

Review: Renewable Energy Systems

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ABSTRACT -The power necessities of the world including India are expanding at disturbing rate and the power request has been running in front of supply. It is additionally now generally perceived that the non-renewable energy sources (i.e., coal, oil and gaseous petrol) and other traditional assets, by and by being utilized for age of electrical vitality, may not be either adequate or appropriate to keep pace with regularly expanding interest of the electrical vitality of the world. Likewise age of electrical power by cool based steam control plant or atomic power plants causes contamination, which is probably going to be more intense in future because of vast producing limit on one side and more noteworthy familiarity with the general population in this regard. The current extreme vitality emergency has constrained the world to grow new and elective strategies for control age, which couldn't be embraced so far because of different reasons. The magneto-hydro-dynamic (MHD) control age is one of the cases of

another remarkable strategy for control age. The other non-regular techniques for control age might be, for example, sun oriented cells, power devices, thermo-electric generator, thermionic converter, sun oriented power age, wind control age, geo-warm vitality age, tidal power age and so on. This paper clarifies about Different Energy sources, why we are going for non-customary vitality sources, Different non-traditional vitality sources and correlation between them, about power modules and their applications.

Keywords: Electrical vitality; Atomic Power Plants; Tidal Power Plants;

I. INTRODUCTION:

Essentially the vitality sources are two composes; they are regular vitality sources like coal, oil, gaseous petrol and so forth and non-customary vitality sources like sunlight based cells, power modules, thermo-electric generator, thermionic converter, sun

oriented power age, wind control age, geo-warm vitality age, tidal power age and so on. Quick exhaustion of traditional vitality sources made us to care for interchange vitality sources, for example, magneto-hydro-dynamic (MHD) control age and other non-customary strategies for control age. Distinctive Non-customary techniques for control age and their efficiencies: From the above table energy unit innovations having higher proficiency contrasted and different strategies for electric power age. Another explanation behind the enthusiasm for energy components is; cost per kW of energy is free of size (or rating) of the power devices. Alternate benefits are as per the following.

Fig: 1.1: Efficiency

Table1:

S. NO	METHOD	EFFICIENCY	
		PRESENT	FUTURE
1.	MHD Power generation	Around 50%	Up to 60%
2.	Thermo-electric power generation	Around 3%	Up to 13%
3.	Thermionic converters	Around 15%	Up to 40%
4.	Photo-voltaic or solar cells	Around 15%	—
5.	Fuel cell technologies	Around 50%	Up to 60%
6.	Solar power generation	Around 30%	Up to 50%
7.	Wind power generation	Around 30%	—
8.	Geo-thermal power generation	Around 15%	—

II. MERITS OF FUEL CELLS:

- The unit is lighter and littler and requires little support as a result of nonattendance of mechanical parts
- They cause little contamination and little clamor.
- No overhead line is required.
- Fuel can be utilized more successfully than in a focal power plant.
- They can wind up noticeably striking home units.
- High effectiveness of around half contrasted with 30% of regular power frameworks.

- Fast startup and quick load reaction.
- A power module gives a couple of times more electrical vitality per unit weight when contrasted with a turbo generator or a capacity battery.
- An assortment of fills, for example, methane, ethane, ethylene, acetylene, propane, butane, benzene, methanol, smelling salts, hydrazine, LPG, biogas or coal gas can be utilized. Subsequently in this paper we need to bargain the power device advancements for the most part due to its characteristic points of interest clarified previously.

III. FUEL CELLS

3.1 INTRODUCTION TO FUEL CELLS:

The fundamental idea engaged with any cutting edge energy unit for electric power age is the electrochemical response amongst hydrogen and oxygen within the sight of impetuses, which produces electrical vitality as a DC current. The side-effects are warmth and water. Since hydrogen has one of the most astounding synthetic reactivity's, it is regularly utilized as either unadulterated hydrogen or hydrogen rich fuel in most current power devices. The fuel is provided on the anode side. The anode response in power modules is either immediate oxidation of hydrogen or methanol or circuitous oxidation through an improving procedure for hydrocarbon fills. The cathode response is oxygen diminishment from air in most power modules. Since the power in an energy unit isn't delivered using warm

vitality, energy component effectiveness isn't restricted by the Carnot proficiency.

The essential segments of an energy unit are the terminals (anode and cathode), the electrolyte and the impetus. The anode comprises of a permeable gas dispersion layer as a terminal and an anodic impetus layer. It conducts electrons produced at the impetus/anode/electrolyte interface to the outside electrical circuit, which in the long run comes back to the cathode. An electrolyte is shaped by an ionic bond, conducts protons or particles to the contrary terminal inside, in this way finishing the electric circuit.

The electrolyte is viewed as the core of the energy component. It comprises of a strong layer having a proton-leading medium (e.g., dampened with water for PEMFC or DMFC), and a strong network with a fluid particle directing electrolyte (e.g., PAFC, MCFC), or a strong grid having particle directing attributes (e.g., SOFC). The cathode comprises of a permeable gas dispersion layer as an anode and a cathodic impetus layer. It conducts electrons coming back from the outer electric circuit to the cathodic impetus layer. Impetuses accelerate the response without really taking an interest in the response. The most astounding oxidation rates and subsequently current densities are found at destinations having huge impetus movement.

3.2 BRIEF THEORY AND OPERATION:

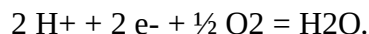
For the hydrogen/oxygen (air) fuel cell, the overall reaction is:



The product of this reaction is water released at the cathode or anode depending on the type of fuel cell. For PEM fuel cell, hydrogen is oxidized at the anode as given by the reaction,



Electrons generated at the anode are flown through external load to the cathode. Protons (H^+) are migrated through the proton exchange membrane to the cathode. The protons and electrons reached at the cathode react with oxygen from air as given by the reaction,



The reversible open circuit voltage E_0 for hydrogen/oxygen power devices at standard states of 25°C and 1 atm weight is 1.23 V. This voltage level is too low to ever be valuable. The vast majority of electronic items require a power source with substantially higher voltage. Numerous phones are associated in arrangement called a phone stack to create helpful voltages (which is the aggregate of individual cell voltages).

The cell current relies upon the region (the size) of a cell. When all is said in done, the bigger the cell region, higher will be present created. Subsequently, the cell current is typically introduced regarding the present thickness, mA/cm^2 or A/cm^2 . Cells are

associated by the bipolar plates or interconnect. in a stack. Other than gathering present, bipolar plates additionally have gas stream channels on each side through which the gases [fuel (hydrogen) and oxidant (air)] equally convey through the whole cell. Bipolar plates may have cooling channels relying upon the stack-cooling prerequisite.

The reversible open circuit voltage E for given working conditions relies upon the working temperature T , fractional weights (P with suitable subscripts) of the reactants and items in the power device, and the quantity of electrons created for every particle of the fuel, and are given by the Nernst condition. Genuine voltages created in a power module are constantly not exactly the Nernstian voltage because of different misfortunes related with an energy unit and the energy unit framework.

These voltage misfortunes for an energy component are because of enactment over potential, ohmic over potential and fixation over potential. Actuation over potential is the voltage misfortune to defeat the electrochemical hindrance of the electrochemical response happening in the energy unit. Ohmic over potential misfortune is the voltage misfortune because of inside electrical protection of the cell. Fixation over potential is the voltage misfortune ascribes to the consumption of responding species on the cathode.

3.3 TYPES OF FUEL CELLS:

- The different types of fuel cells are as follows.

(around 10-100 μm) of Pt or Pt/Ru impetus layer is kept on each side of the film.

The hypothetical voltage for a PEMFC is 1.23 V, while the acknowledged voltage is 0.5-0.9 V. The initiation over capability of oxygen lessening response (ORR) at the cathode is around four times bigger than that of hydrogen oxidation response at the anode.

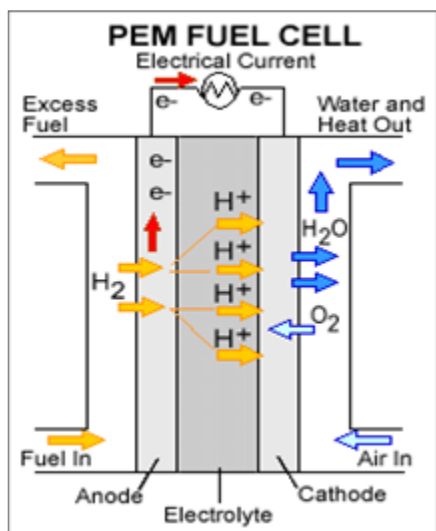


Fig 3.2: PEM CELL

Thus, if the cathode initiation over potential can be diminished, a noteworthy pick up in the PEMFC execution can be figured it out. At present, the platinum and platinum/ruthenium are utilized as a part of the PEMFC and they assume a basic part on the current achievable execution levels. The utilization of the Pt and Pt/Ru impetuses has been significantly decreased over the most recent 30 years from 28 to 0.2 mg/cm² of the cell territory. This sum must be additionally decreased if the PEMFC will be utilized for car control age, where the cost of Pt utilized can go up due its utilization in an expansive number of vehicles delivered

yearly. Additionally, no noteworthy decrease in actuation over potential has been accomplished over the most recent 20 years or something like that. This is a standout amongst the most vital regions of research expected to altogether expand the execution and proficiency of the PEMFC at the cell level.

Despite the fact that the cutting edge innovation empowers decreasing the molecule size of the impetus down to 2-5 nm, the basic response systems of ORR on nano-scale platinum or platinum/ruthenium impetuses are as yet not obviously caught on. Numerous bimetallic impetuses, for example, Pt-Ni and Pt-Co, and trimetallic impetus are being examined. There is a need of computational nanoscience examination to accomplish ideal utilization of the impetus with appropriate impetus structure and arrangement.

Especially, oxygen decrease response at the cathode should be characterized where the significant enactment over potential happens. Since the carbon monoxide harms the Pt impetus, as of now the CO sum in the approaching hydrogen is controlled in the fuel improving procedure to not exactly around 10 ppm. Again novel methods for higher CO tolerant impetuses should be explored which will conceivably lessen the cost of fuel transforming process by diminishing the extent of the special oxidation reactor or evacuating it.

The execution of a PEMFC relies upon the proton conductivity of the right now utilized Nafion layer. This film must be all around

hydrated for good proton conductivity and should likewise be worked at temperatures lower than 100°C for the sturdiness of the layer. Expanding the working temperature of the power device will bring about quicker anode energy and will essentially enhance the phone execution (higher is the working temperature, the lower will be initiation over potential). Another film material with better warm dependability is required for car application. A perfect film requires less or no humidification and can work at higher temperatures without influencing the proton conductivity and corruption; the material ought to be synthetically and mechanically steady and give satisfactory boundary to fuel hybrid and inside current spillage. More slender layers are wanted to lessen the ohmic misfortunes, however in the meantime ought to have the capacity to withstand high-weight differentials. Diminishment in the film cost is very alluring since it speaks to around 18% of the cost of the energy unit. Obviously, as the creation volume expands, the cost of film will go down while the cost of platinum will increment because of more request of platinum.

Water administration in the PEMFC is a critical and complex issue. Water is produced in the cathode because of the oxygen decrease response. Water in the film is relocated from anode to cathode due to electro-osmotic drag. The film on the anode side may lose water while the layer on the cathode side may encounter unreasonable water. It is a tireless adjust of controlling the humidification on the anode and water

vanishing on the cathode. There must be adequate water in the polymer electrolyte to keep up particle conductivity of film and to stop the hybrid of hydrogen fuel. Lack of hydration of the film causes significant increment of ohmic over potential in the layer that outcomes in a noteworthy misfortune in the cell productivity.

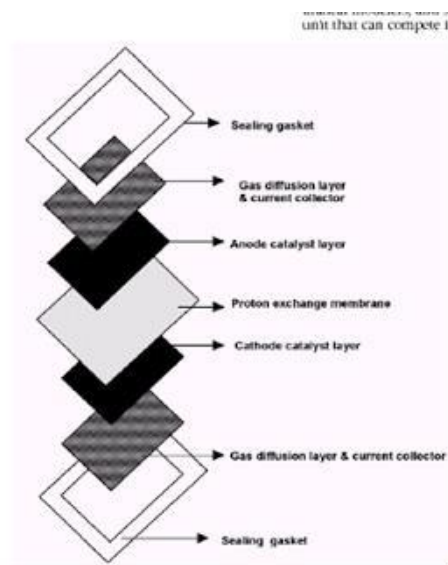


Fig 4.1: PEMFC

The cathode ought to be legitimately dampened to diffuse adequate water in the film for required ionic conductivity. However, it ought not be overflowed. Intemperate water in the cathode obstructs the pores, which are the dissemination pathways for oxygen. Having legitimate hydrophilic/hydrophobic properties of the gas dispersion layer on the anodes and appropriate stickiness of the gulf gas streams waters adjust in the film. The water must be uniformly disseminated in the layer all through the cell. Practically speaking, the air streaming over the cathode might be dry at

the passageway; without flow in the center, and completely soaked close to the leave so it can't get dry any more abundance water. Water administration issue turns out to be more extreme for expanding size and number of cells in the stack. High water weight in reactant streams decreases the cell voltage and increments over potential at the cathode. Water buildup, cathode flooding and impediment of gas channels could prompt operational disappointment.

The warm administration issue is combined with the water administration. Warmth produced in the stack is around an indistinguishable request of greatness from the power created. The stack coolant principally evacuates this warmth since there is insignificant measure of warmth diverted by the fumes gases whose temperature is at the working temperature of the stack. On the off chance that the cell temperature is too low, the yield control is low and water buildup issue may prompt cell operational disappointment. On the off chance that the cell temperature is high, it prompts neighborhood or worldwide cell lack of hydration of the film. This may prompt the loss of execution because of expanded interior safe and conceivable blast because of the hybrid of fuel. Better MEA (layer anode get together) structure and stream channel configuration are expected to enhance water and warm administration at the cell level. Measurement of temperature dissemination in a film/cathode over its whole surface zone is vital to comprehend the present appropriation and enhancement of the cell execution.

4.1 THE STACK:

The stream circulation and related weight drop of hydrogen and air in the cell stack is a main problem for high voltage and high power thickness execution. Novel outlines of the gas stream fields (channel plans) on the anode and cathode sides are expected to make savvy elite gas stream field plate outlines that likewise lessens parasitic misfortunes of streaming the fuel and oxidant.

Stack cooling in an energy unit producing more than 10 kW control is a testing issue. Streaming a coolant through the entries made in a bipolar plate does the stack cooling. Plan of cooling channels for stack cooling should be advanced from the perspectives of cooling, parasitic weight drop and cost contemplations. Likewise, the coolant ought to be non-transmitter or dielectric to counteract voltage misfortune or shortcircuiting. Water as a coolant can represent a significant issue in chilly atmospheres for car applications. A minimal effort dielectric liquid that can work at low temperatures (up to - 40°C) is required for cooling the power module stack. As of now, the water-glycol blend is being considered as coolant for car applications with locally available particle trade sap filler containing both anion and feline particle trade pitches to expel free particles.

Graphite is utilized as the bipolar plate in the lab and model energy components. Stream channels and fuel/air/coolant appropriation manifolds of the bipolar plate are exclusively machined. Bipolar plate speaks

to around 80% mass of the power module, all volume and around 14-24% of the cost of the fuel cell†. Two procedures under improvements are infusion embellishment and metal stamping/framing. These procedures have been industrialized for minimal effort, large scale manufacturing of electronic and car parts. Composite material, for example, carbon powder and sap, is utilized for trim of bipolar plates. Stainless steel is utilized as the bipolar plate for extraordinary applications. Thus, the present course is to go from graphite to metal bipolar plates or composite material to decrease the volume and the cost.

Additionally look into is expected to broaden the lifetime and security of the bipolar plates produced using these procedures. This is on the grounds that the power device working condition is extremely acidic and destructive. The hydrogen spillage in the composite material or embitterment of the metal is likewise the issues with bipolar plates. Fluorine and sulfur filtering issue related with Nafion based films ought to be tended to on the grounds that the resultant low pH level water turning out from energy units may erode/destroy the street surface when the PEMFC is utilized as a part of the car applications expected to expand the lifetime and dependability of the bipolar plates produced using these procedures. This is on the grounds that the energy unit working condition is extremely acidic and destructive. The hydrogen spillage in the composite material or embitterment of the

metal is likewise the issues with bipolar plates.

Fluorine and sulfur filtering issue related with Nafion based layers ought to be tended to in light of the fact that the resultant low pH level water turning out from energy units may consume/destroy the street surface when the PEMFC is utilized as a part of the car applications. Contingent upon the fuel, the fuel-preparing unit is straightforward for hydrogen and complex for hydrocarbon fuel. Hydrocarbon fuel incorporates methane, methanol, ethanol, propane, petroleum gas and gas and so forth. The center of fuel handling unit for hydrocarbon fuel is where the fuel is synthetically changed over to a hydrogen rich gas.

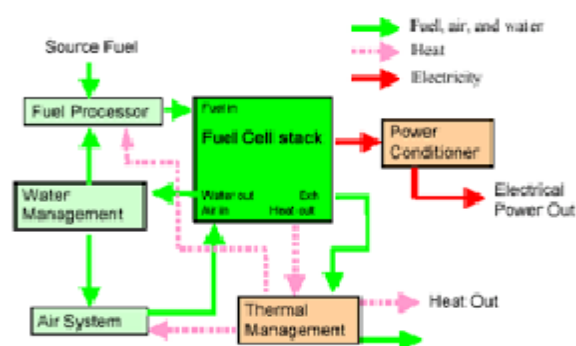


Fig 4.2: Power Conditioner

There is a confound of the working temperature between reformer unit and energy component stack. Warmth created from the power module stack can be utilized for vanishing of fuel yet isn't sufficiently high temperature for the reformer. Released gas from the anode side of the power device containing remaining hydrogen can be utilized for warming reformer. The stacking

of impetus and the outline of reformer a long way from enhanced.

Air compressor and fan are utilized to transport and course the fuel and air. Effective air compressor and fan are required to lessen the power utilization and to expand general framework proficiency. A calm compressor is required since an uproarious air compressor crushes the quiet element of the energy component framework.

Power conditioner assumes a basic part in the energy unit framework. It supports the variance between control request and energy unit yield control, changes over DC control into AC control, and oversees control utilization of individual part in the power module framework. For electrical or electronic industry to oversee control with low present and high voltage is a typical practice. Be that as it may, the normal for energy unit yield control is low voltage and high present. This introduces a remarkable issue for the power conditioner. The electrical-to-electrical vitality change effectiveness (around 85%) is not as much as palatable.

The energy component stack ought to be outlined and enhanced as a major aspect of the framework, which incorporates the fuel transforming framework and the adjust of energy plant. This will require the squeeze investigation for improving the number and area of warmth exchangers and furthermore to coordinate the temperatures of the power device stack and fuel processor. Additionally the major testing zone is to

coordinate the reactors and warmth exchangers for the fuel preparing to diminish both the cost of the framework and furthermore the volume and weight necessities, which is imperative for the transportation applications.

4.2 THE FUEL :

The fuel required for the PEMFC is the hydrogen. It represents various difficulties of hydrogen creation, stockpiling, security and framework, which are past the extent of the present scope.

It gives a biggest test to discover elective energizes that would have the accompanying qualities:

- (1) Direct electrochemical oxidation of fuel.
- (2) Low danger and high synthetic strength.
- (3) Low erosion of current authorities, impetuses, and films.
- (4) High dissolvability in H₂O.
- (5) High vitality thickness.
- (6) Fuel oxidation brings about earth and power device inviting items (e.g., CO₂).

In spite of the fact that methanol and ethanol are getting to be noticeably potential applicants as the fuel for PEMFC, the improving of alcohols or direct electrochemical oxidation of liquor are a long way from fulfillment. The real difficulties in looking new energizes are: Identify fills that are appealing from a thermodynamic perspective (fluid state at

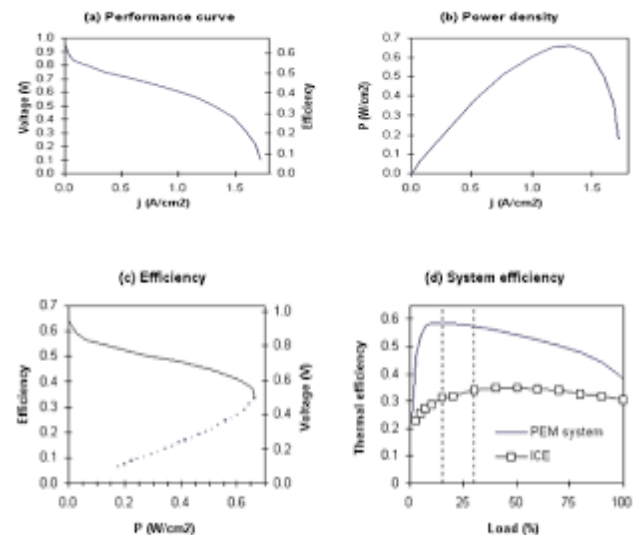
STP, high volumetric vitality thickness, naturally benevolent items, and miscible with water). Decide rate-deciding strides in fuel oxidation responses and look for implies for its change, for example, new impetuses, best molecule size and dissemination.

V. PERFORMANCE CURVES OF PEMFC:

Three critical efficiencies for the hydrogen/oxygen energy component are: Thermodynamic productivity, electrochemical proficiency and the Fuel Utilization coefficient or factor. The thermodynamic proficiency is the proportion of perfect electric vitality to the aggregate synthetic vitality of hydrogen and oxygen. It is the segment of the substance vitality of the fuel, which hypothetically is changed over into electrical vitality. Electrochemical productivity is the proportion of real electrical vitality yield from the cell to the perfect electrical vitality yield from the cell, at 100% fuel usage. At the point when the fuel moves through the anode, not all fuel is synthetically responded for vitality change. Consequently, we characterize a fuel use coefficient μ_f as the genuine fuel responded to the fuel provided on a mass stream rate premise. In the event that $\dot{H}_r$ is the warming estimation of all fuel parts that are changed over electrochemically (e.g., H_2) and $\dot{H}_c$ is the warming estimation of all fills (e.g., including CH_4 or CO), at that point $\dot{H} = \dot{H}_r / \dot{H}_c$.

In this manner when the fuel other than hydrogen is utilized as a part of a H_2/O_2 power module, the aggregate productivity is the duplication of these four efficiencies, and is in the scope of 30-half for most energy components.

Fig 5.1 Efficiency Graphs



VI. DRAW BACKS OF THE PRESENT MODELS:

1. The resultant low pH level water from energy units may consume/destroy the street surface when the PEMFC is utilized as a part of the car applications.
2. The normal for energy component yield control is low voltage and high present. This shows a one of a kind issue for the power conditioner.
3. Bipolar plates possess 14-24% rule cost and 80% volume which ought to be overcome.

VII. MAIN APPLICATIONS:

1. In car part, military, rocket and so forth.
2. The advancement of power modules will be uncommonly helpful to India for supply of electrical vitality to water system directing sets in the towns and remote zones
3. It is conceivable to make valuable possibilities of 100 to 1000 volts and power level of 1kw to 100mw by associating number of cells in arrangement and parallel blend.

VIII. CONCLUSION

Beginnings with the present condition of innovation, the itemized R&D needs are introduced in this paper for the cell, stack, framework, fuel and fuel handling for the proton trade layer. The PEMFC is being produced for car drive, convenient power and appropriated control applications. Toyota Prius (popularized suv vehicle utilizing PEMFC) is the initial phase in vehicles portion discharged in business advertise using the power module innovation. At introduce, these power modules have experienced exhibition ventures for execution levels and expected upgrades. The significant issues are the cost/kW, sturdiness and dependability. Broad endeavors are being committed to enhance the execution with less expensive materials, bring down material substance, more rearranged frameworks/segments, less

number of parts, tending to transient and relentless state execution issues, diminishing the misfortunes, and so on. A broad scope is given in this paper to R&D needs to address some of these issues.

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