ENGINEERING CHEMISTRY

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Electrochemical Sensors - Oxygen sensor

Class content:

- ***Oxygen sensor***
  - ***Applications***
    - ***Oxygen sensor in automobiles***
      - ***Principle***
      - ***Construction and working***

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Oxygen sensor

An electronic device that **measures the proportion of O_2** in the gas or liquid being analysed

Applications of O_2 sensor:

- Divers use to measure partial pressure of O_2 in their breathing gas
- Scientists use as probes to measure respiration or production of O_2
- O_2 analyzers used in medical applications such as anesthesia monitors, respirators etc
- Used to measure exhaust gas concentrations of O_2 in IC engines

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Role of oxygen sensor in automobiles

Principle :

- **Stoichiometric air/fuel ratio** ideal for combustion of gasoline is **14.7:1**
- Located in the **exhaust stream** and indirectly determine air to fuel ratio
- O_2 sensor allows engine control system to maintain ideal ratio across various engine operating systems
- It compares the amount of **O_2 in the exhaust** to the amount of **O_2 in the atmosphere**

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- An output voltage is generated based on the **difference in O_2 concentration** in the exhaust and atmosphere

- An output voltage of **0.2V represents a lean mixture** and **0.8V represents a rich mixture**
- Ideal set point is around **0.45 V**

- The voltage is sent as feedback to Engine control unit which adjusts the air/fuel ratio back to stoichiometric value

- Lean mixture results in more of **NO_X emissions**
- Rich mixture leads to more of **CO , C particles and unburnt fuel emissions**

- Based on **solid state electrochemical fuel cell**

- Operates at a minimum temperature of **360^oC**

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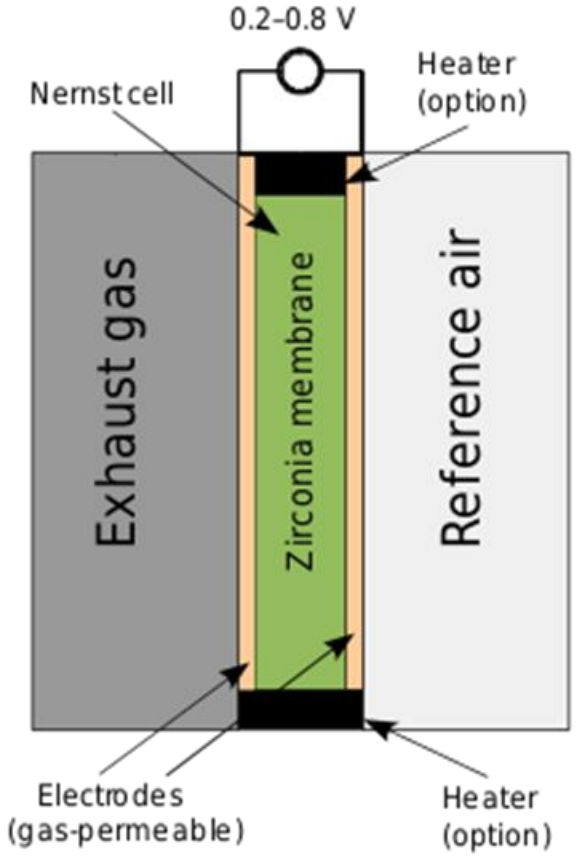
Construction:

Anode : Pt

Cathode : Pt

Electrolyte : Zirconium oxide (ZrO_2)

doped with Yttrium oxide (Y_2O_3)



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Working :

At Anode : $2O^{2-} \longrightarrow O_2 + 4e^-$

At Cathode : $O_2 + 4e^- \longrightarrow 2O^{2-}$

Cell voltage is given by

$$E_{cell} = \frac{2.303RT}{4F} \log \frac{P_1}{P_2}$$

where P_1 and P_2 are the partial pressures of O_2 in reference air and exhaust gas respectively

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- Automobiles fitted with O_2 sensor must use **unleaded gasoline** as lead poisons the Pt catalyst and reduces its efficiency

- Symptoms of failure are – increased tail pipe emissions, increased fuel consumption and hesitation on acceleration

THANK YOU

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