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An Overview of Fuels Types and their Role in Energy Generation

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Abstract: *The proliferation of Internet of Things (IoT) devices in smart environments has created unprecedented challenges in identity management and security. Traditional centralized identity management systems face scalability, privacy, and single-point-of-failure issues when applied to IoT ecosystems. This paper presents a novel blockchain-based framework for decentralized identity management in smart IoT environments. Our proposed framework leverages blockchain technology's immutable ledger, smart contracts, and cryptographic mechanisms to provide secure, scalable, and privacy-preserving identity management for IoT devices. The framework incorporates a multi-layered security architecture that includes device authentication, access control, and identity verification mechanisms. Experimental results demonstrate that our approach achieves 99.7% authentication accuracy with reduced latency compared to traditional centralized systems. The framework also provides enhanced privacy protection through zero-knowledge proofs and selective disclosure mechanisms. This research contributes to the advancement of secure IoT identity management and provides a foundation for future developments in decentralized IoT security.*

Keywords: Fuel Technology, Solid Fuels, Liquid Fuels, Gaseous Fuels, Energy Resources, Industrial Fuels

I. INTRODUCTION

The engine converts the heat energy which is obtained from the chemical combination of fuel with the oxygen, into mechanical energy. Since the heat energy is derived from the fuel, the fundamental knowledge in types of fuels and their characteristics is essential in order to understand the combustion phenomenon. Fuel is a combustible substance, containing carbon as main constituent, which on proper burning gives a large amount of heat, which can be used economically for domestic and industrial purposes. During the process of combustion of a fuel (like coal), the atoms of carbon, hydrogen, etc. combine with oxygen with the simultaneous liberation of heat at a rapid rate. FUEL + O2 PRODUCTS + HEAT The primary or main source of fuels are coals and petroleum oils. These are stored fuels available in earth's crust and are, generally, called 'fossil fuels'.

Classification of Fuels:

The fuels may be classified mainly into two types.

- Primary or natural fuels o Secondary or derived fuels

a) Primary or natural fuels are found in nature such as, for e.g., wood, peat, coal, petroleum, natural gas, etc.

b) Secondary or derived fuels are those which are prepared form the primary fuels. For example, charcoal, coke, kerosene oil, diesel oil, petrol, coal gas, oil gas, producer gas, blast furnace gas, etc. It is further subdivided into following three types. There are

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i. Solid fuels
ii. Liquid fuels
iii. Gaseous fuel.

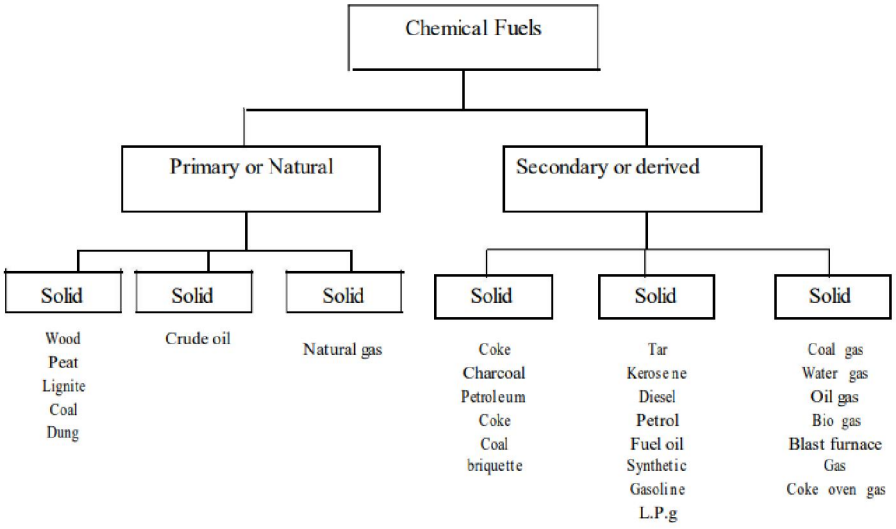

Fig 1: Classification of Fuel

II. SOLID FUELS

The natural solid fuels are wood, peat, lignite or brown coal, bituminous coal and anthracite coal. The prepared solid fuels are wood charcoal, coke, briquetted coal and pulverised coal. Some of the solid fuels are discussed below.

1. Wood

At one time it was extensively used as a fuel. It consists of mainly carbon and hydrogen. The wood is converted into coal when burnt in the absence of air. The average calorific value of the wood is 19700 kJ/kg

2. Peat

It is a spongy humid substance found in boggy land. It may be regarded as the first stage in the formation of coal. It has a large amount of water contents (upto 30%) and therefore has to be dried before use. It has a characteristic odour at the time of burning, and has a smoky flame. Its average calorific value is 23000 kJ/kg.

3. Lignite or brown coal

It represents the next stage of peat in the coal formation, and is an intermediate variety between bituminous coal and peat. It contains nearly 40% moisture and 60% of carbon. When dried, it crumbles and hence does not store well. Due to its brittleness, it is converted into briquettes, which can be handled easily. Its average calorific value is 25000 kJ/kg.

4. Bituminous coal

It represents the next stage of lignite in the coal formation and contains very little moisture (4 to 6%) and 75 % to 90% of carbon. It is weather resistant and burns with a yellow flame. The average calorific value of bituminous coal is 33500 kJ/kg.

5. Anthracite coal

It represents the final stage in the coal formation, and contains 90% or more carbon with a very little volatile matter. It is thus obvious, that the anthracite coal is comparative smokeless, and has very little flame. It possesses a high calorific value of about 36000 kJ/kg and therefore, very valuable for steam raising and general power purposes.

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6. Wood charcoal

It is made by heating wood with a limited supply of air in a temperature not less than 2800 C. It is a well prepared solid fuel, and is used for various metallurgical processes.

7. Coke

It is produced when coal is strongly heated continuously for 42 to 48 hours in the absence of air in a closed vessel. This process is known as carbonisation of coal. Coke is dull black in colour, porous and smokeless. It has high carbon content (85 to 90%) and has a higher calorific value than coal. If the carbonisation of coal is carried out at 500° C to 700° C, the resulting coke is called lower temperature coke or soft coke. It is used as a domestic fuel. The coke produced by carbonisation of coal at 900° C to 1100°C, is known as hard coke. The hard coke is mostly used as a blast furnace fuel for extracting pig iron from iron ores, and to some extent as a fuel in cupola furnace for producing cast iron.

8. Briquetted coal

It is produced from the finely ground coal by moulding under pressure with or without a binding material. The binding materials usually used are pitch, coal tar, crude oil and clay etc.

9. Pulverised coal

The low grade coal with high ash content, is powdered to produce pulverised coal. The coal is first dried and then crushed into a fine powder by pulverising machine. The pulverised coal is widely used in the cement industry and also in metallurgical processes. in industrial systems.

III. LIQUID FUEL

Almost all the commercial liquid fuels are derived from natural petroleum (or crude oil). The liquid fuel consists of hydrocarbons. The natural petroleum may be separated into petrol or gasoline, paraffin oil of kerosene, fuel oils and lubricating oils by boiling crude oil at different temperatures and subsequent fractional distillation or by a process such as cracking. Some of the liquid fuels are discussed below.

1. Petrol or gasoline.

It is the lightest and most volatile liquid fuel, mainly used for light petrol engines. It is distilled at a temperature from 650 C to 220o C.

2. Kerosene or paraffin oil.

It is heavier but less volatile fuel than the petrol, and is used as heating and lighting fuel. It is distilled at a temperature from 220o C to 345o C.

3. Heavy fuel oils.

The liquid fuels are distilled after petrol and kerosene are known as heavy fuel oils. These oils are used in diesel engines and in oil-fired boilers. These are distilled at a temperature from 345oC to 470 o C.

Advantages of liquid fuels over solid fuels

1. High calorific value.
2. Low storage capacity required.
3. Cleanliness and free from dust.
4. Practically no ashes.
5. Non-deterioration in storage.
6. Non-corrosion of boiler plates.

Disadvantages

1. Highly expensive.
2. High risk of fire.
3. Expensive containers are required for storage and transport.

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IV. GASEOUS FUELS

1. Natural gas.

The natural gas is, usually, found in or near the petroleum fields, under the earth's surface. The main constituents of natural gas are methane (CH4) and ethane (C2H6). It has calorific value nearly 21000 kJ/m3 . It is used alternately or simultaneously with oil for internal combustion engines.

2. Coal gas.

The quality of coal gas depends upon the quality of the coal used, temperature of the car bonisation and the type of plant. It is used in domestic lighting, furnaces and for running gas engines. Its calorific value is about 21000 kJ/m3 to 25000 kJ/ m3 3.

3. Producer gas

It is obtained by the partial combustion of coal, coke, anthracite coal charcoal in a mixed air-steam blast. Its manufacturing cost is low, and has a calorific value of about 5000 kJ/m3 to6700 kJ/m3.

4. Water gas.

It is a mixture of hydrogen and carbon monoxide and is made by passing steam overincandescent coke. As it burns with a blue flame, it is also known as blue water gas. The water gas is usually converted into carburetted (enriched) water gas by passing it through a car buretter into which a gas oil is sprayed. It is, usually, mixed with coal gas to form town gas. The water gas is used in furnaces and for welding.

5. Mond gas.

It is produced by passing air and a large amount of steam over waste coal at about 6500 C. It is used for power generation and heating. It is also suitable for use in gas engine. Its calorific value is about 5850 kJ/m3.

6. Blast furnace gas

It is a by-product in the production of pig iron in the blast furnace. The gas serves as a fuel in steel works, for power generation in gas engines, for steam raising in boiler and for pre heating the blast for furnace. It is extensively used as fuel for metallurgical furnaces. The gas leaving the blast furnace has a high dust content the proportion of which varies with the operation of the furnace. It has a low heating value of about 3750 kJ/m3.

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Advantages of gaseous fuels

1. The supply of fuel gas, and hence the temperature of furnace is easily and accurate controlled.
2. The high temperature is obtained at a moderate cost by pre-heating gas and air with combustion of waste gases.
3. They are directly used in internal combustion engines.
4. They are free from solid and liquid impurities.
5. They do not produce ash or smoke.
6. They undergo complete combustion with minimum air supply.

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Disadvantages

1. They are readily inflammable.
2. Air requires large storage capacity.

V. CONCLUSION

Fuels play a vital role in domestic, industrial, and transportation sectors by converting chemical energy into useful heat and mechanical energy. This paper discussed the classification of fuels into solid, liquid, and gaseous forms along with their properties, calorific values, advantages, disadvantages, and applications. Solid fuels such as coal and coke are widely used in power generation and metallurgical industries, while liquid fuels like petrol and diesel are preferred in transportation and internal combustion engines because of their high calorific value and clean combustion. Gaseous fuels provide efficient and controllable combustion with minimum pollution and are extensively used in industrial heating and power generation. Understanding the characteristics and applications of different fuels is essential for improving energy efficiency, reducing environmental impact, and selecting suitable fuels for various engineering applications. The study highlights the importance of fuel technology in modern energy systems and industrial development.

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