

9

SOURCES OF ENERGY



What we have already learnt

- Energy is necessary for doing work.
- Energy can neither be created nor be destroyed.
- Energy in one form can be converted into another form.
- Sun is our prime source of energy.
- Fuel is used for cooking food.
- Energy can be obtained from water.
- Biogas produced by the decomposition of residuants of plant and animals-excretions is a source of energy.
- The prime constituent of biogas is methane.
- Solar energy can be converted into electrical energy using solar cells.
- Wind is a source of energy.

We do different types of work every day. Energy is required for it. Heat energy from burning fuels like wood, coal, petrol and cooking gas is widely used for cooking and other purposes. Different forms of energy are converted into electrical energy. The electrical energy thus obtained is used to operate radio, television, lamps and to run vehicles and heavy machines in factories. Think of a situation where there is no energy. Not only our daily activities but also our very life will come to a stand still. Thus energy is an inseparable part of our life.

This chapter deals with different sources of energy and their characteristics. Besides, the aim of this chapter is to distinguish between renewable and non-renewable sources of energy and to study how they are employed in our daily life. Proper use of fossil fuels is also discussed here.

9.01 Characteristics of the different sources of energy

Sources of energy are those which can supply adequate amount of energy in a suitable form for long periods. List some of the energy sources known to you.

- Sun
- Biomass
- Fossil fuel
- Sea waves
- Wind
-

What are the characteristics of the different sources of energy?

- Must be capable of supplying energy continuously at a constant rate.

- Energy should be available in plenty in a useful form.
- Must be convenient to handle.
- Easy for storage.
- Capable of being transported easily.
-

9.02 Renewable and non-renewable sources of energy

Kerosene and wood are two sources of energy used for domestic purposes. How do they differ as sources of energy?

- Kerosene has been formed over millions of years.
- Kerosene is a petroleum product.
- Kerosene is not renewable.
- Available kerosene will deplete in the near future
- Firewood can be made available by the repeated planting of trees.
- Firewood is renewable.

If so can't we classify the sources of energy into two?

- Renewable sources of energy
- Non-renewable sources of energy

The sources which are perennial and give energy continuously and which do not deplete with use are the renewable sources of energy.

The sources which are formed in earth over millions of years and which get depleted due to their continuous use but not replenished are the non-renewable sources of energy.

Classify the sources of energy given below and note them in the Table 9.1

- Solar energy
- Coal
- Wind energy
- Wave energy
- Petrol
- Kerosene
- Nuclear fuel
- Biomass
- Natural gas
- Biogas
- Diesel
- Naphtha

Renewable sources of energy	Non-renewable sources of energy
<ul style="list-style-type: none"> ● Wind energy ● Wave energy ● ● 	<ul style="list-style-type: none"> ● Nuclear fuel ● Naphtha ● ●

Table 9.1

Find more examples and expand the table

9.03 Solar energy

Sun is the source of many forms of energy available to us. Do you know how energy is obtained from the sun? The most abundant element in sun is hydrogen. It is in a plasma state. This hydrogen at high temperature, high pressure and high density undergoes nuclear fusion and hence releases an enormous amount of energy. This energy is emitted as radiations

of different forms in the electromagnetic spectrum. Out of these X-rays, gamma rays and most of ultraviolet rays do not pass through the earth's atmosphere. But heat energy and light energy are the main radiations that reach the earth. This energy is the basis for the existence of life on earth.

9.04 Using solar energy

It is well known that human beings have been using solar energy for different uses, from ancient days. Find examples of these uses and add to the list given below.

- To dry wet clothes
- To get salt from sea water
- To dry firewood
- To dry cereals
- To dry fish
- To dry leather

We now use several appliances which work using solar energy. Appliances like solar cooker and solar heater absorb solar radiations and convert it into heat. Then what about a solar cell? Solar energy is converted into electrical energy and it is directly used or stored in a battery.

Box type solar cooker

Let us try to construct a solar cooker. Take a metallic box and paint it black on the inner surface. This box is placed in another box which is painted black on the outer surface. Pack the space between the boxes with thermocol or hay. The substances to be cooked are taken in a metallic vessel. The vessel must be such that its outer surface and

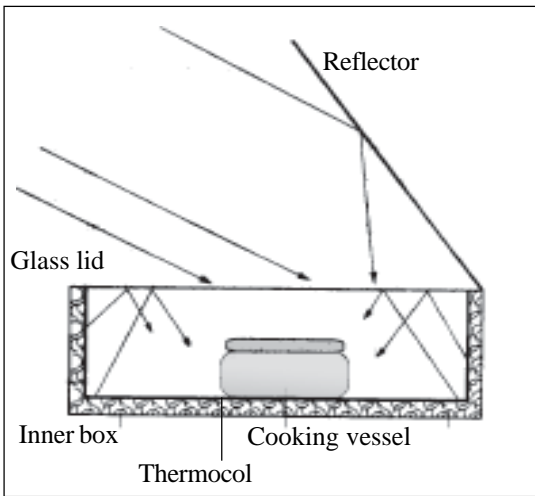


figure 9.1

Boxtype solar cooker with reflector

that of the lid are painted black. This vessel is placed inside the box and the box is closed with a glass sheet. This is now placed in bright sunlight for about two to three hours. The substances inside the vessel will be cooked well. The efficiency of the arrangement increases if a reflector is also used.

We have now studied how to construct a box type solar cooker. We can also make another type of solar cooker.

Solar concentrators

Mirror strips are fixed on the inner surface of a parabolic dish fixed to a stand as shown in Fig 9.2. Its position can be arranged in such a way that most of the solar radiations fall on the dish with the changing positions of the sun.

What happens to the sun's rays that are falling on the mirror?

All the rays of the sun will be concentrated at the focus of the parabola. With the help of a stand place a metallic vessel at the focus. The outer surface of the vessel must be painted black. A lot of heat

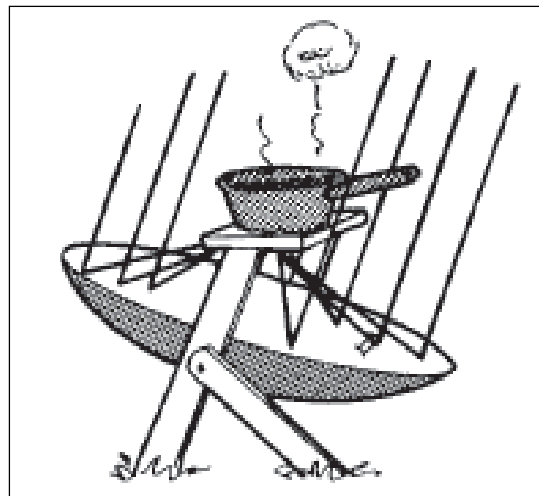


figure 9.2

Solar concentrator

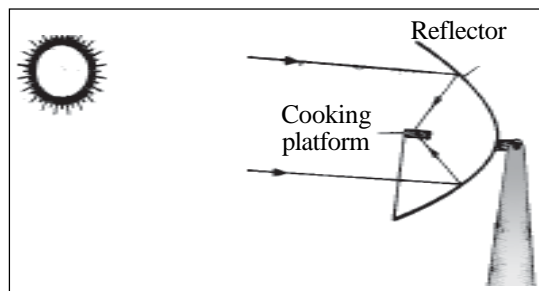


figure 9.3

Schematic representation of a solar concentrator used for cooking

will be obtained in the vessel. Cooking can be done using this arrangement. Depending upon the size of the parabolic reflector and the availability of solar rays, temperature ranging from 180°C to 200°C will be obtained in the solar cookers.

India has started large scale use of solar energy to meet the increasing demand of energy, with the large production of solar cookers. In 1962, India become the first country in the world, to commercially produce solar cookers. Intense research has also been started for the increased use of

solar cookers and for enhancing its efficiency. In Kerala, an organisation ANERT (Agency for Non-conventional Energy and Rural Technology) propagates the use of solar cookers, solar panels and solar lamps.

Find the advantages of a solar cooker and note them down .

- Can be used for cooking.
- The problem of fuel scarcity can be solved to a certain extend.
- Causes no atmospheric pollution.
- It can be placed anywhere if sunlight is available in plenty.
- There is no other expenditure once the solar cooker is installed.
- Can be used for a long time after it is made.
-

But solar cooker has certain limitations. What are they? Let us examine.

- Cannot be used in the night.
- Cannot be used at a time when the sky is cloudy.
- Requires more time for cooking
- Cannot make chappathi, dosa etc in box type solar cookers.

Solar power plant

In the solar power plant, solar energy is used to generate electricity. Sun rays are focused using concave reflectors on to copper tubes filled with water and painted black outside.

The water in the tubes then boil and become steam. This steam is used to drive steam turbine which in turn causes the generator to work. A plant using this principle is working on experimental basis in Gurgaon in Haryana. Its capacity is 500 kilowatt. Another plant of similar type is being constructed in Jodhpur in Rajasthan.

Solar water heater

You are now familiar with the working of a solar cooker. Hot water is often required in our homes. Can solar cooker be always depended upon for hot water? A solution for this is solar water heater.

Let us construct a solar water heater. A long copper pipe is painted black and is placed inside a box which is also painted black. The pipe is bent to form a coil. A tank is placed at a higher level. This is the reservoir. A small tank is placed slightly above the heater as shown in Fig 9.4. A pipe is connected from the reservoir close to the bottom of the small tank near its bottom. Another pipe is connected from the bottom of the small tank

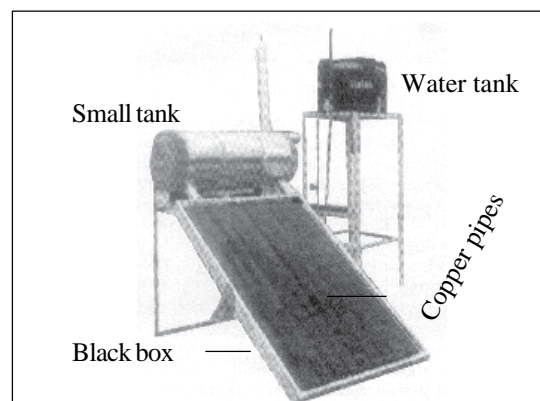


figure 9.4

to one end of the copper pipe in the box. The other end of the pipe is connected to the middle of the small tank. Water from the tank gets heated when it flows through the copper tube. Hot water flows to the middle of the small tank. When this action is repeated water in the tank gets heated.

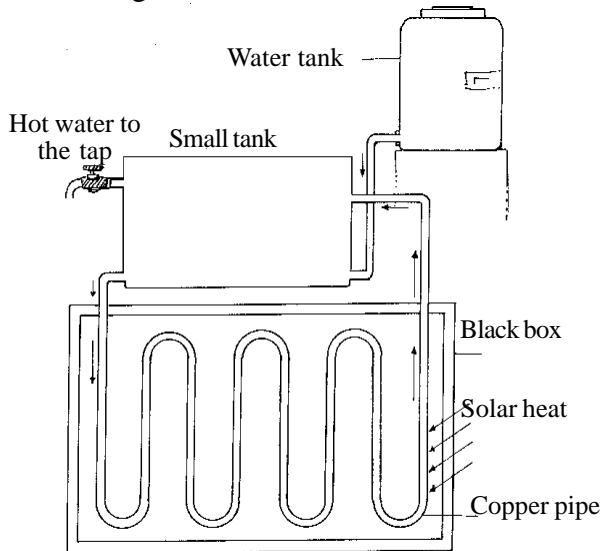


figure 9.5

The schematic representation of a solar water heater

Solar cells and solar panel

Have you seen electrical devices like calculators and lamps which work using solar cells? Have you observed the solar cell in it? What is its structure? Let us examine.

A solar cell is a device used to convert solar energy to electrical energy. A solar cell is a p-n junction semiconductor made of silicon. Do you know how much electric current is obtained from a solar cell of area 4cm^2 ? 60 milliampere (60mA). Then what about the potential difference from this? It is from 0.4V to 0.5V.

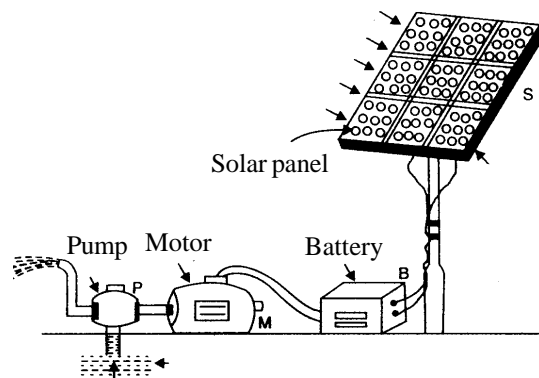


figure 9.6

Water pumped using solar panel

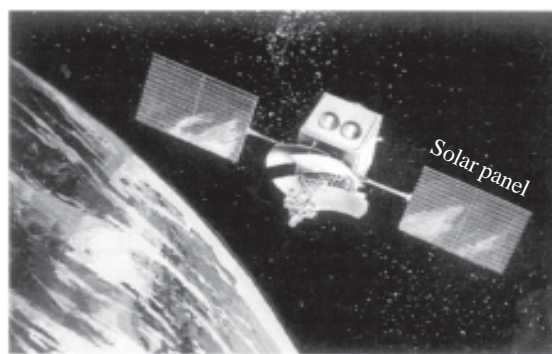


figure 9.7

Solar panel used in artificial satellite

Whether a bulb of 25W can be made to glow using a single solar cell? No. Then what can we do for that? A good number of solar cells suitably arranged can be used. This arrangement is the solar panel. It is the solar panel that supplies the necessary electrical power to the artificial satellites. Find more situations where solar panels are made use of and extend the list given below.

- To light the street lamps.
- To operate television sets in places where electricity is not available
- To activate solar lamps taken to sea.
- To make traffic signal lights work.

9.05 Energy from wind

You usually stand in an open space to enjoy the wind. You know how wind originates. Moving air is wind. Since the wind has velocity it has kinetic energy. This is the energy of the wind. We shall see how the kinetic energy of the wind can be used to produce electricity.



figure 9.8

Wind mill farm

For that, we can use windmills. Windmills are devices which work on wind. How the kinetic energy of the wind is made use of in windmills shall be looked into.

We shall examine the working of a windmill. The important part of a windmill is a structure with large leaves, fixed at the top of a high tower. What will happen when wind blows on these leaves? You may have seen paper fans available at festival places, rotating when the wind blows. In a similar manner the

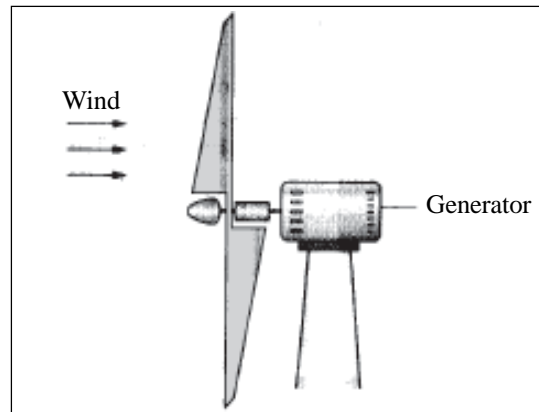


figure 9.9

Generator working on wind energy

speed of leaves changes with the speed of the wind. What happens if the rotation of the windmill is given to the rotor of a generator? Rotor also rotates. Then electricity is obtained from the generator.

What happens if the windmill is connected to a water pump? As the leaves of the windmill rotate pump works pumping out water.

What are the advantages of a windmill system?

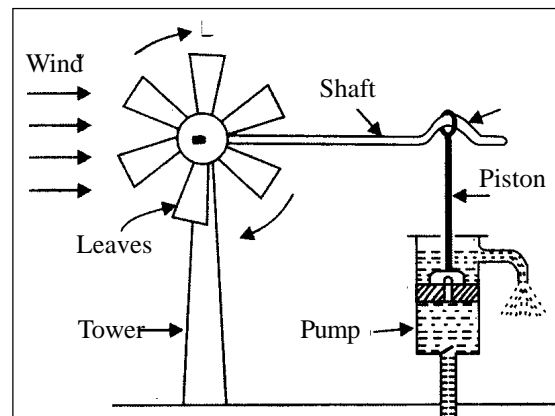


figure 9.10

Water pumped using wind energy

- High technology is not necessary
- Electricity can be produced at a lower cost after installation.
-

It is estimated that electricity upto 20000MW can be produced in India using windmills. Until 1999, a capacity of 1025MW has been achieved. The largest wind mill farm in India is at Valliyur near Kanyakumari in Tamil Nadu. It has a capacity of 380MW.

9.06 Ocean as a source of energy

Do you know that the ocean which covers about $\frac{2}{3}$ portion of the surface of the earth is a great reservoir of energy? Have you not been attracted by the beautiful sight of waves when you visit a beach? How can the energy due to the motion of waves be made use of? Can't we make use of the difference in water level created by high tide and low tide as a source of energy?

Wave energy

Sea waves have large kinetic energy. Can this kinetic energy be used to run the turbine of a generator?

Tidal energy

It is known that sea level sometimes rises and lowers at other times. This is high tide and low tide respectively. How many times do this occur in a day? Water flows to a reservoir during high tide. During low tide this water flows out from the reservoir through a pipe. This flowing water can be used to turn a turbine to produce electricity. In this way tidal energy can be made use of.

In the seashores of Kerala the difference in water level due to high tide and low tide does not go beyond one metre. Therefore electricity production using tidal power is not feasible.

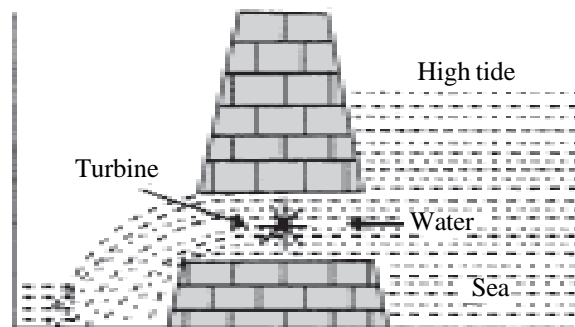


figure 9.11(a)

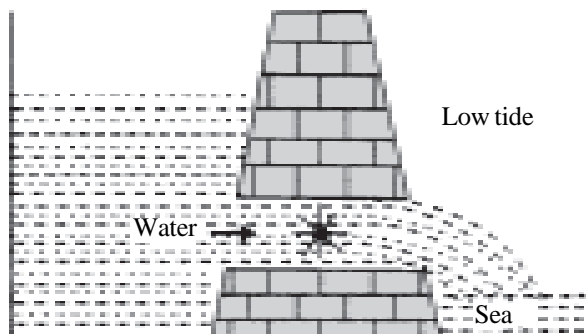


figure 9.11(b)

9.07 Geothermal energy

Do you know that temperature increases as we go deeper and deeper into the earth? At suitable circumstances we can make use of this large thermal energy. The energy that exists in the form of heat inside the earth is geothermal energy. You have studied earlier that the rocks melt to form magma due to the intense heat inside the earth. In some regions this magma moves upward and gets collected at some depth below the surface of the earth. These places, known as hot spots, are the source of geothermal energy. The underground water coming in contact with these hot spots boils and turns into steam. Since this steam is trapped between rocks, its pressure increases. Identifying such places and inserting pipes there to bring out the steam to drive a turbine, electricity can be produced.

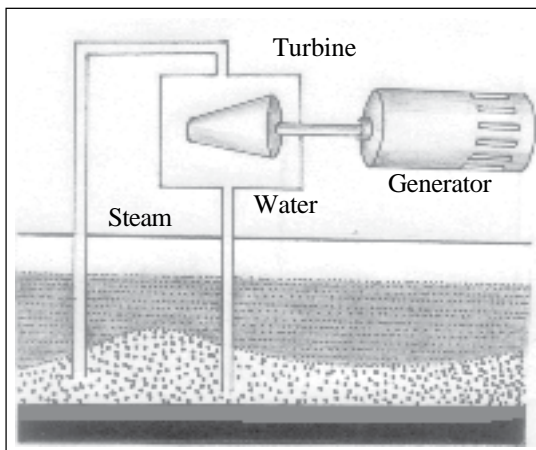


figure 9.12
Geothermal power plant

In India, geothermal energy is available in Madhya Pradesh. Geothermal power plants are operated in New Zealand and America.

Write down the advantages of geothermal power plants.

- Can be operated continuously for years.
- No atmospheric pollution
- Cost is almost half of that for a hydroelectric power station.

9.08 Hydroelectric power

Electricity produced by operating a generator utilizing falling water is hydroelectric power. You have learned already about it.

9.09 Fuels

We have already learnt about the different sources of energy. Heat energy required for cooking food in the kitchen is obtained by burning different types of fuels. Fuels form an important source of energy. When they burn, they release large amount of energy. Is their burning always similar? Let us examine. Isn't oxygen an essential component required for

burning? Is oxygen always available in the required quantity for burning fuels?

If the oxygen required for burning is available complete burning will take place. Find the characteristics of complete burning and write them down in science diary.

- Fuel burns completely
- Fuel is not wasted.
- Smoke will be less.
- Carbon monoxide is not produced instead carbon dioxide is produced.
- Charcoal is not produced.
-

What happens if the required quantity of oxygen is not obtained? Burning will be partial or incomplete. Discuss the characteristics of partial burning and write them in the science diary.

- Fuel does not burn completely
- Fuel is wasted.
- Large quantity of smoke is produced.
- Carbon particles which are not burnt are expelled as smoke.
- Poisonous carbon monoxide is produced.
- Leads to extensive environmental pollution.
-

Now let us examine some forms of fuels.

9.10 Energy from biomass

A part of the energy from the sun is stored by plants and trees as chemical energy through photosynthesis. What we get from biomass is the energy stored in this manner. This is bioenergy.

Have you seen villagers making cakes from cowdung, and burning them after drying? The biosubstances like cow dung cake which can be used as renewable sources of energy, are called biomass. Try to find more examples of biomass and write them down.

- Wood
- Excreta
- Remains of processed food
-

There are many limitations in making use of biomass. Find them out by discussion and expand the list given below.

- When it is burned only a part of the energy is obtained as heat .
- Their burning causes atmospheric pollution
- A lot of carbon monoxide is produced
- Charcoal is produced.

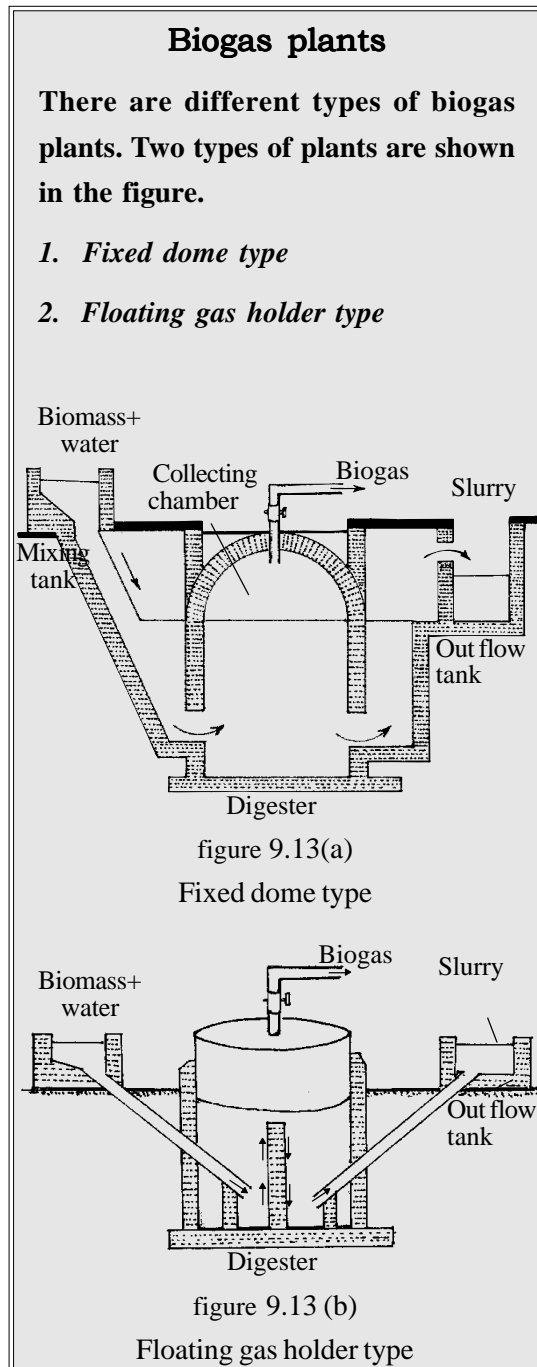
Biogas

Biogas is a good fuel. Have you thought how this is formed? Biomass like animal excreta, vegetable wastes and weeds undergo decomposition in the absence of oxygen in a biogas plant and form a mixture of gases. This mixture is the biogas. Its main constituent is methane. This is used as a fuel for cooking and lighting. What are the advantages of biogas as a fuel over biomass? We shall examine.

- Comparatively simple and can be produced easily.
- Burns without smoke and without leaving ash as residues.
- Household wastes and bio-wastes can be disposed of usefully and in a healthy manner.

- Reduces the use of wood and to a certain extent prevents deforestation.
- The slurry from the biogas plant is an excellent manure.

Prepare a short paper to propagate awareness about the necessity for increasing the use of biogas plants.



The important parts of such plants are

- **The tank where biomass undergoes decomposition (digester)**
- **The tank where biomass is mixed with water (mixing tank)**
- **The tank where slurry of biomass is collected (out flow tank)**
- **Arrangement to store gas**

Due to the action of bacteria in the absence of oxygen, biogas is produced in the plant. This is collected in the tank.

In the gasholder type plant, the cylinder rises up as the gas fills the tank and the storage capacity increases. The gas storage capacity of dome type will be less than that of gas holder type. Residue of biomass (slurry) can be used as a good manure.

9.11 Hydrogen as a fuel

You have learnt in chemistry that hydrogen is a combustible gas. When it burns it releases lots of heat. Water vapour alone is produced. No poisonous gas is produced when hydrogen is burnt. Then is it not a good fuel? Why then hydrogen is not used as a fuel in our daily life? There is every chance for explosion when hydrogen is burnt.

Moreover, it is difficult to store hydrogen safely. Attempts are being made to burn hydrogen in small measures so as to reduce the chance of accident. We can expect that, in future, hydrogen will become a fuel which can be used by anybody. Hydrogen is being used even now as a fuel in rockets.

9.12 Alcohol

Spirit lamp is used in class rooms for experiments. The spirit being used in spirit lamp is alcohol. This is a good fuel. Atmospheric pollution is much less when it is burnt. In certain countries a mixture containing alcohol and petrol is used as fuel in automobiles.

Gasohol

A mixture of petrol (gasoline) and alcohol is being used as fuel in automobiles in Brazil and Zimbabwe. This fuel is gasohol.

9.13 Non-renewable sources of energy

Have you not seen the filling of fuel in automobiles? What are the fuels that are being used in automobiles? What type of sources of energy are they? Are they renewable?

Fossil fuel is an invaluable source of energy produced due to chemical changes taking place in the absence of oxygen, in plants and animals that have been buried deep in the earth's crust for many million years. Fossil fuels like coal, petroleum and natural gas are formed in this manner. These are non renewable sources of energy.

9.14 Coal

Coal is one of the widely used fossil fuels. Important constituent of coal is carbon. Depending upon the quantity of carbon present, coal can be classified into four.

1. Peat
2. Lignite
3. Bituminous coal
4. Anthracite

Coal is being used as fuel in thermal power stations etc. The products obtained when coal is made to undergo destructive distillation are given below.

- Coaltar
- Coal gas
- Coke
- Ammonia

9.15 Petroleum

Petroleum which is a fossil fuel, is the crude oil. This is a mixture consisting of different hydrocarbons. Petroleum is subjected to a process called fractional distillation and the constituents contained in it are separated. The constituents thus obtained are given below. Do you know the uses of these?

- Petroleum gas
- Petrol
- Naphtha
- Kerosene
- Diesel
- Fuel oil
- Paraffin wax
- Lubrication oil
- Bitumen

9.16 LPG (Liquified petroleum gas)

LPG is a widely used fuel in homes. From where is this obtained?

You have learnt earlier that petroleum gas is a constituent obtained when petroleum is subjected to fractional distillation. If high pressure is applied to this gas it will be liquified. This liquid is LPG (Liquified Petroleum Gas).

This is filled in strong cylinders and distributed. The main constituent of this is Butane. Small quantities of Ethane and Propane are also found.

Accident from a spark

Gases in LPG are odourless. What happens if it leaks? We will not know even if it fills the whole room. What will be the result then, if an electric switch is switched on or a match stick is struck? Big fire or explosion will take place. Therefore to detect the leakage of the LPG another gas, Ethyl mercaptan, having a special smell is mixed with it. Smell of this is sometimes felt when the gas cylinder is opened. If this smell is felt never try to light the match or to operate electrical appliances. Doors and windows must be opened and check whether there is any leak in the cylinder. When not in use it is better to have the valve of the cylinder closed.

9.17 Natural gas

Do you know the fact that natural gas known in the short form as CNG is used in buses, trucks etc. in Delhi? Natural gas is a fossil fuel. This is usually formed in the Earth along with petroleum. Its main constituent is methane. It also contains small quantities of Ethane and Propane. Natural gas liquified by applying high pressure is CNG (Compressed Natural Gas). In automobiles, houses and factories, CNG is used as a fuel. It is also used

as a source of hydrogen required in the manufacture of fertilisers.

9.18 Nuclear Fuel

You have learnt in the previous chapter how energy is obtained from nuclear fission and nuclear fusion. The fuels used for these are the nuclear fuels.

9.19 Characteristics of fuels

Different fuels are available to us. Which fuels do we select from these? What is the criterion for this?

Calorific Value

Is food cooked faster in a gas stove or in a wood hearth? Whether heat obtained is the same when different types of wood are burnt? 5g wood, 5g charcoal and 5g paper are taken and burnt. Is heat energy obtained from them of the same quantity?

Can we not understand the efficiency of fuels from the heat energy obtained when they are burnt?

The heat energy obtained when one gram of a fuel is burnt completely, is its calorific value. This is usually expressed in the unit of Kilo joule/gram.

Among the Characteristics required for a good fuel, high calorific value is the important one. Find the other qualities required for fuels and complete the list.

- Easy availability
- Moderate rate of burning
- Moderate temperature for burning
- Low rate of evaporation at ordinary temperature, if the fuel is a liquid
- Low cost
- Easy to store and to transport
-

In this manner fuels have different qualities. All fuels used need not have all the qualities given above. If a fuel has six of these qualities it can be called an ideal fuel.

State of the fuel	Fuel	Calorific value (kJ/g)
Solid	Charcoal	33
	Coal	25 - 33
	Wood	17
	Cow-dungcake	7-8
Liquid	Kerosene	48
	Fuel oil	45
	Ethanol	30
Gas	Hydrogen	150
	Methane	55
	L.P.G	55

Table 9.2

9.20 Energy crisis

Different types of machines have become a part of our lives. For their working we have started lavishly using the sources of energy like petroleum, coal and natural gas. This has led us to an acute energy crisis.

Increased need for energy and the decrease in the availability is the cause of the energy crisis. Find the reason for this through discussion and write it down.

- Increase in population
- Industrialisation
- Lavish use of vehicles
- Use of inefficient machines
- Misuse of energy

- Wastage of fuels

Can this crisis can be allowed to continue? Is not a solution required for this? Solutions may be arrived at through discussions and expand the list.

- Use more of renewable sources of energy.
- Electricity and fuels must be used judiciously
- Use stoves with high fuel efficiency.
- Apply lubricants at the moving parts of machines.
- Use motor vehicles, only when it is essential
- Drive the vehicles at a speed when they can give maximum fuel efficiency.



Preserving energy is equal to producing energy.

Oil is invaluable, do not waste it.

Summary

- Those that supply energy are the sources of energy.
- There are renewable and non-renewable sources of energy
- Biomass, biogas, hydrogen, alcohol etc. are renewable sources of energy.
- Fossil fuels like petroleum, coal and natural gas are non renewable sources of energy.
- The sun is our richest and the most sustainable source of energy.
- Solar energy can be made use of using solar cooker, solar heater, solar cell etc.
- Wave energy and tidal energy are the sources of energy related to ocean. They are renewable.
- Electricity can be produced using geothermal energy also.
- Fuels can have partial combustion or complete burning.
- Increased need of energy and the decrease in availability is the cause of energy crisis.
- With a judicious use of fuels energy crisis can be reduced.



More activities for you

1. A person says that a car moving through the road gets energy from the Sun. Do you agree with him? Explain
2. Prepare a list of important renewable sources of energy,.
3. Smokeless hearth is a way for conserving energy. Write down the advantages of using this.
4. It is more advantageous to use biogas from cowdung for cooking than using the dry cowdung cake. Why?
5. Organise a seminar highlighting the importance of renewable sources of energy to tide over the energy crisis.
6. Find the different household situations where energy is wasted. What are the remedial measures that can be suggested to overcome them?
7. Construct a simple solar cooker and make it work
8. Construct a simple solar heater and exhibit it.

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