

UNIT 2 & 3: FUELS and GAS

What is a fuel?

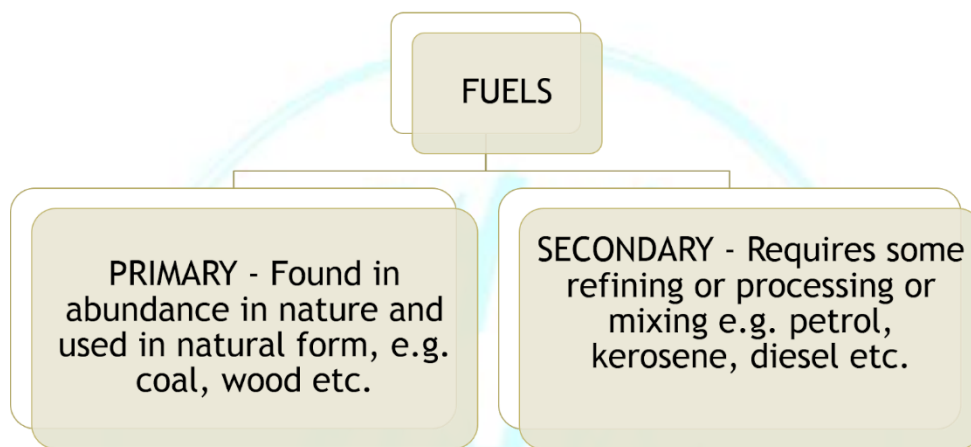
- A fuel is a substance that reacts chemically with another substance to produce heat.
- Any source of heat energy is called fuel.
- The term fuel is limited to those substances that burn readily in air emitting large amount of heat.
- When a fuel is burnt, it combines with oxygen in the air to form carbon dioxide and water vapor.
- A lot of energy (heat and sometimes light) is also produced during this process.
- The heat generated is used for purpose of heating which can be used for various applications.

Various terms and definitions associated with Heat

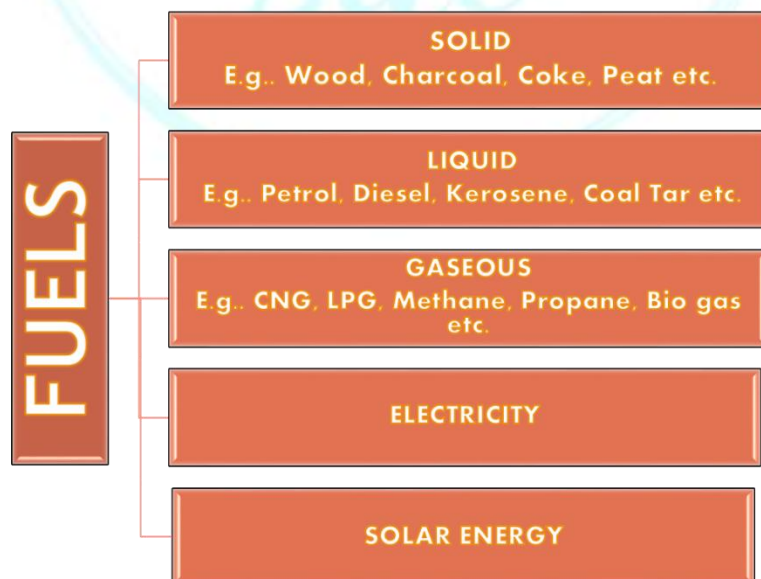
- Heat – it is a form of energy which can be converted to other forms. It is measured in terms of calorie or BTU (British Thermal Unit = 0.252 kCal).
- Temperature – it indicates hotness or coldness. It is measured in terms of degree Celsius or degree Fahrenheit ($10\text{ }^{\circ}\text{C} = 33.8\text{ }^{\circ}\text{F}$).
- Sensible heat – Heat which causes a change in temperature in a substance is called sensible heat.
- Specific Heat Capacity - is the amount of heat energy required to raise the temperature of a substance per unit of mass.

- Latent heat - is the energy absorbed by or released from a substance during a phase change from a gas to a liquid or a solid or vice versa.
- Ignition Point - the lowest temperature at which a combustible substance in air will ignite and continue to burn.

CLASSIFICATION OF FUELS



TYPES OF FUEL



Calorific value of a fuel

- Quantity of heat liberated when a unit mass of solid fuel, or a liquid fuel or a gaseous fuel is burnt completely, is known as the calorific value of the fuel.
- The combustion process also generates water vapour.
- Gross Calorific value (GCV) / Higher Calorific Value (HCV) – is the quantity of heat produced by combustion when the water produced by combustion is allowed to return to the liquid state.
- Net Calorific Value (NCV) / Lower Calorific Value (LCV) – is the quantity of heat produced by combustion when the water produced by combustion remains gaseous.
- Calorific value of a fuel is given in Kcal / Kg in case of solid and liquid fuels and Kcal / m³ in case of gaseous fuels.

PROPERTIES OF IDEAL FUEL

- Low ignition point and high calorific value.
- Produces minimum amount of smoke, ash and soot i.e. least pollutants.
- Should be easy to store and convenient for transportation and should be economical.
- Should have moderate rate of combustion.
- Should have low content of non-volatile material.
- Should be readily available in plenty.
- Should produce no poisonous products on combustion.
- Should be measurable as accurately as possible.
- Should be user – friendly.
- Should not be subjected to any legal regulation.

FUELS AVAILABLE FOR THE CATERING INDUSTRY

Solid fuel Coal: It is used in boilers to produce steam.

Coal/ Coke / Wood: It is charcoal used in tandoor to make Indian breads, kebabs.

Liquid fuel Kerosene: Rarely used in case of emergency to supplement main fuel.

High Speed Diesel: is used in oil fired boilers and water heaters.

Gaseous fuel LPG: It is used in most of the cooking ovens in hotel industry.

PNG: It is used in countries where available.

Coal Gas: Coal gas is the cheapest to use if available. Electricity An expensive option.

COMPARISON OF DIFFERENT FUELS

ADVANTAGES OF SOLID FUEL:

- Low production cost.
- Easily available in plenty.
- Easy to transport.
- No expertise required to operate.
- Not subjected to any inspection by regulatory authority.
- Convenient to store without any risk of spontaneous explosion.
- Have moderate ignition temperature.

Disadvantages of Solid Fuel

- Storage space required.
- Heat cannot be controlled.
- Pollutes the atmosphere.
- Poses heat hazard.
- Ignition time high.
- More labour required to operate.
- Not eco-friendly.
- Not allowed in city hotels.
- Not available instantly.

Advantages of Liquid Fuel

- Flow can be regulated.
- Production of energy is instant.
- Readily available.
- Not as dirty as solid fuel.
- Limited storage space required.
- More user friendly.
- Higher calorific value.
- Easy to transport.
- Require less air for combustion.

Disadvantages of Liquid Fuel

- Requires storage space.
- Lot of care is required during use.
- Releases pollutants on combustion.
- Sources not liable in terms of purity.
- Bad odour.
- Subject to regulatory checks by authorities.
- May not be available instantly.
- Cost is high.

Advantages of Gaseous Fuels

- Easy to handle
- Once installed, saves a lot of labour.
- Flow can be controlled through regulators.
- Very little pollution.
- Instantly available.
- In some city hotels, only this fuel is allowed.
- High calorific value.
- Clean fuel.
- Supply of fuels is by govt. Agencies.
- Supply through a pipe network.
- No storage space required.

Disadvantages of Gaseous Fuels

- Transportation cost is very high because it is volatile.
- Regular check of equipment and supply line is required.
- Lot of care is required in operation.
- Dependence on supply agency for availability.

Advantages of Electricity

- Instant fuel when electricity is available.
- No pollution.
- No storage space required.
- Eco – friendly.
- Very easy to operate.

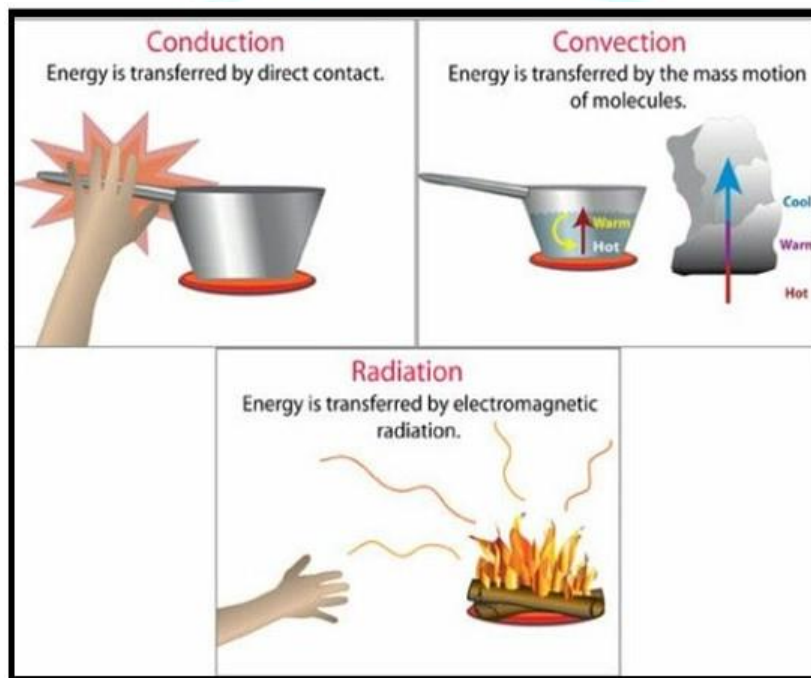
Disadvantages of Electricity

- It is costly.
- Cost of maintenance is high.
- Chances of short circuit and hence could lead to fire.
- Equipments need to be handled with care.

Methods of Heat Transfer

Heat transfer is important in cooking appliances as the food items receive heat from heat sources. Cooking as an important activity in hotels. Cooking methods make use of the following methods of heat transfer.

- Conduction
- Convection
- Radiation



Conduction

- This is the heat transfer method in which heat is transmitted from a hotter part of a body to its colder part without any actual movement of the material.
- The movement of heat is through direct contact.
- The rate of heat transfer through the body is called thermal conductivity of the material.

Convection

- This is the heat transfer method in which heat is transmitted from the hotter part of the body to its colder part by actual movement of the material particles.
- It is possible in liquids not in solids.
- There are two types of Convection:
- Natural Convection
- Mechanical or forced Convection

Radiation

- The process in which heat is transmitted from one place to another without the help of any material medium or without heating the intermediate medium.
- It does not require any physical contact between heat source and the food being cooked.
- Heat energy is transferred by electromagnetic waves or heat waves.
- This mode of heat transfer is very efficient and very fast.
- Used in microwave cooking.

MOST COMMON GASEOUS FUELS IN HOTELS

Two most commonly used fuels in hotels all over the world are:

- LPG (Liquid Petroleum Gas)
- PNG (Piped Natural Gas)

LPG (Liquefied Petroleum Gas)

- It is a mixture of hydrocarbons – Propane (C_3H_8) and Butane (C_4H_{10}) with larger percentage of propane.
- It is derived from the fractional distillation of crude oil in oil refineries.
- LPG is gaseous at normal atmospheric pressure, but may be condensed to the liquid state at normal temperature by the application of moderate pressure.
- It is stored and transported as liquid under pressure for convenience and ease of handling.
- MoPNG

Properties of LPG

- Combustion of LPG produces carbon dioxide (CO_2) and water vapours and requires sufficient air, otherwise carbon monoxide (CO) is produced which is toxic.
- Its calorific value is approximately 11,000 Kcal / kg.
- It is stored as liquid under high pressure.
- The auto ignition temperature of LPG is $500^{\circ}C$.
- Detection of leakage of LPG is very important and cannot be ignored as the vapours of LPG evaporates to produce 250 times volume of gas.
- Due to this reason it can be ignited at a considerable distance from the source of leakage leading to hazards.
- Since it is a colourless and odourless gas, an odorant called ethyl mercaptan is added to LPG for easy detection in case of a leakage.

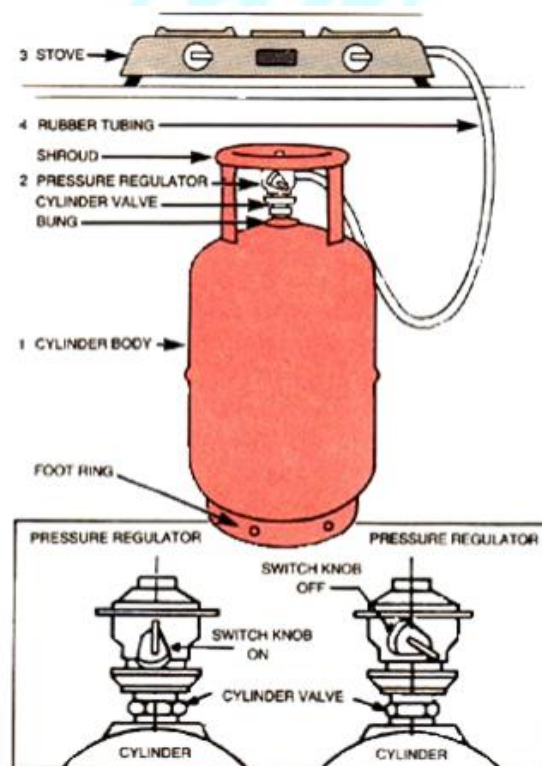
ADVANTAGES OF LPG AS A HOTEL FUEL

- High efficiency and heating rate.
- High calorific value – approx. 11,000 Kcal/kg.
- Complete combustion and no smoke.
- Clean fuel.
- Portable.
- Cheaper than electricity.
- Quantity can be verified at the delivery point.
- No expertise required.
- From a single cylinder multiple stoves can be operated.
- The price of LPG is fixed by the Govt. of India.
- Non – toxic and eco – friendly.

SAFETY IN USE OF LPG

- Always use BIS (Bureau of Indian Standards) – approved appliances, regulators and Suraksha rubber tubes from authentic sources.
- Check that the cylinder has the company seal and safety cap intact.
- The equipment should be cleaned regularly, as the gas corrodes metal.
- Always keep the cylinder in upright position at ground level in a well-ventilated place.
- The gas cylinder should not be tilted to an inclined position while being used, in order to completely utilize the gas.
- Inflammable material should not be kept very close to the gas bank.
- The flexible metal hose connecting the gas valve and oven should be checked at regular intervals, for crack or damage.

- The burner knobs and cylinder regulator must be switched off after work is done.
- Burner heads should be cleaned daily.
- Never keep kerosene or other stoves on the floor where an LPG cylinder is in use.
- Check the cylinder valve to ensure that the rubber 'O' ring is present inside.
- Use only soap solution to check gas leaks; never use lighted match sticks for checking leaks.
- Retain the safety cap with a thread attached to the cylinder. Fix the cap on to the valve to stop leaks, if any.
- Do not store inflammable material like rubber mats, coir etc., inside the kitchen or above the stove.



STEPS IN CASE OF LPG LEAK

- Close the regulator and burner knobs.
- Do not operate electrical switches or appliances in the room.
- Switch off the main power supply.
- Open all doors and windows for ventilation.
- Put off all flames, lamps, incense sticks etc.
- Put the safety cap on the cylinder.
- Call your distributor or emergency service cell for help.

GAS BANK

- All hospitality units have large kitchens for daily service of food items.
- Instead of having individual gas supply to the ovens, a gas bank is often installed in a centralized arrangement usually outside the kitchen.
- When more than one cylinder is connected together through a common header (manifold) it is called a Gas Bank.
- Short pipelines connect each individual oven to this common supply line.
- Depending on the number of burners or total consumption the size of the Manifold is decided.
- Gas banks usually have a primary cylinder bank and a secondary cylinder bank.
- In fully automatic gas bank, the installed system automatically switches to the reserve bank when the primary bank is depleted.
- A LED indicator would indicate an empty bank by turning red.
- An alarm buzzer will also sound to indicate an empty bank.
- The indicator turns green as soon as the system is reset by replacing the depleted cylinder.

- The buzzer also stops.
- The output from the Manifold is regulated through Pressure Regulator and then suitable Gas pipe line is extended in the Kitchen area.

SAFETY PRECAUTIONS WHILE SETTING UP A GAS BANK

- Non – return valves are provided for individual cylinders.
- Flame arrestor is installed to work as safety device
- Cylinders and manifolds are connected through high pressure pig tails and adaptors.
- The operating pressure of the supply gas can be set by primary and secondary regulators.
- Pressure gauges are installed to indicate the gas pressure in the cylinder and the manifold lines.
- An LED indicator and an alarm buzzer are used to indicate the depletion of the primary bank.
- Manually operated shutoff valves are installed on the left and right of the header bar.

Gas Burners

- Gas burners can be classified as Low-Pressure burners (approx. 0.15 Kgf/cm²) and High-Pressure Burners (approx. 4.22 Kgf/cm²).
- The burner has a mixer head (venturi), throat and burner head.
- The mixer head carries an air shutter and a hole for the gas orifice, which is the opening through which the gas flows and by means of which the flow is controlled.
- There are openings in the form of small holes in the burner through which gas air mixture comes out and burns into gas flames.

- These openings are called ports, which are distributed horizontally in series of rows from inner to outer portion of the burner.

