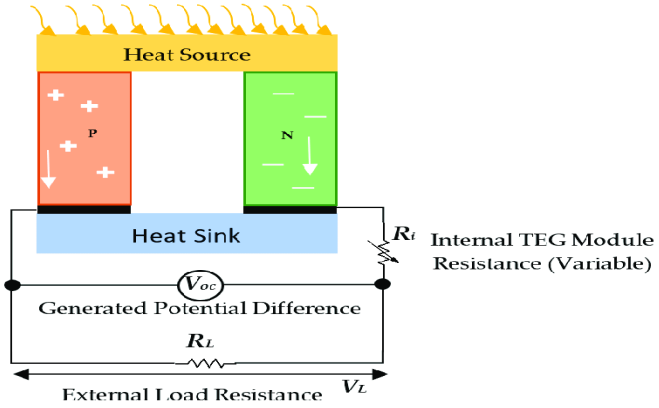
## Solution:

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

**Q 2: Thermo-electric systems are emerging as a popular alternate to conventional thermal power systems. What are the main factors involved in the technology that determine the output power of thermos-electric generator. max power be obtained ?**

**Answer:**

Thermoelectric power generator is a device that converts the heat energy into electrical energy based on the principles of Seebeck effect




*THERMOELECTRIC GENERATOR*

**MAIN FACTORES OF OUTPUT POWER:**

The main factors involved in the technology that determine the output power of thermos-electric generator are

- Temperature gradient
- Seebeck Coefficient
- Thermal Conductivity
- Electrical conductivity
- Figure of merit

## Maximum power Of the system:

Power = $P = I^2R_L$

V=IR,

I= V/R

$P = \frac{(\alpha_{S12}\Delta T)^2}{(R+R_L)} R_L$ $\alpha$=Seebeck coeffiecnt

$P_{max}$ = (when $R=R_L$) =P= $\frac{\alpha_{s12}2\ \Delta T^2}{4R}\ R_L$ ……. (1)

So, we can get maximum power of the system from equation 1.