

Fuels

- Fuel types
 - Gaseous
 - Liquid
 - Solid
- Fuel Characterization
- Fuel Chemistry

Gaseous Fuel

- Natural gas, LPG (liquified petroleum gas), also produced from coal & wood, & from petroleum & natural gas
- Characterization
 - Volumetric analysis
 - Density
 - Heating value

Liquid Fuels

- Sources
 - Primarily from crude oil
 - Oil shale, tar sands, coal, biomass
- Molecular structure
 - Alkanes (paraffins)
 - Cycloalkanes (naphthene)
 - Aromatics
 - Alkenes (olefin)

Characterization of Liquid Fuels

- Heating value (by bomb calorimeter)
- Specific gravity
- Viscosity (pour point)
- Flash point (temp. to catch fire from exposed flame)
- Autoignition temp. (self starting/self sustaining temp)
- Distillation curve

Characterization of Liq. Fuels

- Sulfur content
- Vanadium & lead content
- Octane number (gasolines)
- Cetane number (diesels)
- Smoke point (gas turbine fuels)

Solid fuels

- Sources
 - Wood
 - Biomass
 - Peat
 - Lignite
 - Coal
 - Bituminous
 - Anthracite
 - Municipal waste

Solid fuels

- Contents
 - Hydrogen, Carbon plus
 - Oxygen
 - Water
 - Ash
 - Nitrogen
 - Sulfur

Biomass

- Wood
 - Round wood, chips, bark, sawdust, pulp waste
- Charcoal
 - Heating wood in absence of air
- Agricultural waste
 - Bagasse, straws, husks, hulks
- Manure

Analysis of solid fuels

- ASTM standards
 - Proximate analysis
 - Ultimate analysis
 - Heating value
 - Grindability

Proximate analysis

- Measures
 - Moisture
 - Volatile combustible matter
 - Fixed carbon/char
 - Ash
- Heat at given temp until constant weight
 - 105/110°C get moisture
 - 900°C (covered) get volatile combustible matter
 - 700°C (uncovered) get fixed carbon/ash
 - Remaining residue is ash

Ultimate analysis (mass basis)

- Provides major elemental composition of the coal, together with ash & moisture
- $C + H + O + N + S + M + A = 100\%$ by mass
 - C - Carbon
 - H - Hydrogen
 - O - Oxygen
 - N - Nitrogen
 - S - Sulfur
 - M - Moisture
 - A - Ash