Module 1: Introduction to Combustion

Lecture 3: Fuels

The Lecture Contains:

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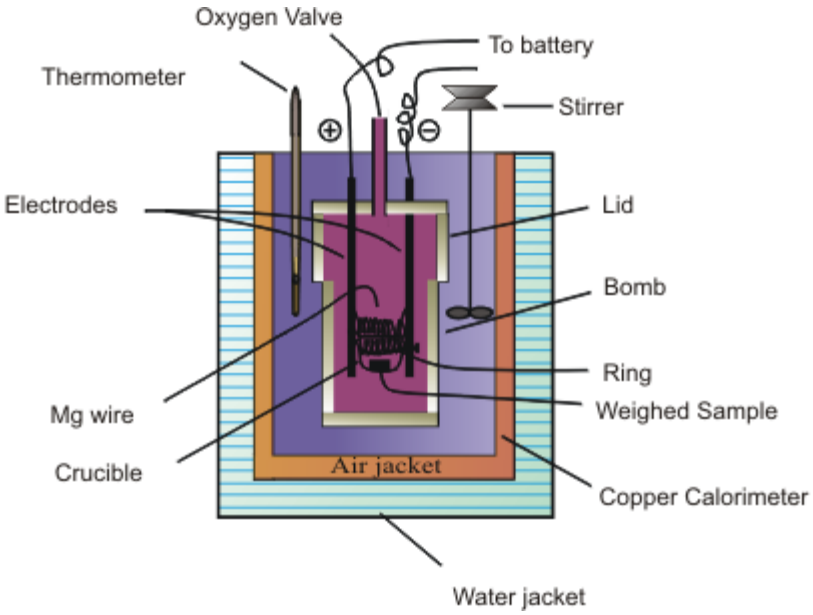
Bomb Calorimeter

- Used to determine the calorific value of the liquid fuel.
- Liquid is burnt in the bomb in the presence of oxygen at about 2.5 MPa .
- The change in temperature in the water bath provides the calorific value of the fuel.



(Figure 3.2)

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Properties of Liquid Fuels

Specific Gravity : Ratio of mass density of fuel to mass density of water at the same temperature

$$SG = \frac{\rho_{fuel}}{\rho_{water}} (at\ the\ same\ temperature)$$

Reference temperature for fuel and water: 288.8 K

American Petroleum Institute (API) Scale:

$$\text{APISG} = \frac{141.5}{\text{SG}} - 131.4$$

Relation between APISG and HHV:

For Gasoline : $\text{HHV} = \text{LHV} + 93(\text{APISG} - 10)\ \text{kJ/kg}$

For Kerosene : $\text{HHV} = \text{LHV} + 93(\text{APISG} - 10)\ \text{kJ/kg}$

Auto Ignition Temperature : The lowest temperature required to make the combustion self sustained without any external aid

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Properties of Liquid Fuels

Flash Point : Minimum temperature at which liquid fuel will produce sufficient vapors to form a flammable mixture with air. Indicates maximum temperature at which liquid fuel can be stored without any fire hazard.

Fire Point : Minimum temperature at which liquid fuel produces sufficient vapors to form a flammable mixture with air that continuously supports combustion establishing flame instead of just flashing.

Smoke Point : Measure of the tendency of a liquid fuel to produce soot.

Properties of Common Liquid Fuels

Fuel Type	Automotive Gasoline	Diesel Fuel	Methanol	Kerosene	ATF (JP8)
Specific gravity	0.72 - 0.78	0.85	0.796	0.82	0.71
Kinematics viscosity @ 293 K (m^2/s)	0.8×10^{-6}	2.5×10^{-6}	0.75×10^{-6}	3.626×10^{-6}	--
Boiling point range (K) @ STP	303 - 576	483 - 508	338	423-473	442
Flash point (K)	230	325	284	311	325
Auto ignition temperature (K)	643	527	737	483	--
Stoichiometric air/fuel by weight	14.7	14.7	6.45	15	15.1
Heat of Vaporization (kJ/kg)	380	375	1185	298.5	--
Lower heating value (MJ/kg)	43.5	45	20.1	45.2	43.3

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Solid Fuels and Oxidizers

Solid Fuels:

(Figure 3.2)

Constituents of Solid Fuel:

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Types of Solid Fuels and Oxidizers:

S. No.	Fuel	Oxidizer	Applications
1	Biomass (Wood, Saw Dust, Rice Husk, Rice Straw, Wheat Straw, etc)	Air/O_2	Domestic Burner, Engine With Producer Gas
2	Coal, Coke, Charcoal	do	do
3	Special Fuels Nitrocellulose (NC), HTPB, CTPB	Nitroglycerine, Ammonium Perchlorate , Ammonium Nitrate, Nitrogen Tetraoxide	Solid Propellant Rocket, Hybrid Rocket

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