



Republic of Iraq
Ministry of Higher Education
and Scientific Research
Al-Mustaqbal University College
Chemical Engineering and Petroleum Industries
Department

Subject: Fuel Technology
2nd Class
Lecture 1

Introduction

Fuels: is a substance, which when burning and react with oxygen or air, produces a large amount of heat. A fuel is mainly composed of carbon and hydrogen. The energy produced by burning of fuel in the form of heat is known as chemical energy.

Fuels are classified mainly in four general classes namely fossil fuel, by-products fuel, chemical fuel, nuclear fuel.

- **Fossil fuels** are those which have been derived from fossil remains of plant and animal life and are found in the crust of the earth e.g. coal, petroleum, natural gas, etc.
- **By- product fuels** are the co-product of some regular manufacturing process and are of a secondary nature. As for example, coke oven gas and blast furnace gas are the by-product fuels in the process of coke and iron making respectively.
- **Chemical fuels** are of an exotic nature and normally not used in conventional processes. Examples are hydrazine (a rocket fuel), ammonium nitrate, fluorine, etc.
- **Nuclear fuels** which release heat by fission are uranium, plutonium, etc. and those generating heat by fusion are deuterium and tritium (both are isotopes of hydrogen) etc. In both the situations, the mass is converted into energy.

The first three release heat by combustion in presence of air or oxygen. Nuclear fuels release heat by nuclear fission or fusion by converting mass into energy.

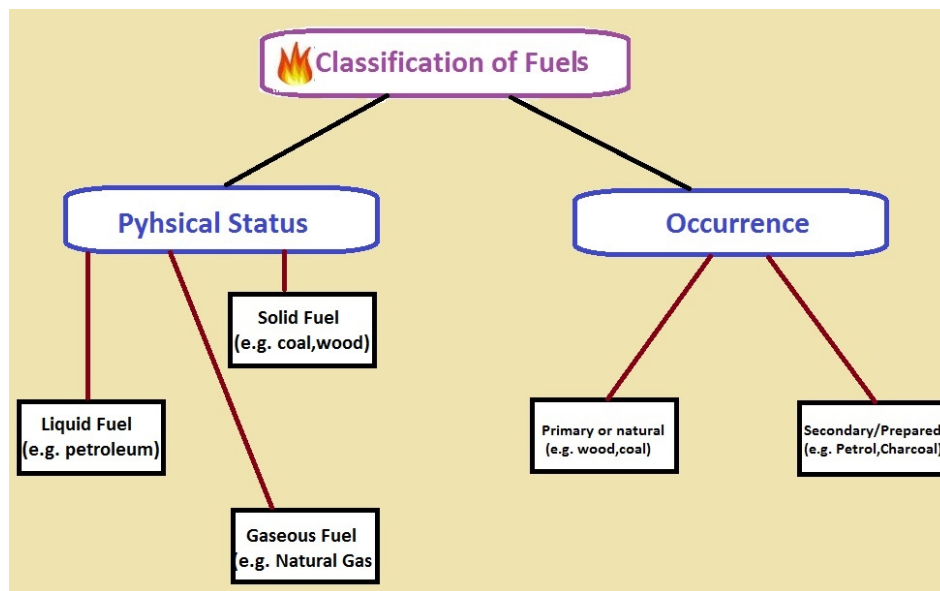
Fuels may be classified as follows:

A. Based on their physical state, the fuels are classified as:

1. Solid fuel.
2. liquid fuel.
3. Gaseous fuel.

B. Based on their occurrence they are classified as primary fuel (natural fuels) and secondary fuels (artificial fuels or prepared).

1. Primary fuel are those which occur in nature e.g. coal, wood, crude oil, natural gas, etc.
2. Secondary fuels are those which are derived from primary fuel e.g. fuel oil& kerosene (derived from petroleum), etc.



Secondary fuels are further classified into manufactured and by-product fuels.

- Manufactured fuels are those which are made for some specific purpose e.g. coke (made for iron making), gasoline (made for internal combustion engines), producer gas (made for industrial heating) etc.
- By-product fuels are those which are a co-product / side product (unavoidable product) of a regular manufacturing process e.g. bagasse, tar, refinery gas etc. By-product fuels help industries in conserving primary fuels.

Table 1.1 gives the classified list of important fuels (excluding chemical & nuclear fuel).

Table 1.1: General Classification of Fuels

General Division	Primary Fuels	Secondary Fuels	
	Natural	Manufactured	By-product
Solid	Wood , Coal	Semi-coke , Coke, Charcoal, Briquettes Pulverised Coal	Charcoal, Wood refuse, Bagasse, Coke breeze, Waste material from grain
Liquid	Petroleum	Petrol, Kerosene, Alcohol Colloidal fuels, Fuel oil, Naphtha, Vegetable Oil	Tar Pitch Benzol Paper pulp mill waste
Gaseous	Natural gas	Producer gas, Water gas, Carburetted water gas, Coal gas, Oil gas, Gobar gas, Reformed natural gas Butane Propane Acetylene Hydrogen LPG	Blast furnace gas, Coke oven gas, Oil refinery gas, Sewage gas, L.D. converter gas

C. Based on their usage, fuels are classified as:

1. Domestic fuel,
2. Illuminating fuel,
3. Industrial fuel,
4. Rocket fuel.

- ❖ Domestic fuels supply heat for cooking and space heating.
- ❖ Illuminating fuels e.g. kerosene, town gas etc. supply light in darkness.
- ❖ Industrial fuels supply heat for process heating, steam and electricity generation etc.
- ❖ Rocket fuels e.g. hydrazine are used for producing enormous thrust for the propulsion of rocket.

Characteristics of a good fuel

1. It should be readily available at cheap rate.
2. It should be easy & safe to handle, store and transport and at a low cost.
3. It should have high heating value (Calorific value).
4. Its moisture content should be low, as it reduces the heating value.
5. It should have moderate ignition temperature as low ignition temperature fuel will catch fire easily and one with high ignition temperature will present difficulty in igniting it.
6. Its non-combustible matter content should be low.

FUELS AND THEIR CHARACTERISTICS

1- SOLID FUELS AND THEIR CHARACTERISTICS

Solid fuels are mainly classified into two categories, i.e. **natural fuels**, such as wood, coal, etc. and **manufactured fuels**, such as charcoal, coke, etc.

The various advantages and disadvantages of solid fuels are given below:

Advantages

- a) They are easy to transport.
- b) They are suitable to store without any risk of spontaneous explosion.
- c) Their cost of production is low.
- d) They possess moderate ignition temperature.

Disadvantages

- a) Their ash content is high.
- b) Their large proportion of heat is wasted.
- c) They burn with clinker formation (slag).
- d) Their combustion operation cannot be controlled easily.
- e) Their cost of handling is high.

2- LIQUID FUELS AND THEIR CHARACTERISTICS

The liquid fuels can be classified as follows:

- 1) Natural or crude oil.
- 2) Manufactured oils.

The advantages and disadvantages of liquid fuels can be summarized as follows:

Advantages

- a) They possess higher calorific value per unit mass than solid fuels.
- b) They burn without dust, ash, clinkers, etc.
- c) Their firing is easier and also fire can be extinguished easily by stopping liquid fuel supply.
- d) They are easy to transport through pipes.
- e) They can be stored indefinitely without any loss.
- f) They are clean in use and economic to handle.
- g) They require less excess air for complete combustion.
- h) They require less furnace space for combustion.

Disadvantages

- a) The cost of liquid fuel is relatively much higher as compared to solid fuel.
- b) Costly special storage tanks are required for storing liquid fuels.
- c) They give bad odour.

3- GASEOUS FUELS AND THEIR CHARACTERISTICS

Gaseous fuels occur in **nature**, besides being **manufactured** from solid and liquid fuels.

The advantages and disadvantages of gaseous fuels are given below:

Advantages

following advantages over solid or liquid fuels:

- a. They are easy to be loaded, unloaded or transported using pumps and pipes.
- b. They can be lighted at ease.
- c. They have high heat contents and hence help us in having higher temperatures.
- d. They produces a great amount of heat energy with combustion of only one kg fuel.
- e. They are clean in use.
- f. They do not require any special burner.
- g. They burn without any shoot, or smoke and ashes.
- h. They are free from impurities found in solid and liquid fuels.

Disadvantages

- (a) Very large storage tanks are needed.
- (b) They are highly inflammable, so chances of fire hazards in their use is high.

Comparison of solid liquid and gaseous fuels

Characteristic property of fuel	Solid fuels	liquid fuels	Gaseous fuels
1) Cost	Cheap	Costlier than solid fuels	Costly
2) Storage	Easy to store	Closed container should be used	Storage space required is huge
3) Risk towards fire hazards	Less	More	Very high since these fuels are highly inflammable
4) Combustion rate	It is a slow process	Fast process very rapid and efficient	Very rapid and efficient
5) Handling cost	High since labour is required in their storage transport	Low since fuels can be transported through pipes.	Low, similar to liquid fuels, these can be transported through pipes
6) Ash	Ash is produced	No problem of ash	No problem of ash
7) Calorific value	Least	High	Highest