

Module 1: Introduction to Combustion

Lecture 2: What is Fuel and Oxidizer?

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What is Fuel and Oxidizer?

Electronegativity

The ability of an element to accept or donate electrons.

Amount of pull that one atom exerts on the electron that it is sharing with other atom.

The term electronegativity was coined by **Linus Pauling**, a Noble Laureate.

Element	Electro-negativity	Element	Electro-negativity	Element	Electro-negativity
F	4	Br	2.8	B	2.0
O	3.5	C,S,I	2.5	Be,Al	1.5
N,Cl	3.0	H,P	2.1	Mg	1.2

Fluorine is having **Highest Electronegativity** (Most powerful oxidizer).

Oxygen has second highest electronegativity.

Carbon, Hydrogen, Aluminum and Magnesium have **Low Electronegativity** (Fuels).

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Types of Fuels and Oxidizers

Gaseous Fuel and Oxidizer

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Types of Gaseous Fuel and Oxidizer

Sl. No.	Fuel	Oxidizer	Application
1	LPG	Air/O ₂	Domestic Burner, Furnace
2	Natural Gas (NG)	Air/O ₂	IC Engines, Furnaces
3	Producer Gas	Air/O ₂	EC/IC Engines
4	CH ₄ , C ₃ H ₈ , H ₂	Air/O ₂	EC/IC Engines
5	Biogas	Air/O ₂	EC/IC Engines, Burners
6	Acetylene	Air/O ₂	Gas welding, Gas cutting

* **EC**=External Combustion
IC =Internal Combustion

Composition of Some Gaseous Fuels

Fuel	CO ₂	O ₂	N ₂	CO	H ₂	CH ₄	C ₂ H ₆	C ₃ H ₈	C ₄ H ₁₀
LPG	-	-	-	-	-	-	-	70	30
Natural Gas	-	-	5	-	-	90	5	-	-
Producer Gas	8	0.1	50	23.2	17.7	1	-	-	-
Propane	-	-	-	-	-	-	2.2	97.3	0.5
Biogas	33	-	1	-	1	65	-	-	-

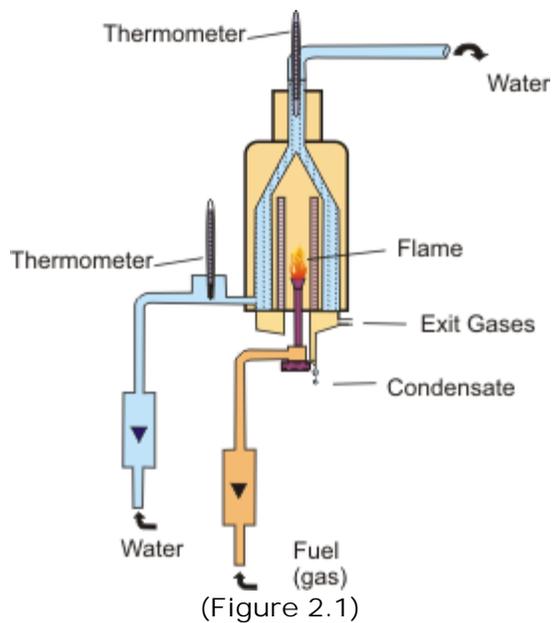
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Characterization of a Gaseous Fuel

Heating Value:

- Amount of heat released per unit volume when it undergoes oxidation at normal pressure and temperature (0.1 MPa and 298 K).
- Lower heating value (LHV) – amount of heat released by burning 1 kg of fuel assuming the latent heat of vaporization in the reaction products is not recovered.
- Higher heating value (HHV) – heating value of the fuel when water is condensed.
- ΔH_v is the Latent heat of vaporization of water at 298.15 K

Junker's Calorimeter



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Determines the heating value of the gaseous fuel.

Fuel and air are burnt in a burner.

Cooling water in the water jacket-absorbs the heat released during combustion.

Heating value- calculated from the water flow rate and rise in temperature.

Liquid Fuels and Oxidizers

- Liquid fuel is one of the major energy sources in the transport sector.
- Crude oil is formed from organic sources, animals, vegetables – which are entrapped in rocks under high pressure and temperature for million years.

	Fuel	Oxidizer	Application
1	Gasoline	Air	S.I. Engine, Aircraft Piston Engine
2	HSD	Air	C.I. Engine
3	Furnace Oil	Air	Furnaces
4	Kerosene	Air	Aircraft, Gas Turbine, Engines Ramjet, Domestic Burner
5	Alcohols	Air	I.C. Engine
6	Hydrazine, UDMH, MMH, Liquid Hydrogen, Triethyl Amine	Liquid O ₂ , RFNA (Red Fuming Nitric Acid) N ₂ O ₄	Liquid propellant rocket Engines
7	Hydrogen, Kerocene	Air	Ramjet/Scramjet

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Refinery End-Products of Typical Crude Oil

- Crude oil undergoes several process in the refinery.
- Generally separation of petroleum constituents occur in the distillation column.
- Constituents of typical crude oil is shown below.

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