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Power Generation from PUMP JET of a Personal Water Craft (PWC) Using Magneto Hydrodynamics (MHD) Generator

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Abstract:
This paper describes to generate power from High speed boats or jet Ski boats. In High speed boats, sea water (salt water) which is an electrically conducting fluid comes out of the driving a pump jet that has a screw-shaped impeller to create thrust for propulsion and steering. So that sea water jet can be used to generate power by MHD principle and store it for further uses.

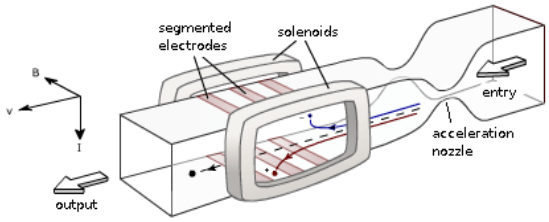

Fig 1: MHD Power generation

I. INTRODUTION

Introduction to Magnet Hydro Dynamics (MHD):

Magneto hydrodynamics (MHD)is the study of the magnetic properties of electrically conducting fluids. Examples of such electrically conducting fluidsare plasma, liquid metals, and salt water or electrolytes. The word magneto hydrodynamics (MHD) is derived from magneto- meaning magnetic field, hydro- meaning water, and -dynamics meaning movement. Magneto hydrodynamics (MHD) is the physical-mathematical framework that concerns the dynamics of magnetic fields in electrically conducting fluids, e.g. in plasmas and liquid metals. The word magneto hydrodynamics is comprised of the words magneto-meaning magnetic, hydro- meaning water (or liquid) and -dynamics referring to the movement of an object by forces. Synonyms of MHD that are less frequently used are the terms magneto fluid dynamics and hydro magnetic.

Faraday's First Law:

Any change in the magnetic field of a coil of wire will cause an EMF to be induced in the coil. This EMF induced is called induced EMF and if the conductor circuit is closed, the current will also circulate through the circuit and this current is called induced current.
Method to change magnetic field:
1. by moving a magnet towards or away from the coil
2. by moving the coil into or out of the magnetic field.
3. By changing the area of a coil placed in the magnetic field
4. By rotating the coil relative to the magnet.

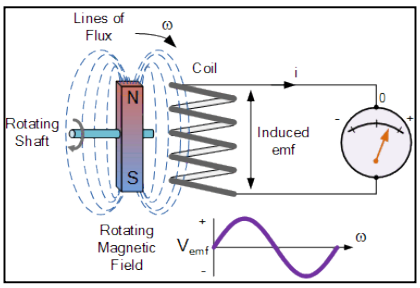

Fig 2: Faraday's First Law

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Faraday's Second Law

It states that the magnitude of EMF induced in the coil is equal to the rate of change of flux that linkages with the coil. The flux linkage of the coil is the product of number of turns in the coil and flux associated with the coil.

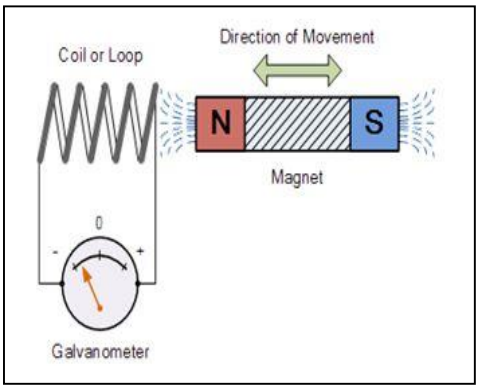

Fig 3: Faraday's Second Law

Economics:

MHD generators have not been employed for large scale mass energy conversion because other techniques with comparable efficiency have a lower lifecycle investment cost. Advances in natural gas turbines achieved similar thermal efficiencies at lower costs, by having the turbine's exhaust drive a Rankine cycle steam plant. To get more electricity from coal, it is cheaper to simply add more low-temperature steam-generating capacity.

Faraday MHD Generator:

A simple Faraday generator would consist of a wedge-shaped pipe or tube of some non-conductive material. When an electrically conductive fluid flows through the tube, in the presence of a significant perpendicular magnetic field, a voltage is induced in the field, which can be drawn off as electrical power by placing the electrodes on the sides at 90 degree angles to the magnetic field.

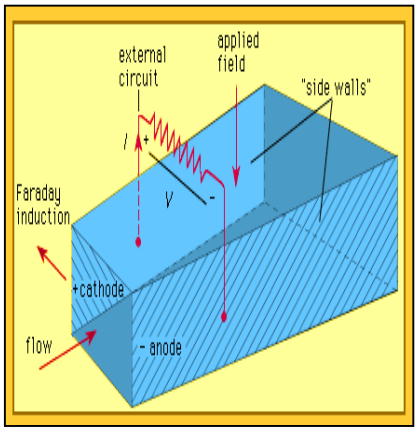

Fig 4: Faraday MHD Generator

Hall Generator:

The most common solution is to use the Hall Effect to create a current that flows with the fluid. The normal scheme is to place arrays of short, vertical electrodes on the sides of the duct. The first and last electrodes in the duct power the load.

Each other electrode is shorted to an electrode on the opposite side of the duct. These shorts of the Faraday current induce a powerful magnetic field within the fluid, but in a chord of a circle at right angles to the Faraday current. This secondary, induced field makes current flow in a rainbow shape between the first and last electrodes.

Losses are less than a Faraday generator, and voltages are higher because there is less shorting of the final induced current. However, this design has problems because the speed of the material flow requires the middle electrodes to be offset to "catch" the Faraday currents. As the load varies, the fluid flow speed varies, misaligning the Faraday current with its intended electrodes, and making the generator's efficiency very sensitive to its load.

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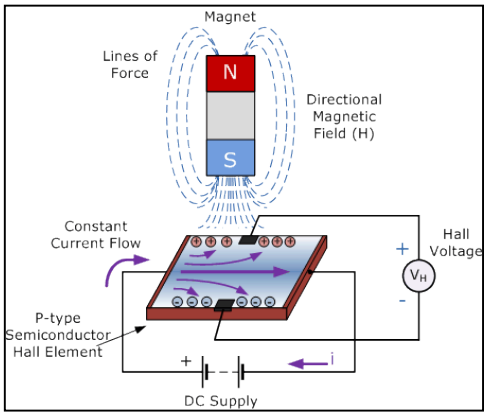

Fig 5: Hall Generator

Principle of MHD Generation:

The principal of MHD power generationis very simple and is based on Faraday's law of electromagnetic induction, which states that when a conductor and a magnetic field moves relative to each other, then voltage is induced in the conductor, which results in flow of current across the terminals. As the name implies, the magneto hydro dynamics generator shown in the figure 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 strips while in an MHD generator the hot ionized gas or conducting fluid replaces the solid conductor.

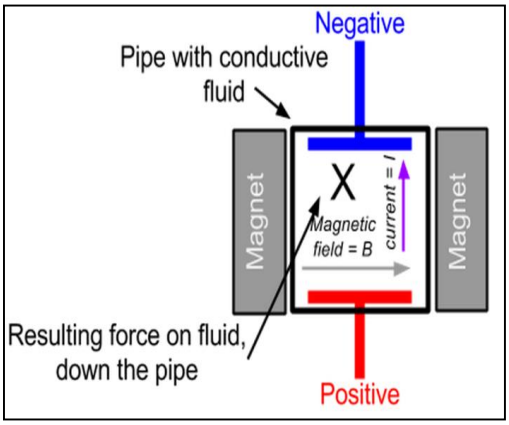

Fig 6: Principle of MHD Generation

II. EXPLICATION OF MAGNETOHYDRODYNAMICS

Fundamentals of Magneto Hydrodynamics

Magnetic Field:

A magnetic field is the magnetic effect of electric currents and magnetic materials. The magnetic field at any given point is specified by both a direction and a magnitude (or strength); as such it is a vector field. The term is used for two distinct but closely related fields denoted by the symbols B and H,

Where **H** is measured in units of amperes per meter (symbol: $A \cdot m^{-1}$ or A/m) in the SI.

B is measured in teslas (symbol:T)

Newton's per meter per ampere (symbol:N/(m ·A)

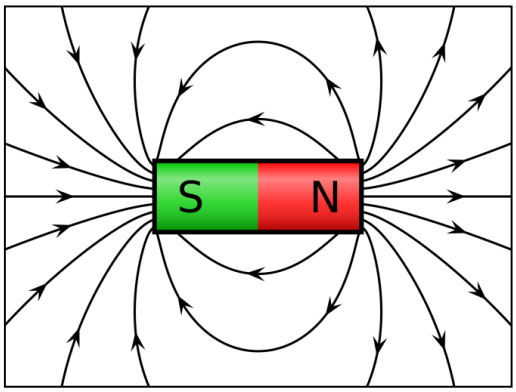

Fig 7: Magnetic Field

Perpendicular Current:

An electric current is a flow of electric charge. In electric circuits this charge is often carried by moving electrons in a wire. It can also be carried by ions in an electrolyte, or by both ions and electrons such as in plasma. The SI unit for measuring an electric current is the ampere, which is the flow of electric charge across a surface at the rate of onecoulomb per second. Electric current is measured using a device called an ammeter.

Magnetic Fluid:

Pure water or distilled water is a poor conductor of electricity. But the presence of even small amount of impurities makes water a good conductor. Hence water from taps, wells, ponds, rivers, seas, lakes, etc. conduct electricity as they contain impurities. That is why we get electrical shock when we touch the conducting parts of electrical appliances with wet hands. Our dry hands also have sweat on them which conducts

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electricity. So we should never touch the conducting parts of electrical devices.

Electrodes

Electrode is a conductor through which an electric current enters or leaves a nonmetallic portion of a circuit, as adielectric, anelectrolyte, or a semiconductor.

MHD Setup

The setup consists of:

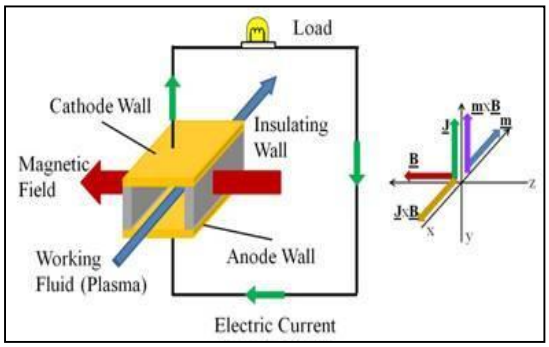

Fig 8: MHD Setup

Magnets

Magnets which are used in MHD setup should be of high magnetic field strength such as 0.5~6 Tesla. Such high strength is needed because it has to apply. Lorentz force on the flowing liquid to dissociate ions. For this purpose permanent magnets or rare earth magnets are used such as neodymium magnets. They are kept at a distance from each other and should face each other such that the magnetic lines of force travel from NORTH to SOUTH.

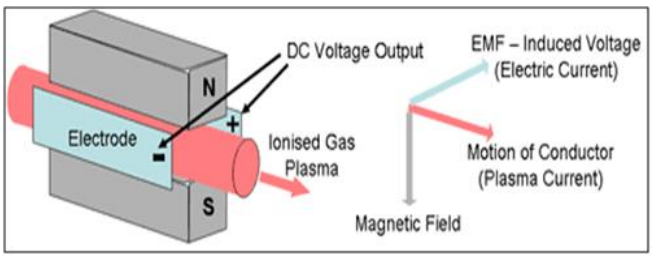

Fig 9: MHD Duct Contents

Importance of MHD:

The ability to create a force between two different mediums, without contactan engine that does not need a rotor or turbine to create motion, therefore nearly eliminating engine degradation caused from moving parts, The resistivity caused by its various mediums is comparably low when analyzed alongside current engines, due to MHD's utilization of fluids and gases. Various applications across a multitude of fields, which will be presented in detail shortly.

III. Applications of MHD Engineering:

Fusion reactions combine light atomic nuclei such as hydrogen to form heavier ones such as helium. To overcome the electrostatic repulsion between them, the neutral atoms are heated by tens of millions of degrees until they exist in a plasma state. Magnetic confinement fusion attempts to create the conditions needed for fusion energy production by using the electrical conductivity of the plasma to contain it with magnetic fields. This can be thought of as a balance between magnetic pressure and plasma pressure, or in terms of individual particles spiraling along magnetic field lines.

Medicine:

Currently being developed for cancer treatment Treatment begins by injecting a patient intravenously with a drug that's either encapsulated into a magnetic microsphere (or Nano-sphere) or conjugated on the surface of the micro/Nano-sphere. A magnetic field is then applied to the target site of the patient, thus allowing them to deliver the drug locally. Very high concentration of chemotherapeutic agents can be achieved near the target site without any toxic effect to normal surrounding tissue or to whole body.

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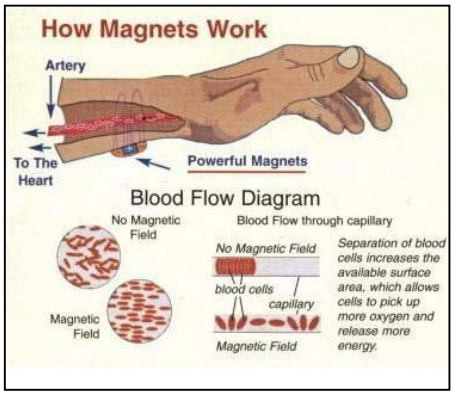

Fig 10: Cancer Treatment magnetic Microsphere

Geophysics:

Beneath the Earth's mantle lies the core, which is made up of two parts: the solid inner core and liquid outer core. Both have significant quantities of iron. The liquid outer core moves in the presence of the magnetic field and eddies are set up into the same due to the Coriolis Effect. These eddies develop a magnetic field which boosts Earth's original magnetic field—a process which is self-sustaining and is called the geomagnetic dynamo.

Advantages & Disadvantages:

Advantages:

- Conversion efficiency of about 50%
- Less fuel consumption
- Large amount of pollution free power generated
- Ability to reach fullpower level as soon as started
- Plant sizeis considerably smaller than conventional fossil fuel plants
- Less overall generation cost
- No moving parts, so morereliable

Disadvantages:

- Suffers from reverse flow (short circuits) of electrons through the conducting fluids around the ends of the magnetic field.
- Needs very large magnets and this is a major expense.
- High friction and heattransfer losses.
- High operating temperature.
- Coal used as fuel poses problem of molten ash which may short circuit the electrodes. Hence, oil or natural gas are much better fuels for MHDs. Restriction on use of fuel makes the operation more expensive.

IV. PLANNING AND MPLEMENTATION

Electric Energy Regeneration from Speed Boats with Pump Jet Engine:

The objective of the project is to develop electricity from moving speed boat in sea water. This can be achieved by using magneto hydrodynamics generator attached to the outlet nozzle of the jet ump inside speed boat. When salt water flows through the MHD setup, EMF is induced in the electrodes which can be further stored in batteries. By this electric energy is regenerated from speed boats. The kinetic energy of flowing sea water to again generate electricity using MHD generator called as regeneration. The force of seawater from the speed boats is too high. It has high thrust force to drive the whole boat at full knots.

Prototype Model of the Project

In this project, we are developing electricity from jet boat. As we cannot represent the full scale model of a speed boat, we developed a prototype model of a speed boat using,

- Plastic can to depict the boat shape
- Air blower with venturi attached with a suction nozzle which acts as a pump jet
- Pair of neodymium magnets
- Pair of ferrite magnets
- Electrodes
- Digital voltmeter

For this purpose we made a boat propulsion system suing an air blower and venture so that it can with draw salt water from bottom, so as to depict the original flow of seawater in oceans from boat.

Prototype Model Parts

- Jet Boat
- Blower
- Nozzle
- Venturi tube
- MHD setup
- Water recollecting setup

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Blower:

A centrifugal fan is a mechanical device for moving air or other gases. The terms "blower" and "squirrel cage fan" (because it looks like a hamster wheel) are frequently used as synonyms. These fans increase the speed of air stream with the rotatingimpellers. They use the kinetic energy of the impellers or the rotating blade to increase the pressure of the air/gas stream which in turn moves them against the resistance caused by ducts, dampers and other components. Centrifugal fans accelerate air radially, changing the direction (typically by 90°) of the airflow. They are sturdy, quiet, reliable, and capable of operating over a wide range of conditions.

Construction:

- Main parts of a centrifugal fan are:
- Fan housing
- Impellers
- Inlet and outlet ducts
- Drive shaft
- Drive mechanism

Other components used may include bearings, couplings, impeller locking device, fan discharge casing, shaft seal plates etc.

Drive mechanisms:

The fan drive determines the speed of the fan wheel (impeller) and the extent to which this speed can be varied. There are three basic types of fan drives.

Bearings:

Bearings are an important part of a fan. Sleeve-ring oil bearings are used extensively in fans. Some sleeve-ring bearings may be water-cooled. Water-cooled sleeve bearings are often used when hot gases are being moved by the fan. Heat is conducted through the shaft and into the oil which must be cooled to prevent overheating of the bearing.Since lower-speed fans have bearings in hard-to-reach spots, grease-packed anti-friction bearings are used.Many turbo blowers use either an air bearing or a magnetic bearing.

Fan dampers and vanes:

Fan dampers are used to control gas flow into and out of the centrifugal fan. They may be installed on the inlet side or on the outlet side of the fan, or both. Dampers on the outlet side impose a flow resistance that is used to control gas flow. Dampers on the inlet side (inlet vanes) are designed to control gas flow by changing the amount of gas or air admitted to the fan inlet.

Fan blades:

The fan wheel consists of a hub on which a number of fan blades are attached. The fan blades on the hub can be arranged in three different ways: forward-curved, backward-curved or radial.

Straight radial:

Radial blowers, have wheels whose blades extend straight out from the center of the hub. Radial bladed wheels are often used on particulate-laden gas streams because they are the least sensitive to solid build-up on the blades, but they are often characterized by greater noise output. High speeds, low volumes, and high pressures are common with radial blower, and are often used in vacuum cleaners, pneumatic material conveying systems, and similar processes.

Bernoulli's principle:

In fluid dynamics, Bernoulli's principle states that an increase in the speed of a fluid occurs simultaneously with a decrease in pressure or a decrease in the fluid's potential energy. Bernoulli's principle can be applied to various types of fluid flow, resulting in various forms of Bernoulli's equation; there are different forms of Bernoulli's equation for different types of flow. The simple form of Bernoulli's equation is valid for incompressible flows. Bernoulli's principle can be derived from the principle of conservation of energy. This states that, in a steady flow, the sum of all forms of energy in a fluid along a streamline is the same at all points on that streamline.

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Magnets:

A magnet is a material or object that produces a magnetic field. This magnetic field is invisible but is responsible for the most notable property of a magnet: a force that pulls on other ferromagnetic materials, such as iron, and attracts or repels other magnets.

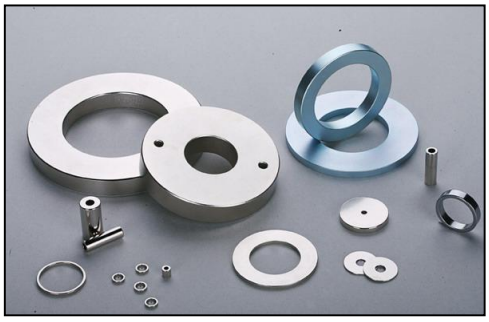

Fig 11: Magnets

Electrodes:

An electrode is an electrical conductor used to make contact with a nonmetallic part of a circuit (e.g. a semiconductor, anelectrolyte, a vacuum or air).

Electrode Materials:

Copper is second only to silver in terms of bulk electrical conductivity. Copper has better strength than silver, but offers inferior oxidation resistance. Copper is a common base metal for electrical contact and electrode applications. It is also used in alloys with graphite, tellurium, and tungsten, and is used to make brass and bronze. Copper has better EDM wear resistance than brass, but is more difficult to machine than either brass or graphite. Copper is also more expensive than graphite.

V. PARTS ASSEMBLY

Parts ofthe Prototype

Wooden Base:

The whole setup of MHD power generation is made on a fixed base. For that we made wooden planks which are joined using straight clamps on all sides and fixed with hot glue gun.

Size of the base: 120 cm x 30 cm

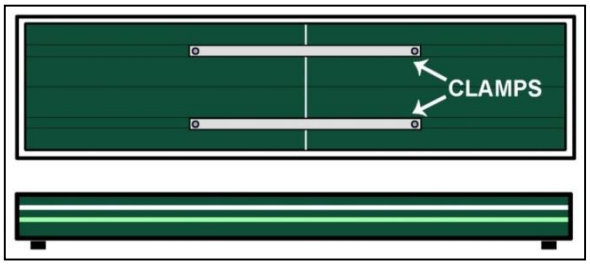

Fig 12: Wooden Base

Jet Boat:

The Original Jet Boat Model Is Represented By A Plastic Model Using Water Can And Pieces Of Card Board Joined To Look Same As Boat Shape. It Is Fixed To The Base With The Help Of An Iron Stand That Could Bear The Load Of A The Blower And Boat Setup.

Speed Settings:	No
Technology:	Start Easy
Anti-vibration System:	No
Inlet pipe diameter:	4cm
Outlet pipe diameter:	2 cm

Magneto hydrodynamics Duct:

The MHD Duct Is made of thickly coated metal can for insulation. The can shape is a wedge shape with variable decreasing cross section. Combination of magnets i.e. ferrite magnets and neodymium magnets are placed on top and bottom face of the duct. Segmented electrodes are arranged inside the duct for maximum extraction of voltage. Nozzle is made up of hard plastic which is inserted in the blower nozzle to fit exactly. A hole is made in the nozzle to fit salt water inlet pipe. The intersection part of the nozzle and blower nozzle is decrease in diameter by using lathe machine turning operation. When the air from the blower flows over the salt water inlet pipe, it creates a low pressure on the top of the pipe which creates suction in salt water pipe. In this way salt water is sucked in the nozzle and a fine mist is formed with high pressure and high velocity.

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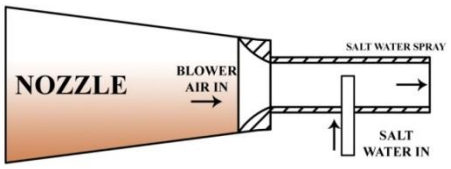

Fig 13: Nozzle Design

Catchment system:

After the salt water spray is passed through the MHD setup, the water has to again reflow to the salt water container. For this purpose a catchment system is made of semicircular plastic tub placed vertically such as the concave face is facing the nozzle. The catchment system out let is connected to a pipe which is connected to the salt water tub below.

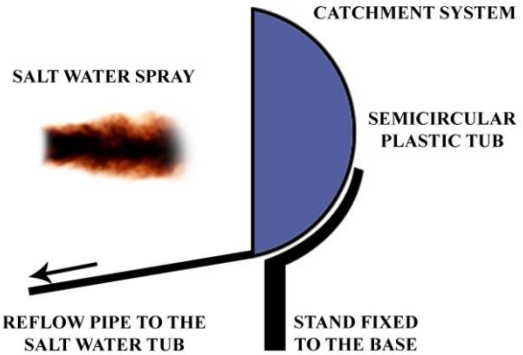

Fig15: Catchment System

VI. CONCLUSION:

In this paper construction of MHD generator for the production of electricity from high speed jet boats has been proposed. We have used the principle of MHD power generation under faradays law of electromagnetic induction using sea water attached to a pump jet propulsion of a jet boat. The various tests which have been performed on the design of the duct shape and nozzle design has been presented and discussed in this project. The design setup has been constructed as per the calculations. The emf which is produced can be increased if the following variables are altered.

- Magnetic field strength.
- Distance between electrodes in the duct setup.
- Using a laminar flow rather than jet spray of sea water.
- Increasing the velocity of flow of fluid through the MHD Duct.

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