SNS COLLEGE OF TECHNOLOGY

COIMBATORE - 35

DEPARTMENT OF MECHANICAL ENGINEERING

Fuels

Fuels are substances that store chemical energy, which can be released as heat or work through combustion. They are classified as:

1. **Solid Fuels**
   - **Examples**: Coal, wood, peat, biomass, charcoal.
   - **Advantages**: Easy to store, stable, inexpensive.
   - **Disadvantages**: Lower efficiency, high ash content, environmental concerns due to pollutants.
2. **Liquid Fuels**
   - **Examples**: Gasoline, diesel, kerosene, ethanol, biodiesel.
   - **Advantages**: High energy density, ease of transport and storage, used in IC engines.
   - **Disadvantages**: Expensive, volatile, environmental concerns.
3. **Gaseous Fuels**
   - **Examples**: Natural gas, hydrogen, LPG, biogas, producer gas.
   - **Advantages**: High efficiency, cleaner combustion, easily distributed.
   - **Disadvantages**: Storage and transportation challenges, safety concerns.

Combustion

Combustion is a chemical process where a fuel reacts with an oxidizer (usually oxygen) to produce heat and often light. It can occur in several forms:

Types of Combustion

1. **Complete Combustion**
   - Reaction: Fuel+O2→CO2+H2O+Heat\text{Fuel} + O_2 \rightarrow \text{CO}_2 + \text{H}_2\text{O} + \text{Heat}Fuel+O2→CO2+H2O+Heat
   - Products: Carbon dioxide and water.
   - Characteristics: High efficiency, minimal pollutants.
2. **Incomplete Combustion**
   - Reaction: Fuel+O2→CO+H2O+Unburned Hydrocarbons+Heat\text{Fuel} + O_2 \rightarrow \text{CO} + \text{H}_2\text{O} + \text{Unburned Hydrocarbons} + \text{Heat}Fuel+O2→CO+H2O+Unburned Hydrocarbons+Heat
   - Products: Carbon monoxide, soot, and other hydrocarbons.
   - Characteristics: Lower efficiency, high pollutant output.

3. **Stoichiometric Combustion**
    - Exact balance between fuel and oxidizer.
    - Ideal for complete combustion but rarely achieved in practical systems.
4. **Lean Combustion**
    - More oxidizer than required.
    - Higher efficiency but may lead to NOx emissions.
5. **Rich Combustion**
    - Less oxidizer than required.
    - Produces CO, soot, and unburned hydrocarbons.

Applications

1. **Internal Combustion Engines** (Automotive, aerospace).
2. **Power Plants** (Coal, natural gas, and biomass-based).
3. **Industrial Furnaces and Boilers** (Metallurgical, glassmaking).
4. **Residential Heating** (Stoves, heaters).

Recent Trends in Fuels and Combustion

1. **Alternative Fuels**
    - Hydrogen, biofuels, and synthetic fuels to reduce carbon footprint.
2. **Advanced Combustion Technologies**
    - **Homogeneous Charge Compression Ignition (HCCI)**: High efficiency and low emissions.
    - **Low-Temperature Combustion (LTC)**: Reduces NOx and soot simultaneously.
3. **Carbon Capture and Storage (CCS)**
    - Integrated with combustion processes to reduce greenhouse gas emissions.
4. **Combustion Modeling**
    - Computational Fluid Dynamics (CFD) for designing efficient combustion systems.