ALKALINE FUEL CELL

Mr.M.Balaji ,ME.,
Assistant professor /Mech
SNS College of Technology
Coimbatore

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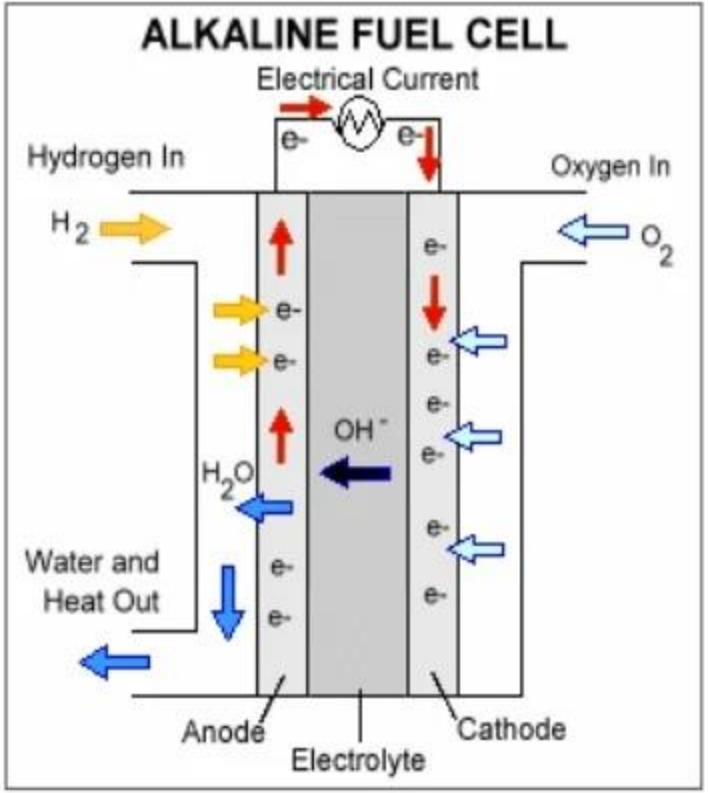


Definition's :

Cell : A cell is a single arrangement of two electrodes.

Battery : A battery is a combination of two or more cell arranged in a series.

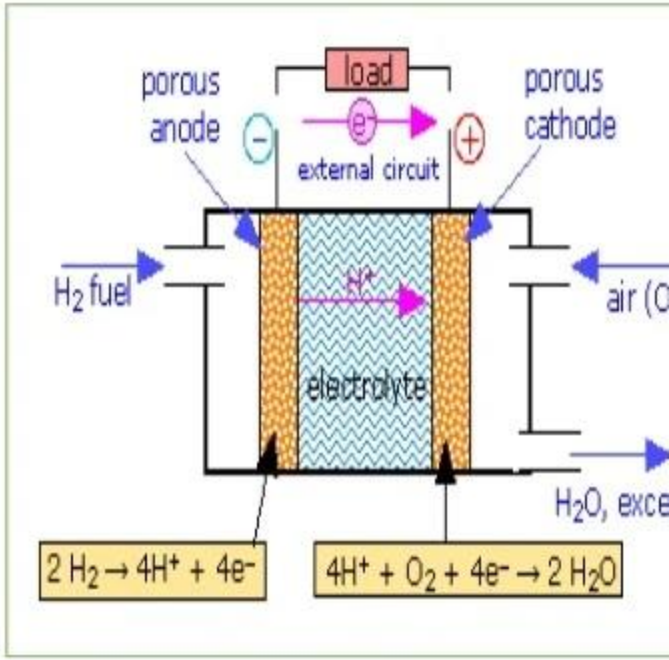
Fuel cell: Fuel cells are electrochemical devices consisting of an electrolyte an ion containing solution liquid are solid in contact with two electrodes.

Alkaline fuel cell: The alkaline fuel cell converts controlled quantities of gaseous hydrogen and gaseous oxygen into electricity using a direct ,low temperature, electrochemical reaction.

General Representation of fuel cell :

Principle :

- Fuel cells combine hydrogen and oxygen, separated by a proton-conductive membrane impermeable to gas .
- which results in the generation of energy and production of water.
- .Therefore, fuel cells represent an optimum method of directly converting chemical energy to electrical energy and heat in an electrochemical process.



Basic reaction in fuel cell

Anode side (an oxidation): $2H_2 \longrightarrow 4H^+ + 4e^-$

Cathode side (a reduction): $O_2 + 4H^+ + 4e^- \longrightarrow 2H_2O$

NET REACTION : $2H_2 + O_2 \longrightarrow 2H_2O$ + electrical energy + heat

Energy routes :

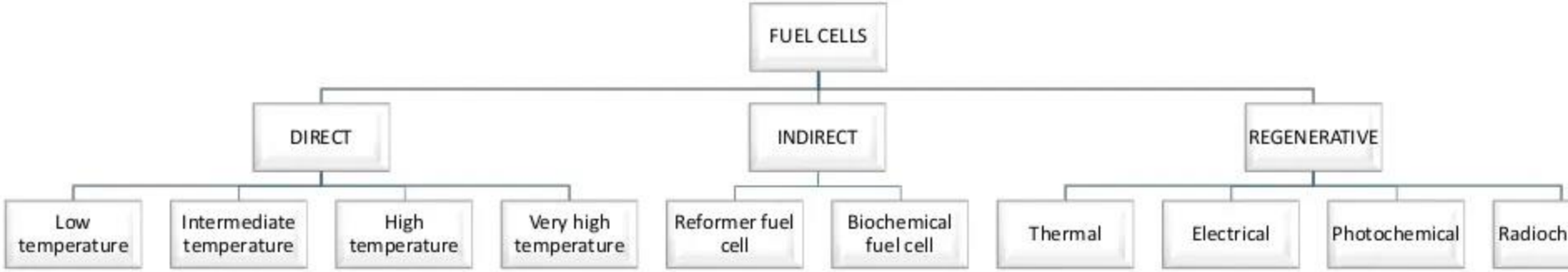
- Second route will be subjected to second law of thermodynamic.
- It will operate with an efficiency of 30% .
- First route of the fuel cell should operate at least theoretically with 100% .

Fuel choice:

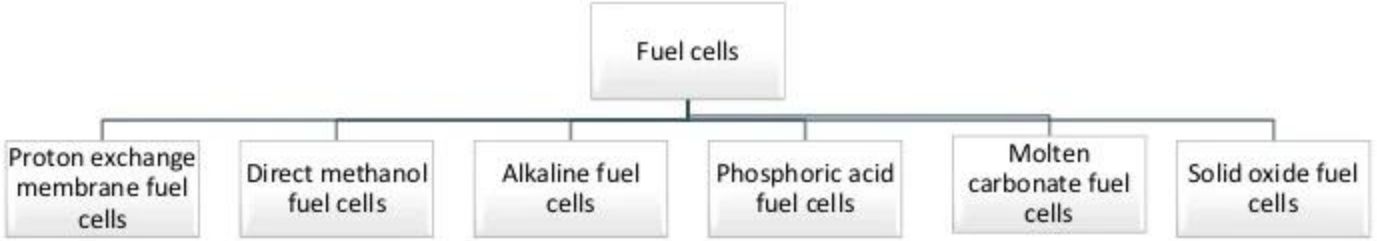
- Depend on the operating condition fuel can be solid, liquid or the gaseous form.
- Fuel cell operate at maximum efficiency when operating on pure hydrogen and pure oxygen.
- Both are expensive therefore gaseous mixture of hydrogen and oxygen can be created by processing of fossil fuel or biomass.

Classification of fuel cell :

1. Depending upon the temperature of operation



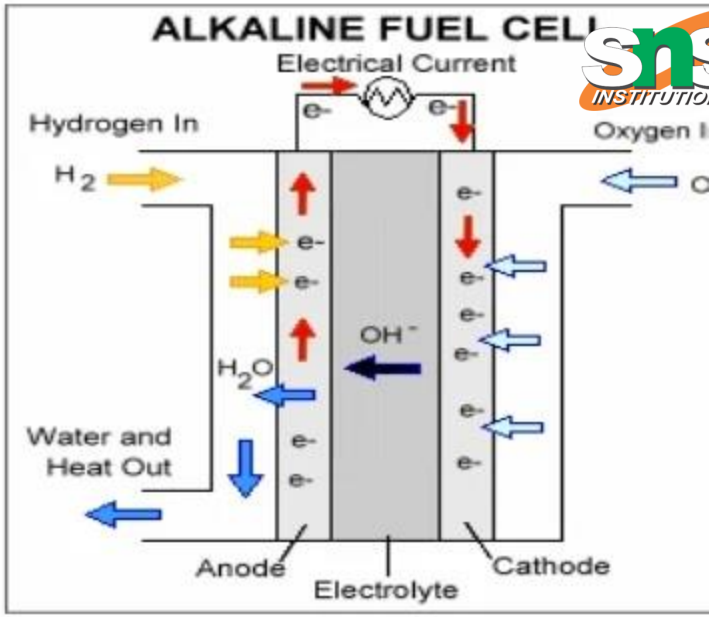
2 .Depending upon medium and electrolyte used in fuel cells



KALINE FUEL CELLS :

Principle :

- This cell works optimally at 80°C using relatively inexpensive material.
- A single AFC consist of two porous electrode with liquid KOH electrolyte between them.
- The hydrogen fuel is supplied to the anode electrode , while oxygen from the air is supplied to the cathode .
- Voltage between the anode and the cathode of a single fuel cell is between 0.9V and 0.5V depending on the load.



- Basic reaction

At anode :

$$2H_2 + 4OH^- \longrightarrow 4H_2O + 4e^-$$

At cathode :

$$O_2 + 4e^- + 2H_2O \longrightarrow 4OH^-$$

Net reaction :

working:

Hydrogen atom enter fuel cell at anode where a platinum catalyst causes the Hydrogen to split into positive Hydrogen ions (protons)and negatively charge electrons.

- The positively charge Hydrogen ions react with Hydroxyl (OH-)ions in the electrolyte to form water.
- The negatively charge electrons can not flow through the electrolyte to reach the positively charge cathode, so they must flow through an external circuit, forming an electrical current.
- Oxygen enter the fuel cell at cathode and picks up electrons and then travel through electrolytes to The anode , where it combines with hydrogen atom.
- Oxygen with electron combine hydrogen at anode

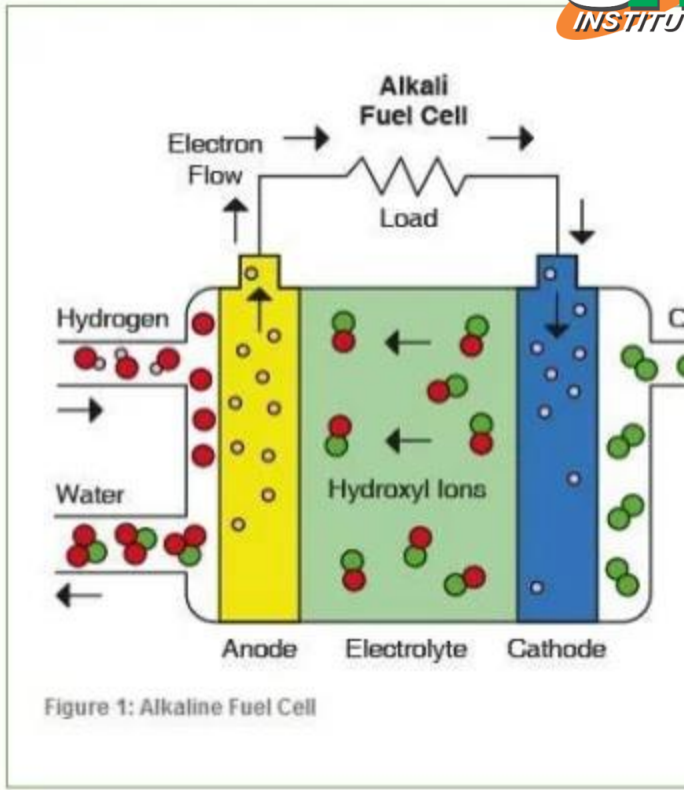


Figure 1: Alkaline Fuel Cell

TYPES OF ALKALINE ELECTROLYTE FUEL CELLS

1. Mobile electrolyte alkaline fuel cells:

- Uses pure hydrogen as the fuel at the anode and air for the reaction at the cathode.
- Electrolyte is pumped around an external circuit
- The Hydrogen must be circulated to extract the water produced by means of a condenser
- Reaction between KOH and CO2 is the major problems in mobile electrolyte alkaline fuel cells
- $2KOH + CO_2 \longrightarrow K_2CO_3 + H_2O$

2.STATIC ELECTROLYTE ALKALINE FUEL CELLS:

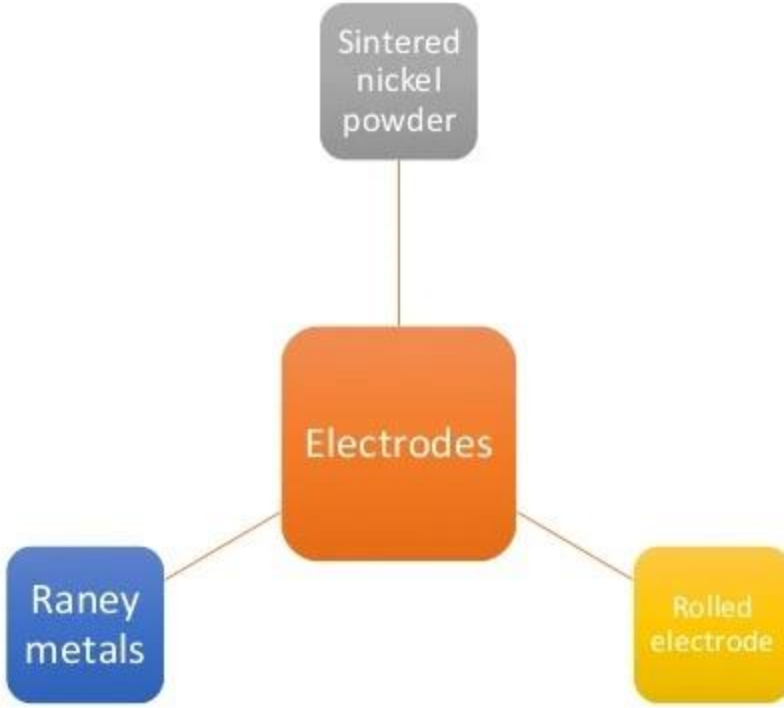
- Electrolyte is held in a matrix material and therefore does not circulate as in the mobile phase.
- Use pure oxygen as the reactant for cathode side but does not have to be in pure form.
- Individual cooling system is needed to keep fuel cell with in operational temperature range.

3.Dissolved fuel alkaline fuel cells :

- KOH is used as the electrolyte along with a fuel such as hydrazine or ammonia combined with it.
- Do not work for large power generation applications.
- Hydrazine dissociate into hydrogen and nitrogen on surface of fuel cell electrode
- Resulting hydrogen can be use as fuel ,but it toxic , carcinogen and explosive it is replace by methanol
- $CH_3OH + 6OH^- \longrightarrow 5H_2O + CO_2 + 6e^-$

Electrodes for alkaline electrolyte fuel cells

- Alkaline electrode fuel cells operate at a wide range of temperatures and pressures and their application is very limited.
- As a result different type of electrodes used
- Some of the various types of electrodes are explained as follows .



Comparison of typical characteristics with other fuel ce

Fuel cell type / Characteristics	PEMFC	AFC	PAFC	MCFC	SOFC
Operating temperature range (k)	303-353	343-363	373-493	923-112	973-1273
Current density	High	High	Moderate	Moderate	High
electrodes	Pt	Ni/Ag metal oxides , noble metals	Pt	Nu anode , NiO cathode	Co-ZrO_2 Ni-ZrO_2 Anode ,Sr-$LaMnO_3$ cathode
Charge carrier	H^+	OH^-	H^+	$CO3^{2-}$	O_2^-

PEMFC :Proton Exchange Membrane Fuel cells.
AFC :Alkaline Fuel cells.
PAFC :Phosphoric Acid Fuel cells.
MCFC :Molten Carbonate Fuel cells.

Advantages of alkaline fuel cells :

- Activation over voltages at the cathode is usually less than with an acid electrolyte fuel cells
- Electrodes do not have to be made of precious metals.
- High electrical efficiency of up to 60-70% in moderate condition.
- Mobile electrolyte fuel cell can easily cooled by circulated hydrogen.
- High performance , simple design.
- Good power density.
- Low temperature operation.

Disadvantages of alkaline fuel cells:

- They need to be installed in a CO_2 free environment
- Preparation of the electrodes with noble metal catalysts is very expensive.
- Diaphragm made of asbestos but this material is hazardous for health.

Application of alkaline fuel cells :

- Alkali cell provides drinking water for the astronauts
- NASA alkali fuel cells for the space shuttle fleet as well as apolllo program.
- It is use as a power source in experimental purpose.

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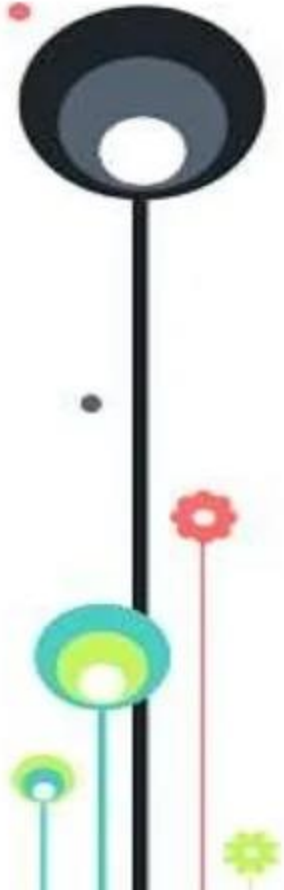

Do you have any questions?

THANK YOU FOR YOUR ATTENTION !