Structure and Working of Science Models

39th Jawaharlal Nehru National Science, Mathematics and Environment Exhibition for Children

2012

Silvassa

Dadra and Nagar Haveli

Structure and Working of Science Models

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1–7 December 2012
Silvassa, Dadra and Nagar Haveli

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PREFACE

The learning of Science is instrumental in developing well-defined abilities and skills such as spirit of enquiry, creativity, objectivity and aesthetic sensibilities among children. Children learn through interactions with the environment around, nature, thing and people. They actively engage with the world around them in exploring, responding, inventing, working things out and interpreting. Science Exhibition offers an opportunity to children to express and exchange their creative ideas with joy of scientific investigation. It helps them to learn the methods of science, provide them with opportunity to develop their problem-solving skills and creative abilities.

The National Council of Educational Research and Training (NCERT) is organising the Jawaharlal Nehru National Science, Mathematics and Environment Exhibition (JNNSMEE) for Children as an annual event in collaboration with a State or Union Territory. The JNNSMEE is the culminating activity of a series of exhibitions organised at school, zonal, district, regional and state levels. A large number of students and teachers participate in such events.

The present publication i.e., 'Structure and Working of Science Models' includes write-ups of a few exhibits selected for display in the 39th JNNSMEE – 2012 which is being organised in Silvassa, Dadra and Nagar Haveli. Other materials like "List of Exhibits" which contains the titles and synopsis of exhibits selected for participation in the JNNSMEE–2012 along with information brochures stating objectives and other details of the exhibition have also been published. It is expected that these publications will motivate and help children to participate in future Exhibitions.

The write-ups included in the present publication were selected out of the entries received from all the states/UT's and other agencies. These were reviewed and edited by an expert committee in the Department of Education in Science and Mathematics, NCERT, comprising Dr Gagan Gupta, Dr Alka Mehrotra, Dr R. K. Parashar and Dr C.V. Shimray. I appreciate the sincere efforts of the committee.

Further, I appreciate and specially thank Dr Gagan Gupta for coordinating the 39th JNNSMEE–2012 and seeing this manuscript through the press. I thank Ajeet Kumar, Ramesh Kumar, Girish Goyal and Narender Kr. Verma, DTP Operators, for their consistent help. I also thank the Publication Division, NCERT for the cooperation in bringing out this publication.

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New Delhi
1 December 2012

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1

Two-in-One Honey Squeezing Machine

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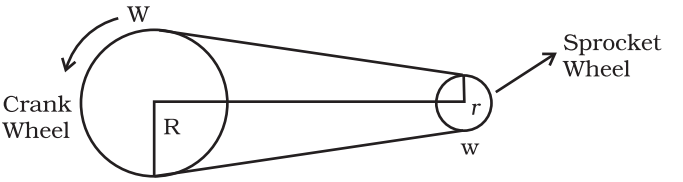
Introduction

Honey is an edible natural fluid. It is a rich source of energy containing many vital nutrients. Though Manipur has nearly 10,000 bee-keepers but the honey is not appropriately produced.

In Manipur, honey is extracted from honey comb by squeezing or by rotating manually. This type of method could not extract all the honey from the honey comb. Instead it loses muscular power, contains impurities and is also a time consuming work. So, it is necessary to make a machine which can extract large quantity of honey that contains no impurities. Such type of machine is envisaged in this model. The present model is an attempt to solve the problems while extracting honey by using excessive muscular power.

Scientific Principles Involved

(i) When a crank connected to a sprocket wheel by a chain is made to rotate, the linear speed '*v*' is the same for both wheels.



Therefore, $v = WR = wr$, where R and r are radii of the crank and the sprocket respectively. Hence, $w = W\left(\frac{R}{r}\right)$, '$v$' is the speed and W and w are their angular speeds.

Since, $R >> r$, $w >> W$.

Therefore, for one rotation of the crank, there will be a number of rotations (depending upon $\frac{R}{r}$) of the sprocket wheel.

(ii) Principle of experiencing a centrifugal force when an object is made to rotate in a direction away from the centre of the circular path.

Materials Required

Wood, stainless steel, honey comb, chain, sprocket wheel, paddle, handle, pot etc.

Construction and Working

(i) One honey comb container.
(ii) Three sprocket wheels, different in size.
(iii) One iron rod in the middle of comb container to attach the comb.
(iv) One crank and one honey collector.

When the paddle connected to the crank is rotated by hand or foot of a person sitting on the saddle, the sprocket wheel, the radius which is five times (say) smaller than the crank, rotates five times faster. The honey comb frames, connected/attached to the axle of the sprocket wheel also rotates, because of the centrifugal force experienced due to rotational motion. The honey gets separated from the honey combs due to striking the curved surface of the hollow cylindrical drum whose, axis is kept coinciding with axis of rotation. The honey is collected in a vessel placed below the drum through the holes provided. The other sprocket wheel close to the 1st one, allows the honey comb to rotate in the opposite direction. By rotating the crank in the reverse direction, honey comes out from the other side of the honey comb also. This helps in extraction of honey more efficiently.

Application

It is used to extract honey. Besides this, the machine has even the provision for generating power (electricity) if a generator (D.C.) is connected to the rear rotating system and can be used as a source of light for working in dark.

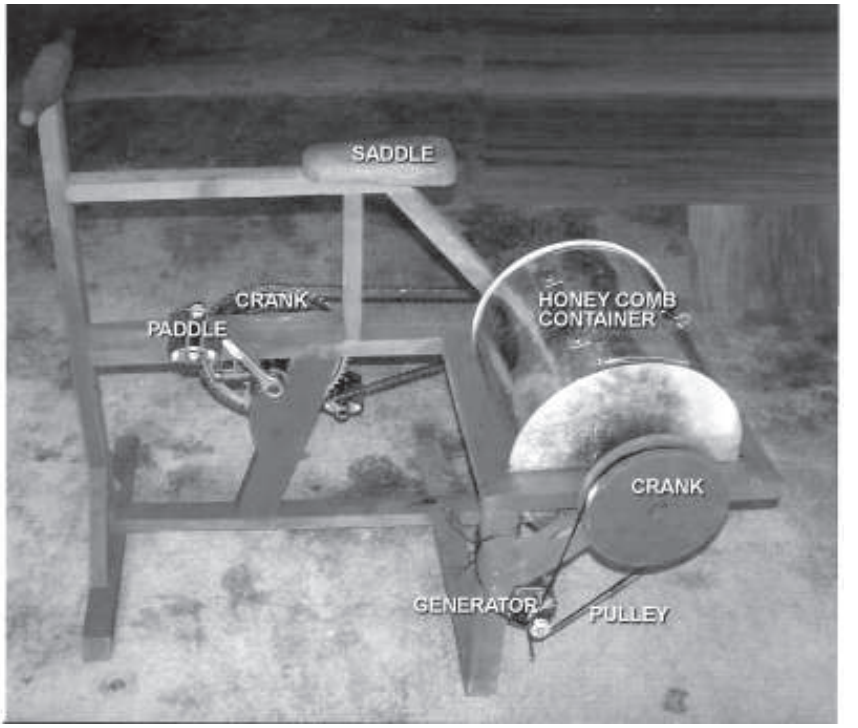


Fig. 1.1: Honey Squeezing Machine

Advantages

(i) Physical exercise of the man by paddling the crank in both direction. (clockwise and anti-clock-wise).

(ii) Effective use of muscular energy in doing physical exercise.

(iii) More production of honey from honey comb.

(iv) Saving time both in doing physical exercise and extraction of honey.

2

Food Grain Cleaner

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Introduction

India is basically an agrarian society. A lot of food grains are used for dietary purposes. Therefore there is a need of energy efficient, low cost, food grain cleaner. Thus, manually operable cleaner serves the purpose.

Rationale

Food grains for our daily use are required to be cleaned at different levels. First at farm level, second at marketing yard level and finally at household consumer level. So the need of time is a food grain cleaner that is very easy and fast to operate and will consume no electricity.

Scientific Principle Involve

As the grain passes through the rotating sieve, according to the size of sieve mesh, it gets cleaned. Rotating sieve will be kept inclined to get natural flow due to gravity.

Materials Required

1. Rotating Sieve : Galvanised Iron Sheet
2. Hopper : Mild Steel Sheet

3. Main Body : Mild Steel Sheet
4. Handle : Mild Steel
5. Rotating Shaft : Mild Steel
6. Bearings : Bearing Steel
7. Main Frame Legs : Mild Steel Angles
8. Clean Grain Collectors : Plastic

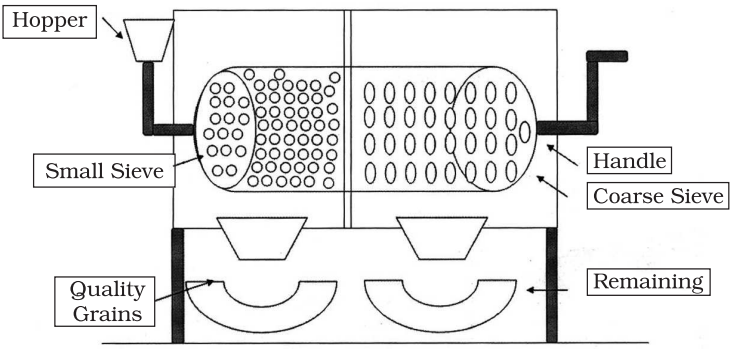

Fig. 2.1: Food Grain Cleaner

Construction and Working

There is a rotating cylindrical sieve connected to the shaft with the help of ribs so that it allows sieve to rotate and at the same time allows the grains to pass from one end to the other. A handle is connected with one end of the shaft and the shaft is connected with the main frame with the help of bearings. There is a hopper at one end of the rotating cylindrical sieve from where food grains are added. The cylindrical sieves have two type of mesh surface, first the smaller mesh and second the larger one. As the grain passes through the first part of mesh the smaller grain, dirt, small stones, broken grains are cleaned and collected in first plastic tray and only good size of grains enters in second part of mesh where it passes through the mesh and gets collected in the second plastic tray. If there is any other impurity which are bigger than the grain size it will remain in the cylindrical sieve at the end and can be collected as the sieve is removable. The entire frame is stabled with help of four legs.

3

De-humidified Drying of High Value Food Commodities

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Introduction

Increasing population necessarily requires large quantities of food products and their preservation. Diversity in climatic conditions among places stops food from being stored in natural conditions. The traditional methods of food drying for preservation are either inefficient or defective. The vegetables are dried at 70 C to 80 C by blowing hot air from a compressor. Since Vitamin-C (ascorbic acid) is volatile in nature and readily destroyed by heat and light, it escapes out of the food at this temperature. Higher temperature is required only due to the presence of humidity in air. If humidity is reduced from air, then food can be dried at low temperature between 40 C to 50 C. The sole purpose of this exhibit is to create awareness about new scientific techniques used in food drying for preservation so that dried food does not lose Vitamin-C, green pigments and flavor. It also highlights the eradication of scurvy disease which is caused due to deficiency of Vitamin-C.

Rationale

This project is an attempt to solve the problems arising during the present system of drying food for preservation in which lot of

food neutrient values are destroyed. In the present model the humidity of air is reduced at first stage by silica gel and then exposed into the drying chamber being hot by solar ray. After reduction of humidity from air, drying of food is made at low temperature to preserve food value of the dried food.

Scientific Principles Involved

De-Humidification: Silica gel absorbs the water particles from the air and make the air dry.

Head Radiation: Black body radiation causes very good heating effect to heat the dry air.

Parabolic Reflector: Parabolic reflector concentrates solar rays at a point for better efficiency and heat the air moderately.

Food Drying: De-humidified drying of food at low temperature preserves food values like Vitamin-C, green pigments and flavour.

Energy Conservation: Solar cell is used to drive all the electrical equipments to conserve traditional energy

Convention of Air: Hot dried air enters into the food drying chamber and absorbs water content from the vegetables and gets saturated with moisture. Exhaust fan exhausts this air out of the chamber and natural air from the atmosphere enters in to fill the vacuum.

Materials Required

Wooden house, aluminium reflector, transparent plastic sheet, 6V solar cell, metal pipe, wire net, wooden stand, wire, switch and hardware materials, 2 nos. fan blades to be fitted with the motors, silica gel, chalk pieces, 6V motor (2 nos.), gear box etc.

Construction and Working

Make a small house of plywood. Fit two nos. of wire net inside this house at six inches distance with respect to each other. The frame of wire net should be parallel to the floor of the house. Fit one door on the front side of the house. The roof of the house should be made up of transparent plastic sheets to allow sun rays to enter into the drying chamber. Make a hole on one side of the roof and fit a 6V exhaust fan in it. The 6V solar cell should be

fitted on top end of the wall of the house. A hole should be made on the bottom of another wall and the metal pipe be inserted in it. Another fan should also be fitted on the one end of the pipe. Now connect both the fans with the solar cell through wire and switch. The other end of the pipe should be fitted with an air dryer filled with silica gel. The middle part of the metal pipe should be covered by a parabolic aluminium reflector from one side. Fit a plastic separator in between the air dryer and the metal pipe to prevent heat conduction. Paint the metal pipe which is in the reflector by black paint. The reflector should be fitted with the gear box through a 6 V motor which will be driven by solar cell. Now expose the whole system to the sunlight.

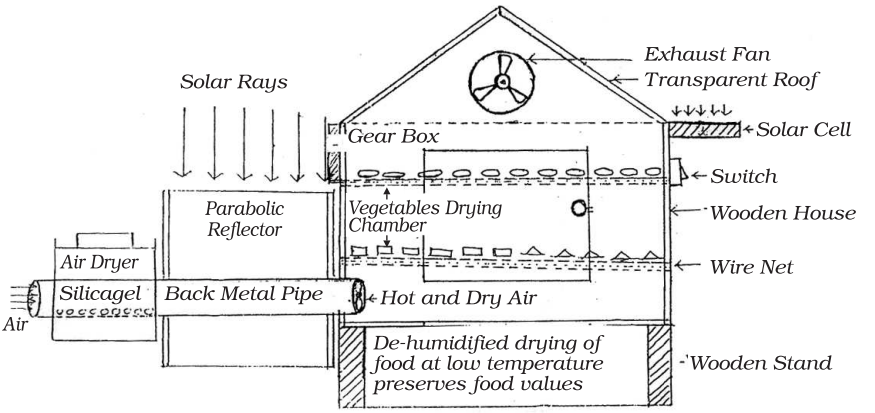

Fig. 3.1: Food Drying Machine

When the set-up is exposed to the sunlight, both the fans will start rotating as these get power from solar cell. The inner fan which is fitted with the metal pipe will suck air from the atmosphere. The air will flow through the air dryer which is filled with silica gel. The water vapours in the air will be absorbed by silica gel here. Only dry air will flow through the rest pipe. Due to black body radiation and reflection of light of sun, the inner air would be hot enough. Then only hot and dry air will enter into the drying chamber. Vegetables which are to be dried up should be kept on the wire net. When dry hot air will enter inside, the air itself will absorb water content of the vegetables at faster rate as the air is dry and hot. Hence vegetables will be dried below 50 C.

The other fan fitted at the top end of the roof, will exhaust the hot air from inside of the drying chamber. The gear box already fitted with the reflector will rotate the reflector very slowly so that the 'hot air pipe' will always face towards the sun to gain more heating effect. Through this process, we can dry vegetables at low temperature and preserve Vitamin-C, green pigments and flavour of the dried food.

Applications

It is a dynamic model made out of new indigenous technology run on solar energy. Food drying at low temperature has great and wonderful applications. Compared with the traditional methods, above technique is energy saving, economical and can provide safe food. No food value is damaged while drying.

4

Low-Cost Cold Storages

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Introduction

Fresh fruits and vegetables start to deteriorate as soon as they are harvested because they are cut off from their source of water and nutrition. They lose weight, texture, flavor, nutritive value, and appeal. Cooling significantly slows down the rate of deterioration, thereby increasing the shelf-life of the produce. The cooler the temperature, the slower the deterioration and the longer the storage life. Much commercial produce is stored at low temperatures just above which it will damage, so that it can have the maximum possible shelf-life for many weeks or even months and can be transported to very long distance. Sometimes long storage times at very low temperatures may not be required for many produce because fresh produce deteriorates substantially within a day or two if not cooled at all from ambient condition, especially during the hot summer months. Low-cost cold storage options can benefit growers by preserving freshness and quality of produce for a few additional days. Produce losses of growers can be significantly reduced, especially for the growers who have higher level of production and can carry excess produce of one to the next day to the market.

Requirement Analysis

The following problems are being observed in different cash crops and other major cultivations.

Ginger

Fungal Diseases: Yellowing of leaves, rhizome rot by *Fusarium oxysporum, Pythium* sp.

Bacterial Disease: Pseudomonas sp.

Cardamom

Fungal Disease: Glomirula sp., *Fusarium oxysporum, Pythium* sp.

Bacterial Diseases: Pseudomonas sp.

Orange

Fungal Disease: Mild Dew, *Elsinoe fawcettii* (causes citrus scab) *Alternaria citri* (causes decay).

Potato

Bacterial Diseases: Brown Rot (*Pseudomonas solanacearum).*

Fungal Disease: Brown spot and black pit *(Alternaria tenuis).*

The objective of this endeavour of making a low-cost cold storage system are to construct the ecofriendly, low cost storage system affordable by the weaker section of the society and to provide the optimum temperature for the storage of fruits and vegetables.

The construction of low-cost cold storage is based on the principle of evaporation and latent heat transfer.

Materials Used

Plywood, fevicol, nails, straw, saw-dust, sand, thermometer, water, plastic pipe, water reservoir, charcoal, wood bark etc.

Construction and Working

Low-cost cold storage consists of a double walled room (wooden or concrete), having a gap of 6 to 10 inches between the outer and inner wall. Between the walls sufficient amount of straw, saw-dust, sand, charcoal, wood bark are placed accordingly. The holes are made at roof between the two layers as water can enter through these holes in the gap. The ventilation and holes are made at the outer wall so that air can pass and evaporated gas can come out through it. The excess water comes out through the outlet which can again be used for irrigation purpose.

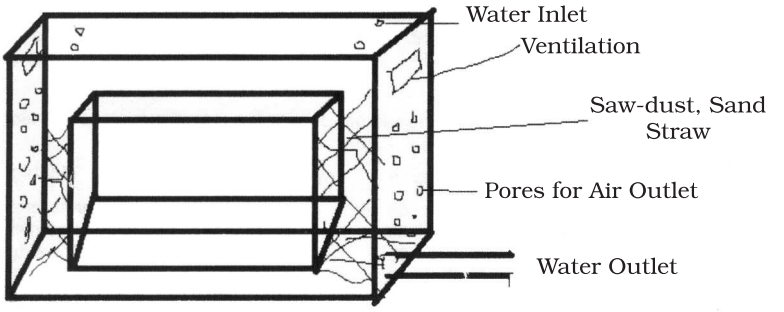

Fig. 4.1: Storage of Fruits and Vegetables

Table 4.1: Fruits ands Vegetables that Require Cold, Moist Conditions

Vegetable	*Temperature (F)*	*Relative Humidity*	*Length of Storage*
Asparagus	32-36	96	2-3 weeks
Apples	32	90	2-6 months
Beets	32	95	3-5 months
Broccoli	32	95	10-14 days
Brussels Sprouts	32	95	3-5 weeks
Cabbage, Early	32	95	3-6 weeks
Cabbage, Late	32	95	3-4 months
Cabbage, Chinese	32	95	1-2 months
Carrots, Mature	32	95	4-5 months
Carrots, Immature	32	95	4-6 weeks
Cauliflower	32	95	2-4 weeks
Celeriac	32	95	3-4 months
Celery	32	95	2-3 months
Collards	32	95	10-14 days
Corn, Sweet	32	95	4-8 days
Endive, Escarole	32	95	2-3 weeks
Grapes	32	90	4-6 weeks
Kale	32	95	10-14 days
Leeks, Green	32	95	1-3 months
Lettuce	32	95	2-3 weeks
Parsley	32	95	1-2 months
Parsnips	32	95	2-6 months
Pears	32	95	2-7 months

Peas, Green	32	95	1-3 weeks
Potatoes, Early	50	90	1-3 weeks
Potatoes, Late	39	90	4-9 months
Radishes, Spring	32	95	3-4 months
Radishes, Winter	32	95	2-4 months
Rhubarb	32	95	2-4 months
Rutabagas	32	95	2-4 months
Spinach	32	95	10-14 days

Table 4.2: Vegetables that Require Cool, Moist Conditions

Vegetable	*Temperature (F)*	*Relative Humidity*	*Length of Storage*
Beans, Snap	40-50	95	7-10 days
Cucumbers	45-50	95	10-14 days
Eggplant	45-50	90	1 week
Cantaloupe	40	90	15 days
Watermelon	40-50	80-85	2-3 weeks
Peppers, Sweet	45-50	95	2-3 weeks
Potatoes, Early	50	90	1-3 weeks
Potatoes, Late	40	90	4-9 months
Tomatoes, Green	50-70	90	1-3 weeks
Tomatoes, Ripe	45-50	90	4-7 days

Table 4.3: Vegetables that Require Cool Dry Conditions

Vegetable	*Temperature (F)*	*Relative Humidity*	*Length of Storage*
Garlic	32	65-70	6-7 months
Onions	32	65-70	6-7 months

Table 4.4: Vegetables that Require Warm Dry Conditions

Vegetable	*Temperature (F)*	*Relative Humidity*	*Length of Storage*
Peppers, Hot	50	60-65	6 months
Pumpkins	50-55	70-75	2-3 months
Squash, Winter	50-55	50-60	2-6 months
Sweet Potato	55-60	80-85	4-5 months

Source: ISO Standard for Food Storage

Working of the Exhibit

The low-cost cold storage works on the principle of evaporation and latent heat transfer. Water enters in the gap between the outer and inner layer which is filled with sand, straw, saw-dust, and gets trapped into it. The excess water comes out through the outlet which is used for irrigation and other purposes. The water source can be rain or stored water from river or stream water. The trapped water particles of sand, straw and saw-dust, when gets in contact with outside air, the temperature inside starts increasing thereby causing the water molecules inside to be evaporated and comes out through the pores on the wall. Thus, inside heat is transferred according to latent transfer of heat thereby causing the inside temperature to fall, which makes the inner room conducive for storing the vegetables and fruits.

Effectiveness of the Exhibit

This model is specially designed for the storage of food articles mainly produced in the mountainous region like Sikkim. We have measured the inside and outside temperatures of cold storage room and temperature difference of 10-18 C is observed. Thus, the optimum temperature for the storage of ginger *(Zingiber officinale)*, potato *(Solanum tuberosum)*, sweet potato *(Ipomea batatas)*, orange *(Citrus reticulata)* and dry cardamom *(Ammomum subulatum)* can be achieved by using this storage.

Advantages of the Exhibit

Such low-cost cold storages are cost effective, environment friendly and use natural resources. These are easy to install and can be used by farmers to store ginger, potato, orange, etc.

The cold storage provide the efficient utilisation of rain water. The excess water may further be utilised for irrigation and for some other domestic purpose after filtration. The straw after certain months can be replaced by the fresh one and the old straw can further be utilised as manure.

5

MECHANICAL BIRD

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INTRODUCTION

When we observe the sky, we see many animals in flight, be them birds, bats or bees. Man has been fascinated with flight and has tried to achieve it since time immemorial. Leonardo da Vinci was one of the first persons to observe and make a detailed scientific account of their flight in the 1500s. In the early 1900s, the Wright brothers created history by being the first persons to build a plane that could fly. After the invention of the first aeroplane, there has been no turning back. Today we have supersonic jets that can fly faster than sound and rockets that can escape the earth's gravity.

Commercial flying has become a major way to transport people. However, commercial flight is not popular in India due to the relatively high costs. But commercial flight has come under immense scrutiny these days due to the global scenario of increase in fuel prices and environmental problems.

This project is an aim to create mechanism of low – drag flight, so as to ensure a greener, cheaper future.

What it Takes to Fly

For an object to fly with constant velocity, a lifting force or **lift** equal to its **weight** and a forward force or **thrust** equal to the viscous friction or **drag** is needed.

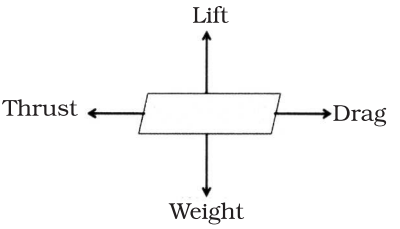

Fig. 5.1: Four Forces for Flight

Aeroplane

An aeroplane employs two separate mechanisms, viz. one for lift and other for thrust.

For lift, the aeroplane has wings tilted to the horizontal at an angle (α). The aeroplane move forward against the direction of airflow. It is opposed by a force which can be resolved into a horizontal component (drag) and vertical component (Lift).

For thrust, the plane has to make use of a propeller that increases the airflow opposing it so as to get pushed forward.

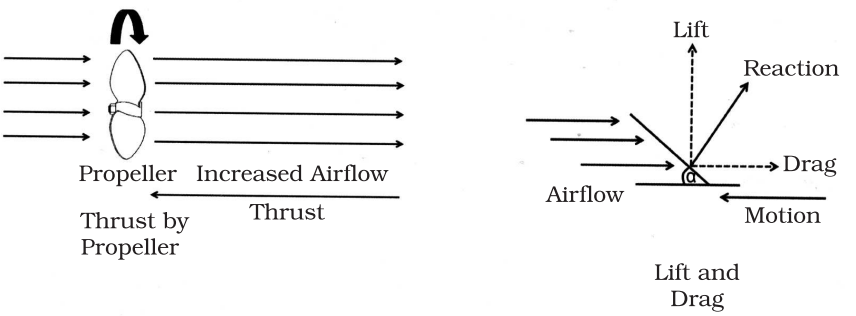

Fig. 5.2: Mechanisms of an Aeroplane

An aeroplane must achieve lift and thrust separately. This reduces efficiency and in the present day scenario of increasing costs and environmental pollution, this leads to a problem.

Flapping Wings

Flapping wings ensures that one can gain both lift and thrust in the same stroke resulting in higher efficiency.

The upstroke however, presents problems. The lift and thrust gained in the downstroke is lost on the upstroke.

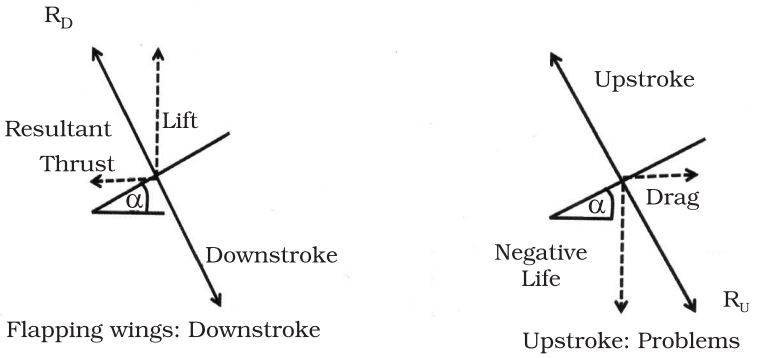

Fig. 5.3: Ray Diagramme of Flapping Wings

Equations Governing Flapped Wing Flight

Resultant force on downstroke (R_D) for a circular wing is given by:

R_D = dp/dt (p is the momentum of the displaced air)

R_D = mdv/dt (m is the mass of air and v is the velocity of air

m = $V\rho$ (V is the volume of the air displaced and ρ is the density of air)

R_D = $V\rho$ dv/dt

If the resultant force on the upstroke $R_U < R_D$, then the object will fly.

Bird: A Case Study

R_D (bird), assuming circular wings is given by, $\mathbf{R_D = (4/3)\pi r^3 \rho\, dv/dt}$

R_U (bird) = $V\rho$ dv/dt (accelerations on both strokes are same)

Birds reduce volume of air displaced on the upstroke by splitting and bending their wings.

In our discussion, let us assume that due to the split wing the radius of the wing is reduced by a factor of 2

Therefore, R_U (bird) = $(1/6)\,\pi r^3 \rho$ dv/dt

Mechanical Bird for Flight

The project involves a novel adaptation of a rack and pinion gear mechanism for efficient flapping wing flight. The flapping mechanism is analogous to the breaststroke in swimming.

In swimming also, $R_D = V \rho \, dv/dt$

Since ρ (water) > ρ (air), V and dv/dt need not be very high and practical experience validates this.

Whereas in the case of the mechanical bird, since ρ (air) is small, V and dv/dt need to be proportionally higher.

Test for R_D

The Mechanical Bird was mounted on a 6-axis Force and Torque sensor. The sensor comprises 6 strain gauges, which capture forces and moments along 3 axes.

Fig. 5.4 (a) **Mechanical Bird** **Fig. 5.4 (b)**

We are interested in forces along the Z-axis. When the Mechanical Bird flaps its wings, two types of forces are generated, viz. inertial forces due to movement of set up, and aerodynamic forces due to movement of wing. In order to measure only aerodynamic forces, the test was carried out in two steps.

Step 1: The Mechanical Bird was mounted on the set up without its wings so as to measure only the inertial forces (assuming the wing frame produces negligible aerodynamic forces).

Step 2: The Mechanical Bird was mounted with the wings on the set up to measure both aerodynamic and inertial forces.

Result

The forces measured in the above two steps were plotted in a Force-time graph. The difference between the graph of Step 1 and that of Step 2 gives the aerodynamic forces produced (assuming that the wing produces negligible inertial force).

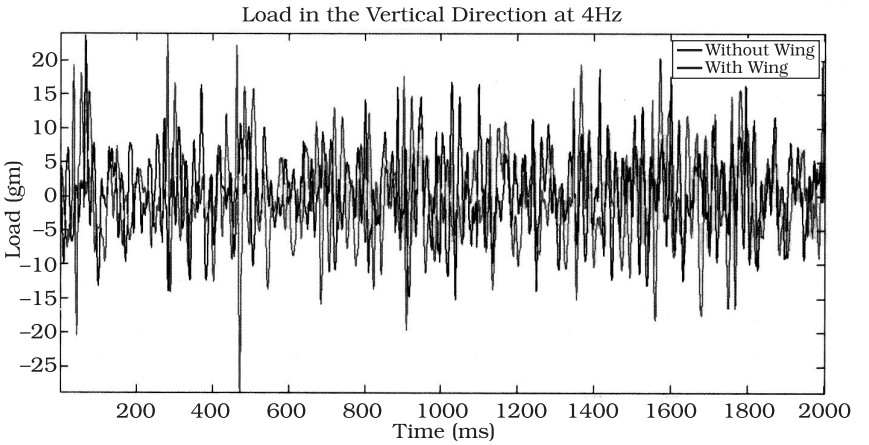

Fig. 5.5: Force-time Graph

In the above graph, we see eight cycles in a time period of two seconds. Each cycle can be broken into two parts, downstroke and upstroke.

Inference

From the above graph, assuming the mechanical bird is oriented perpendicular to the ground, we infer that for a flapping frequency of **4 Hz** and wing area of **90 cm²**, the average lift produced is **7 gf**. Hence we conclude that a Mechanical Bird of such specification and weight less than **7 gf** can achieve flight.

Theoretical analysis of R_U

We compare the R_U values of a bird and the mechanical bird

R_U (mechanical bird) = $V \rho\, dv/dt$ (acceleration of bird and mechanical bird are same)

V = Volume of the wing = $\pi r^2 h$ (h is the thickness of the wing)

R_U (mechanical bird) = $\pi r^2 h \rho\, dv/dt$

R_U (mechanical bird)/R_U (bird) = $\pi r^2 h/(1/6)\, \pi r^3 = 6h/r$

By construction, $h << r$

Hence, R_U (mechanical bird) < R_U (bird)

Flight is thus **possible** and more **efficient**.

Materials Used

Acrylic, Balsa wood, Carbon Fibre Rod, DC Motor, Wires and Screws

Construction and Working

Racks and pinions of specified dimensions were laser cut on acrylic sheet. They were then mounted onto a sheet of balsa wood. A motor was mounted on top to drive the mechanism. Paper wings were attached to the rack-gears.

The basic structure consists of a gear system with two pairs of gears – one rack and one pinion each. The rack is anchored at a point. When the pinion rotates, the rack traces an arc of radius equal to the length of the rack. This motion replicates the downstroke of a bird. For the upstroke, the rack traces a straight-line path back to its initial position.

Applications

Such a mechanical bird would find immense practical applications at both micro and macro level.

At the macro level, if we could make aeroplanes for public transport, lots of fuel would be saved leading the way to a greener cheaper world.

At the micro level, the following applications may be cited:

(i) *Search and Rescue:* This application would prove to be life-saving in rough terrains and water-logged areas.

(ii) *Security and Surveillance:* These applications could be used to prevent frauds and thefts.

(iii) *Spying:* These are useful for national security.

(iv) *Animal Surveys:* They can be used to maintain ecological balance.

(v) *Traffic Control:* Mechanical birds can be used to ensure every one follows the rules and aid in de-clogging of streets.

(vi) *Agriculture:* In order to check pest infestation and ensure all plants are growing well, mechanical birds can be used. They may also be used for drip irrigation in fields in order to conserve water, one of the most important and depleting resources.

6

Rover without Driver

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Introduction

The knowledge of science helps humans to handle unpredictable critical conditions endangering life. Technological advancements like robotics help to make life safe and easy. Disaster is an unexpected event that brings heavy loss to property, life and it may leave its effects for a long time. A disaster may be natural like tsunami, earthquakes, volcanic eruption, landslides, avalanches, forest fire or may be due to human activities like leakage of poisonous gases, nuclear spell out from atomic reactors.

This exhibit presents the design of a rover which is unmanned automatic vehicle which can be easily employed in numerous real time applications like material handling, in hazardous, in slummy and inaccessible environments. Often it is difficult to operate rescue procedures at the time of disaster to mitigate their effects. It is mainly due to inaccessibility to the site. Such issues require automobiles that can be operated without driver to reach at site for performing mitigation procedure.

Here in this project, a prototype module of line follower trolley type machine is designed, which can be used for many applications. To prove practically for one application, this trolley can be used to carry goods from one reference point to the other, which in turn may provide service to the soldiers at borders.

Depending upon the programme prepared for micro controller, the work cycle is simple.

This exhibit is based on the principle of transformation of electrical energy into mechanical energy using I.R. sensors.

Materials Used

IR sensors (LEDs, detectors); MCU (Micro Controller Unit); two relays; H – Bridge IC (amplifier); three DC Motors: two for movement of the vehicle and one for avoiding the obstacle; capacitors; transistors; resistors; voltage regulators; alarm; knot gates; tone decoder; obstacle avoider; battery (12 Volts); On/Off switch; crystal oscillator; diode and limit switches.

Construction and Working

This is to develop a robot that will follow a specific line. The path can be visible like a black line on white surface or it can be invisible like a magnetic field. This robot is designed with a sensor array, controlling circuitry and motors working together to follow a black line.

Sensor Arrays

Sensor array is designed with two sets of optical sensors. These sensors are arranged below the vehicle at front side. The function of these sensors is to detect the black line if any deviation is there in the vehicle movement that information is fed to the MCU.

Path Sensing Controlling Circuitry

Depending upon the information produced by sensors the microcontroller controls motors through the H-Bridge IC and obstacle avoiding mechanism motor is controlled through relays.

The basic operation is to identify and recognise the black line. This is achieved by the help of IR Sensors mounted below the vehicle. Preferable black tape may be stuck over the white floor for better results. The idea of choosing black colour is that the IR energy delivered from the IR LED (Light Emitting Diode) will be absorbed by the black colour. If there is any deviation, IR energy hits the white floor and the signal will be reflected. The output of the IR detector is amplified and it is fed to microcontroller through

knot gates. These are used to generate a perfect logic output, essential for microcontroller. If the vehicle is running over the track, both sensors output will be zero. Otherwise depending upon the deviation side corresponding sensor output would become high.

Motors that Drives the Vehicle

The common configuration used in mobile robots consists of two differentially driven wheels and one castor wheel (steerable front wheel or free running wheel). DC motors or step motors can be used for driving the two controlled wheels. In our design, we choose DC motors since these are easy to control and consume less energy. These are 12 volts DC motors used to drive the mechanism. Wooden plank is used as platform. The two motors are mounted below the platform at rear side. It is provided with a reduction gear mechanism to regulate the speed.

Micro Controller Unit

A microcontroller count contains C.P.U., Clock Circuitry, ROM and RAM and I/O, Circuitry on a single integrated circuit package. The intension behind choosing MCU instead of conventional microprocessor is as there are several advantages like cost and space effectiveness, cheaper maintenance, portability etc.

Working Theory of H-Bridge

The name H-Bridge is derived from the actual shape of the switching circuit which controls the motion of the motor. It is also known as Full Bridge. Basically there are four switching elements in the H-Bridge. When these switches are turned on in pairs motor changes its direction accordingly like if we switch on high side left and low side right then motor rotate in forward direction, as current flows from power supply through the motor coil goes to ground via switch low side right. Similarly, when we switch on low side left and high side right, the current flows in opposite direction and motor rotates in backward direction.

Obstacle Sensing Circuit

It is designed with IR sensors with tone decoder IC and it also generates tone frequency. Presently, the demo module is

constructed with 3 sets of IR sensors and they are arranged at the front portion of the trolley. The function of these sensors is to detect the presence of any object that is existed over the path. If the circuit detects any object, the controller stops the vehicle and avoids the object through obstacle avoiding mechanism, and after clearance, the vehicle will be moved further automatically. Sensing block is designed with two IR LES namely IR signal transmitting LED and IR signal sensor.

The tone generator part of the IC is configured as a stable mode of operation. The amplified signal is radiated through the transmitting IR LED. The signal delivered by the IR LED transmits in a line like LASER beam, whenever this signal strikes the object the signal will be interrupted and it will be spread into the air in all directions. Some of the signal will be reflected back. This signal is tracked by the IR signal detector that is arranged side by the IR LED.

On the receipt of optical signal, the tone decoder part of the IC detects the signal through the optical sensor and generates a high signal for the micro controller. According to the received information from the sensors, the controller controls the motor through relays and avoids the obstacle with its mechanism.

Limit Switches

A limit switch is one of the most basic and reliable of all available sensors. This exhibit produces the lowest noise and most easily interpreted signal. Here this switch is used to restrict the movements of obstacle avoiding mechanism. To stop the mechanism at a particular position for both sides, two limit switches are used. When the switch detects the obstacle mechanism immediately controller stops the motor. There are different types and design of limit switches available in the market however all limit switches have the same operating concept.

The basic design and working of such a vehicle is given in Fig. 6.1. The detailed electrical cirentary is also available. Some designed and developed rovers may be useful in: (i) carrying radioactive materials from nuclear power stations; (ii) transporting things to the contaminated areas; (iii) help the people in disaster

places like radiation leakage areas in nuclear power stations, in poisonous gas leakage places; (iv) supplying the daily needs to the army at borders; transporting material through hazardous places like forests and deserts; helping humans in places where human access is limited etc.

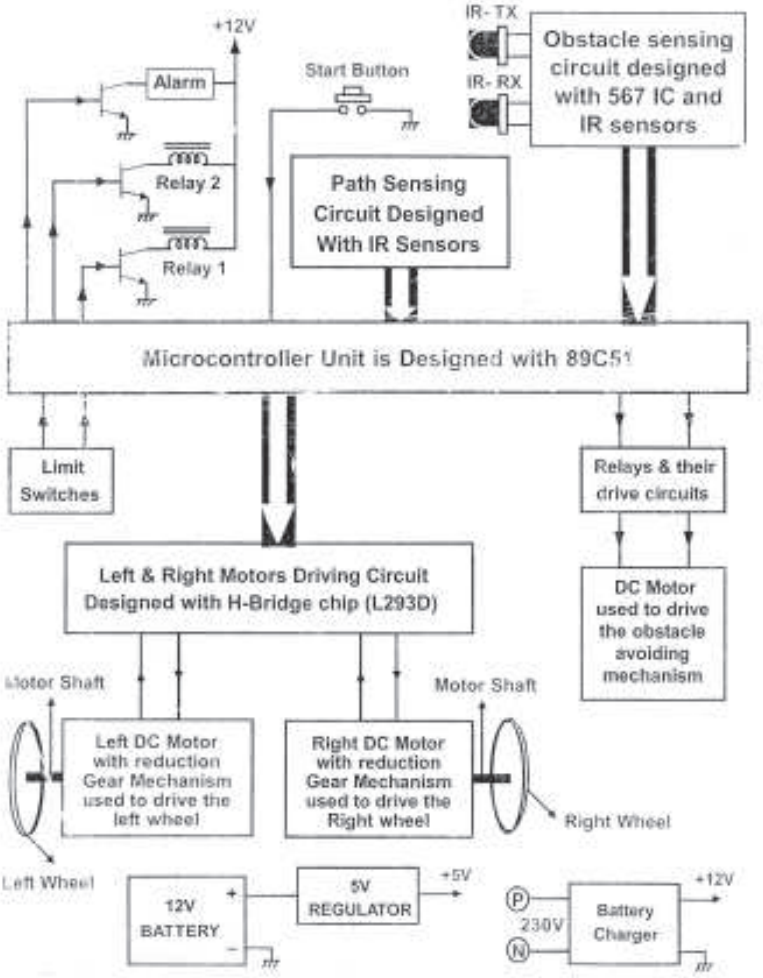

Fig. 6.1: Trolley with Obstacle Avoiding System

7

Water Pump System

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Introduction

Water is a precious gift of nature. One cannot survive without water. Now a days, we are facing a prime concern, i.e., scarcity of water, not only in metros but also in smaller cities. Most of the cities are supplied with water by the Municipal Corporations or other water supply system is made possible through pipe lines and channels.

Life gets frozen when the water supply is blocked for a single day. Thousands of gallons of water is lost or wasted due to wreckage of the pipes. This becomes a huge loss to the people who are suffering due to acute water scarcity. The breakages found in water supply chains are attributed mainly to the high pressure formed in the pipes, and the pipes which got wrecked due to usage for a very long period of time. Sometimes the breakage of pipes and channels create artificial water stagnation and inturn disruption of vehicular and manual traffic.

In villages, the situation is not different. Wastage of water leads to pooling of water in agricultural fields causing heavy damage of crops. The solution to this problem lies in implementing a working model.

Materials Required

PVC pipes; relay switches; valves; floating ball (plastic ball); metal string; copper wire; water; pump; batteries (Volt); motor and 6V mini motor and mechanism of time piece

Construction and Working

The main pipe is attached with two vertical pipes, one big and the other small. As the water flows in the main pipe, the water level in these side pipes is as par with the main one.

The vertical pipes are provided with 2 balls on the surface of the water level with one attached with a metal string that keeps them floating. In order to showcase the high pressure in the pipeline, a valve at the other end of the pipe is closed.

When high pressure is formed due to obstruction caused by some or the other reason the floating ball in the big vertical pipe gets raised in turn raising the metallic strip attached with the floating ball leading to the completion of one circuit. This makes the relay switch on and resulting in closure of the valve from the pumping station and it will stop further water supply to the pipeline. Thus, we can avoid the situation of breakage of pipes.

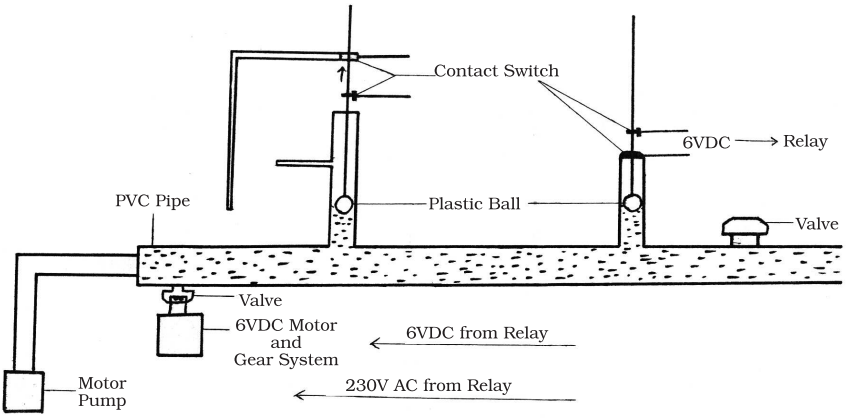

Fig. 7.1: Water Pump System

In order to showcase the breakage of the pipe in the model, another pipe is kept open at the starting of the pipe. When the pipe breaks due to some reason or the other, a low pressure is

created in the pipe line. As a result of this, the water level in the smaller pipe gets down and in turn the floating ball (plastic ball) with metallic strip gets down making the 2nd circuit complete. In turn it will switch on the relay cirucit resulting in closure of the valve in the pumping station. There will be no further loss of water.

Applications

To detect the breakage of water and to avoid the cause that results in breakage. This is done by not allowing excess pressure created inside the water pumps.

8

Maglev Rail

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Introduction

In city, road traffic blocks are common. To overcome this, metro rails are introduced in cities to meet the everyday travel needs of employees and workers within time. Conventional trains require more energy due to the friction between rail and the wheels than Maglev trains. But the levitation is attained only at very high speed. This technology is not suitable for metros because before attaining the levitation speed, next station is reached. Also this requires huge capital investment, maintenance cost, sophisticated equipments, highly qualified and skilled employees. It also consumes a large amount of electricity. To cut down all these, especially the energy consumption of energy, we are introducing a concept for city travel, "Energy Saving Maglev Rail Plane Metro".

Scientific Principles Involved

Like poles of magnets repel each other. This principle is used in levitation of train. Electric motor driven propellers can propel the floating train easily. Rack and pinion mechanism with electric geared motor can open/close the train doors smoothly and efficiently. A small electronic circuit with microcontroller can display the 'coming station" in an LCD display in the train.

Materials Required

Plywood, wooden reaper, aluminium angle, acrylic sheet, bar magnets, parts of toy train, toy plane and toy car, electronic circuits, DVD loader, microcontroller, LCD display, On/Off switches, micro leaf limit switches, wires, screws, paint, DC power supply 12 Volts and 5 Volts, etc.

Construction and Working

Our new model is constructed as two separate units. One consists of Maglev train with rail and propulsion system. Other unit consists of train door opening/closing facility and automatic coming station (next stop) display system. These are explained below.

Overhead Rail with Levitating Magnets

A wooden platform having 4 feet long 10 inches wide and 2 inches thick is made out of plywood and reaper which is used as under side road. Wooden reapers of 13 inches height are erected at both sides (5 nos. on each side) of the road as supporting pillars for the rail. Aluminium angles 25 mm 40 mm, 4 feet long are screwed

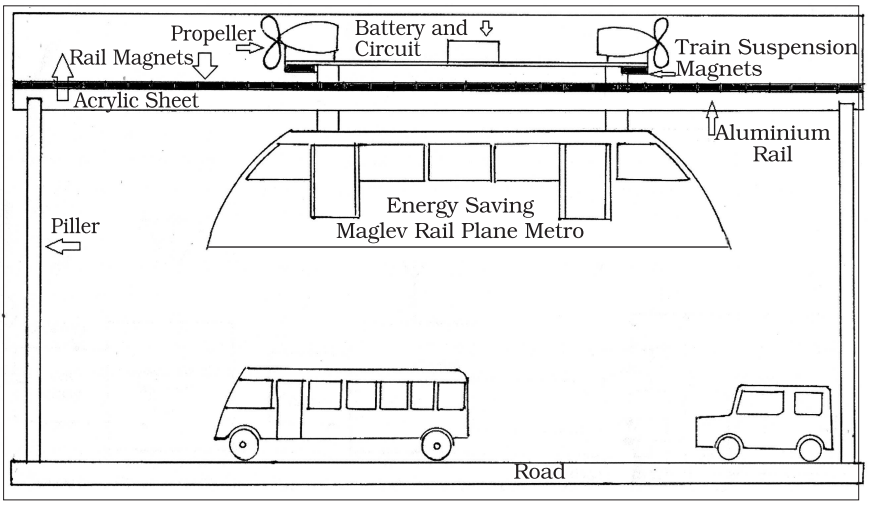

Fig.8.1: Layout of Maglev Rail Plane System

on these pillars to act as rails. Bar magnets 26 mm 10 mm 6mm size are glued on these rails (48 nos. on each side) with south poles on the top side. Acrylic sheet having 4 feet long, 5 inches height and 3 mm thick are screwed on the outer side of each rail which is used as guards.

Train with Suspension Magnets and Propulsion System

An acrylic sheet (28 mm 11 cm 2mm) is suspended horizontally above the magnetic rail by fixing bar magnets (South Pole bottom side) below this sheet. Above this fix two propellers of toy plane with driving motors of 6 volt DC, one on each end. At the centre of this floating platform there is an electronic circuit (receiver of remote controlled toy car) with chargeable cell for remote controlling. A plastic toy train body is attached at the bottom of platform by 4 small acrylic pieces. A rubber roller (pinch roller of tape recorder) is glued to each corner of this platform to reduce any friction when running. To change the direction of the train a two way switch is provided on train body.

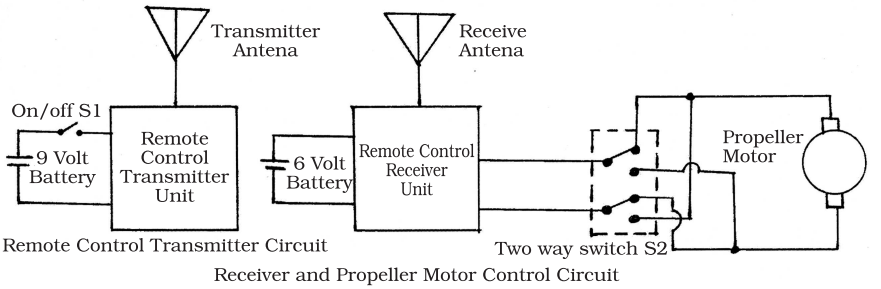

Fig. 8.2: Train Propulsion Control Circuit

When the switch S1 of the remote control is pressed, the transmitter emits a signal in a particular frequency. This signal is picked up by the receiver circuit on the train. This causes switching on of 6 Volt DC to the propeller motors. The propellers rotate and push air backwards with some force. According to Newton's third law of motion, "Every action has an equal and opposite reaction", a thrust is induced in the propellers. This thrust propels the train forward. To reverse the train, put the two-way switch S2 in reverse position. Now the polarity of DC voltage to the propeller motors is reversed. They rotate in reverse direction and train moves in backward direction. The acrylic guards prevent sideways movement of the train and also protect the outer environment from propulsion air.

Door Opening and Closing System

A hylam sheet of 2 feet long and 10 inches height is fitted on a wooden base. An opening of 16 cm 12 cm is made on this as

door opening of the train compartment. On each side of the opening, one DVD loader mechanisms is screwed as doors. Each mechanism has a 5 volt DC motor and rack and pinion arrangement for opening and closing of the doors. One two-way switch S3 is provided for changing the polarity of DC supply to the motor for clock wise and anti-clock-wise rotation. Two limit switches (micro leaf switches) L1 and L2 are also provided to stop the motor when the doors are fully opened or fully closed on each mechanism. The circuit of this is shown in Fig. 8.3.

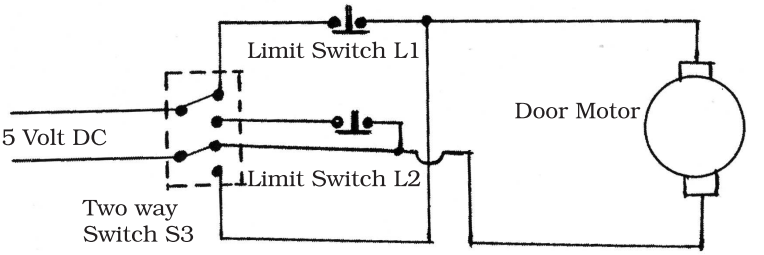

Fig. 8.3: Door Opening/Closing Circuit

To open the door, engine driver put the two-way switch S3 in open position. Now the DC voltage from the battery turns the motors of the DVD mechanisms in clock-wise direction which causes opening of the doors. When the doors are fully opened its end touches a limit switch L1 and the supply to the motor become Off. To close the door, put the switch in close position. Now the polarities of DC supply to the motors are changed and the motors turn in anti clock-wise direction and the gates are closed. After the gates are fully closed the end of the gate touches the limit switch L2 which stops the motors.

Coming Station Display System

This is based on a micro controller PIC 16F 877A. The block diagram of this circuit is shown in the Fig. 8.4. The circuit board is fitted on above the doors of the compartment. The display can be seen through an opening above the door. This can be fitted anywhere in the train.

After every stop, the door is closed for resuming the journey. When door is fully closed, limit switch L2 is activated. This sends

a signal to the micro controller. Micro controller process this signal and gives an output to the LCD to display the name of the coming station. A push button switch is also provided to change the display manually.

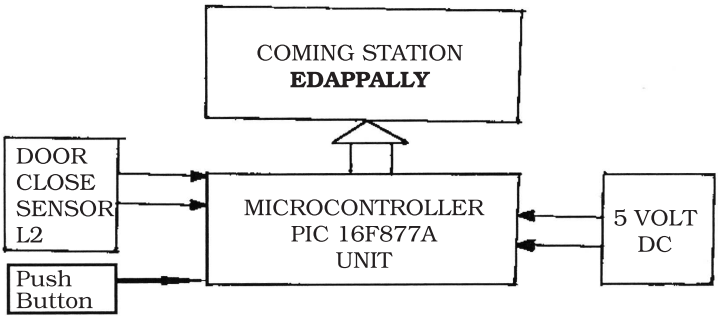

Fig. 8.4: Block Diagramme of Coming Station Display

Application and Advantages

This system can be used in city or suburban to meet the daily travel needs of employees and workers due to the following reasons:

(i) As the train floats on magnetism, there is no physical contact between track and train, so energy required for running the train is very less compared to conventional railway.

(ii) By using permanent magnet for levitation, energy required for electromagnetic levitation can be saved as compared to maglev trains.

(iii) In maglev trains levitation is attained only at very high speed. But in metro rails, stops are generally within every km and to attain this levitation speed is not possible within this short distance. But the new model can run at any speed.

(iv) Sophisticated levitation and traction coils embedded track construction can be avoided.

(v) Huge capital investment can be saved.

(vi) It can be constructed over the existing road. So land acquisition and related issues are avoided.

(vii) Quite simple mechanism and easy to operate as compared to bullet trains.

Conculusion

Our new model saves and conserve energy and money in construction, running and maintenance of metro rails in the cities and suburban areas.

9

SAFE SKY SCRAPER

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INTRODUCTION

No more fear for earthquake. No storm, no lightning, no flood can affect your building. Not a dream, not an illusion, but it is simply a reality. Scientifically proven theories back this innovative multicomplex structure. It can provide safe buildings. No lightning can destroy them. These can resist earthquakes, lightning, storm and flood.

This exhibit proposes to use base isolation technique for the purpose. To rectify the problem of small angular displacements that may be caused to the building during the earthquake, a shear core is constructed through the exact centre of the building. To address the problem of lightning arrest, a lightning conductor through inside the shear core is placed. Building's resistance to wind and storm is improved by providing a special unique shape and also by making the building to be porous externally as shown in Fig. 9.1 and Fig. 9. 2. Now if the building is being built on sea-shore areas there may be the threat of tidal waves and tsunamis. To overcome this problem a hydraulic lift may be used.

Fig. 9.1: The Building

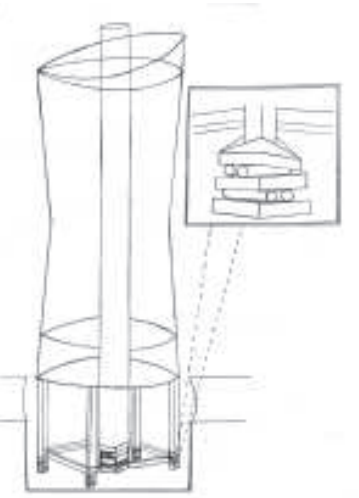

Fig. 9.2: Sectional View of the Building

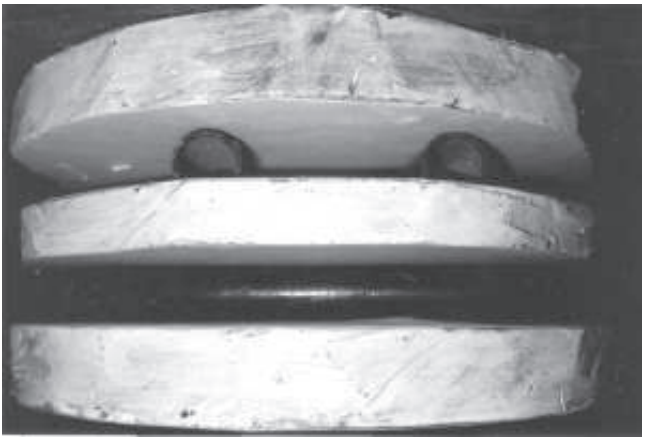

Fig. 9.3: Base Isolaters

Scientific Principles Involved

First of all we shall mention about the principle behind the base isolation for resistance against earthquakes. The concept of base isolation is that the building is resting on frictionless rollers as shown in Fig. 9.3. In this, two pairs of rollers are arranged perpendicularly between three concrete slabs. Even though the building exerts a greater pressure on the ground, the seismic

waves are much powerful and has the potential to collapse the building. So when the ground shakes, the rollers freely roll, but the building above does not move. Thus, no force is transferred to the building due to the shaking of the ground. But there is a chance for the building to get a small angular displacement. So, to correct this, a shear core is used.

The next thing to be mentioned is that of the porous external structure (Fig. 9.1). In whichever direction the wind (Hurricane/ Storm) come, it enters through the pores in a particular direction and comes out through the corresponding pores on the other side of the building. And also due to the special unique shape of this building (as shown in Fig. 9.1), the wind diverges into two directions such that their strength is reduced. Thus the building is protected from stormy winds.

Now to protect the building from lightning, a lightning arrester (or a conductor) is used. Here lightning conductor is a thick rod which runs through inside the shear core. When a charged thundercloud, say a positively charged cloud, flows over the lightning arrester, by induction negative charges are induced on the sharp spikes fitted to the upper end of the lightning arrester. Since the lightning arrester is earthed the positive induced charges at the farther end flow to the earth. Due to the action of points, the negative charges carried by the air near the points flow upwards. When the negatively charged air comes in contact with the cloud, the cloud is neutralised. Thus lightning is prevented from affecting the building.

Now if the building is in a sea-shore area, there is a threat of tidal waves and tsunamis. So to prevent this problem a hydraulic lift may be used. In this hydraulic lift, the principle used is that, whenever external pressure is applied on any part of a fluid contained in a vessel, it is transmitted undiminished and equally in all directions. Here we could make a huge slab around the building so as to take up the maximum amount of force from the tidal waves or tsunamis. Thus the force is imparted to the hydraulic fluid and it lifts the building by about five to seven metres above the original level. Thus the building is protected from tidal waves.

Various materials are used for the construction of this building. As a frame the building is supported with vertical,

horizontal and diagonal supports throughout (as seen in Fig. 2). The main frame is an exterior diagonal tube which is suitable for building upto 100 storeys. The main structure of the building is made of steel bars as used in most skyscrapers. The building is supported at the base by four equatoral legs and a larger leg at the centre. Beneath each leg there is an isolator. Each isolator consits of three very thick (aproximately four feet) concrete slabs and in between each of the two concrete slabs there is a pair of rollers. Thus in an isolator there are two pairs of rollers and they are placed perpendicular to each other between the three concrete slabs.

The rollers that are placed betwen the concrete slabs are lead-rubber bearings. The lead rubber bearing is made from layers of rubber sandwiched together with layers of steel. In the middle of the solid lead "Plug", on top and bottom, the bearings are fitted with steel plates which are used to attach the bearing to the building and foundation. The bearing is very stiff and strong in the vertical direction, but flexible in the horizontal direction so that it can withstand the whole weight of the building. The shear core that is used to rectify the small angular displacements of the building is actually made out of concrete mixed with some suitable substance that provide the building with maximum shear strain. There is a wider but small hole through the middle of the of the shear core which accommodates the long rod for the lightning arrester.

To meet the energy needs, there are solar panels attached to the external walls of the building.

10

Make your own Star Finder

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Diu

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Introduction

This 'Star Finder' demonstrates the working of a device to locate a star or planet simply by turning two dials and then looking through a specially designed sight.

Scientific Principle Involved

The working principle of the Star Finder is simple. It is based on the fact that the positions of stars and constellations in the night sky at any particular hour on any specific date is always the same regardless of the year. For example, if you find any bright star overhead at 9 P.M. on 15th November this year, it will be more-or-less so every year at 9 P.M. on 15th November.

Next to recall is the slow but steady westward 'movement' of the constellations, night after night. Every night the stars and constellations rise in the east four minutes earlier than on the previous night. This means that they gain two hours in a month. Over a year, the gain is a full 24 hours so that the constellation pattern on any night becomes the same at the end of the year.

The third point to remember here is that in an hour the constellation pattern moves westward by 15".

Materials Used

This device can be easily constructed using bits and pieces of plywood, cardboard, woodblocks, a small piece of wooden dowel and a magnetic compass.

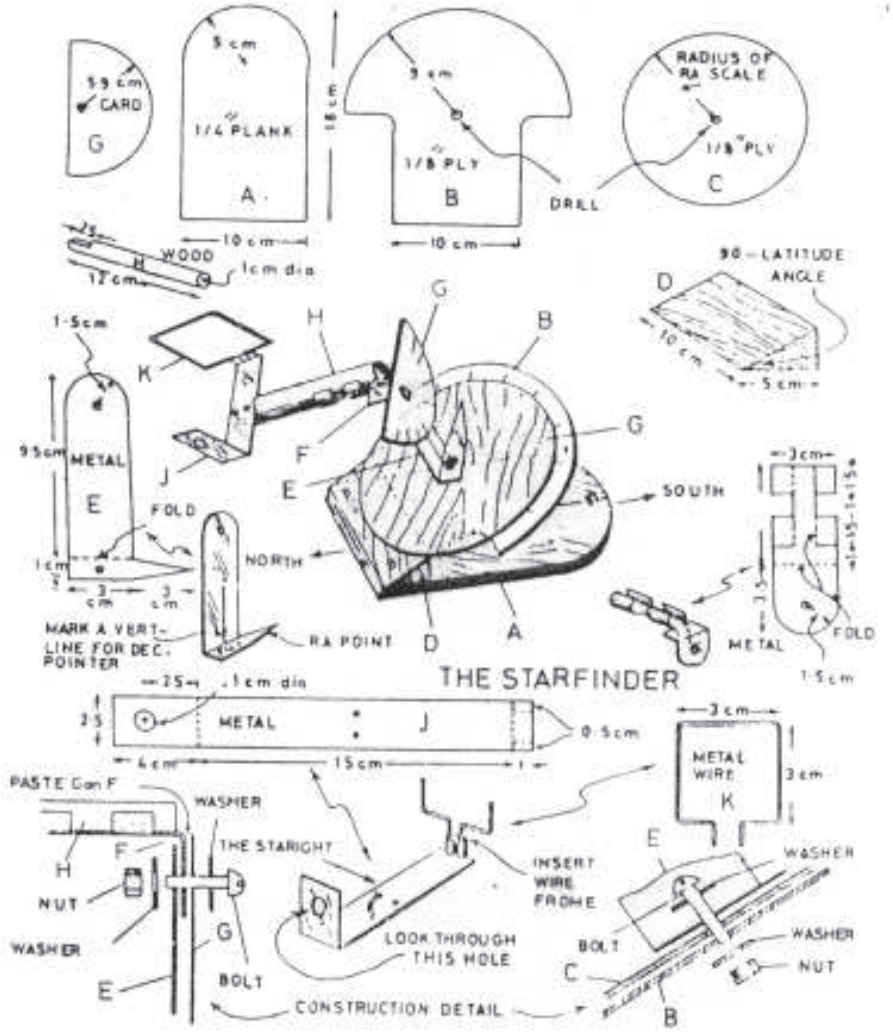

Fig. 10.1: Star Finder

Construction

Essentially, the Star Finder consists of two dials – one of which we may call the Right Ascension Dial (Fig. 10.1) and the other is called Declination Dial. Along the outer rim of the RA Dial dates are marked along with month of the year. Next to the month scale is another circle which shows right ascension values from 0h 0m to 23h 50m. Each hour division is further subdivided into 10-minutes segments. The important point to note here is that the 0h 0m mark of the RA scale falls just bellow the date September 23 marked on the outermost scale.

The RA dial is fixed on a board which has a semi-circular scale marking the 'local time' from 6 P.M. to 6 A.M. Mounted at the centre of the RA dial is an upright bracket which holds the Declination Dial at the Star Sight. The Declination Dial is a simple semi-circular scale marked in degrees as shown in Fig. 1 when the Declination Dial is at 0 degree the star sight point exactly to the celestial equator.

The assembly of the Star Finder is shown in detail in Fig. 10.1 The RA dial is fixed to a base board held at an angle with the horizontal equal to 90 minus, the latitude of the place of use (Table 10.1). On the base board is marked a line which is aligned with the north-south direction before using the instrument. The star sight is fitted at the end of long tube or wooden dowel to clear the base of the instrument. This is necessary for viewing stars near the zenith.

Table 10.1: Correction Factor for Selected Towns

Town	*Latitude (Degrees North)*	*Longitude (Degrees East)*	*Correction Factor (Minutes)*
Ahmedabad	23.0	72.5	- 40
Bangalore	12.5	77.5	- 20
Kolkata	22.5	88.0	+ 22
Delhi	28.5	77.0	- 22

Table 10.2: Coordinates of Prominent Stars

Star	*Constellation*	*Magnitude*	*RA*	*Declination*
Achernar	Eridanus	0.60	1h 40m	57.0^0 S
Bellatrix	Orion	1.70	5h 20m	6.0 N
Castor	Gemini	1.99	7h 30m	31.5 N
Deneb	Cygnus	1.33	20h 40m	45.0 N

Table 10.3: Coordinates of Some Star Clusters and Nebulas

Star	*Magnitude*	*RA*	*Declination*
Andromeda Galaxy (M31)	4.8	0h 40m	40 N
Hyades cluster	0.6	4h 20m	15.5 N
Orion Nebula (M42)	3.8	5h 30m	6.0 S
Ploiades cluster (M45)	1.3	3h 40m	24.0 N

Table 10.4. Mean coordinates of constellations

Constellation	*RA*	*Declination*
Aries	3h	20 N
Cancer	9h	20 N
Gemini	7h	20 N
Leo	11h	15 N

Working

The first step in using the Star Finder is to align the instrument with the North-South direction. For this a magnetic compass will be required. The next thing is to set the latitude angle correctly (Latitude of Diu is nearly 21.42 degree N).

Once the Star Finder is set in North-South direction and set the latitude angle correctly, one can go ahead with finding any star. The working of the Star Finder is based on location.

Next the date can be set on the outer scale of RA dial against the local time (as calculated from the IST) marked on the semi-circular scale. Now the inner scale of RA dial will show the right ascension of stars and constellations in the sky in their correct orientations for that particular time and date. To locate any particular star or constellation one can find out its RA and Declination value from Table-10.2, now the two pointers are to be set accordingly against the RA and Declination dials. You will see the required star or constellation if you now look through the star sight. On locating through the Star Sight, the required star or constellation can now be seen. RA and Declination values for the prominent constellation are given in Table 10.3 and 10.4.

Applications

(i) This simple and low cost project can be utilised in the classroom to give the practical knowledge to students in getting a clear concept about the sight of star and constellation.

(ii) To know the position of the star and constellation in the sky.

(iii) This instrument is very useful in space science study.

11

Wealth from Waste

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Introduction

Plastics are polymers mostly containing carbon and hydrogen. Polymers are made up of small molecules called monomers. They are light in weight, easily moulded, have very good strength and toughness, chemically inert, and have thermal and electric insulating properties, very good water resistor, strong and cheap to produce. Because of these advantages, plastic is everywhere in today's lifestyle. It is used in packing, for protection, serving, communication, infotech, building construction, etc. We are not in a position to avoid its usage.

However, plastics are hazardous to our health and the environment. Over 10,000 metric tonnes of plastic wastes are generated daily in our country, of which only 40% is recycled and the rests cause various kinds of environmental and health hazards. We are aware that improper usage of plastic leads to health problems such as breast cancer, reproductive problems in humans and animals, genital abnormalities and even a decline in human sperm count and quality. But if a ban is put on the use of

plastic the cost would be much higher and inconveniences rise. So, environmental burden is concerned with the judicious use and reuse of plastics.

Energy in the form of fuel is also a problem to the world. The issues of plastic waste disposal and energy crisis can be solved by using plastic waste for the following: (i) construction of walls of houses with PET (Polyethylene terephthalate) bottles, (ii) producing crude oil and energy from garbage, and (iii) laying roads. By keeping our environment clean "Let us live a long and healthy life".

Rationale Behind the Construction of the Exhibit

This project is an attempt to solve the problems arising due to waste plastic and shortage of energy. In the present model the waste plastic is used for laying roads, constructing walls and extracting fuel by depolymerising plastic waste without polluting environment. The bi-product in the process of extracting fuel is LPG.

Scientific Principle Involved

Depolymerisation is a process of conversion of the polymers into monomers.

Materials Required

Used plastic bottles, PVC Pipes, Coloured paper, Fevicol, Thermocol, PET bottles and Charts.

Construction and Working

Roads from Plastic Waste

Waste plastic is ground and made into powder. Then 3 to 4% of plastic is mixed with bitumen. The mixture is blended at 45.5 C. The mixture is then laid on the land surface like the normal road.

Plastic Walls

Waste PET bottles are filled with mud and sand. One or two layers of these PET bottles and one layer bricks are used in constructing walls.

Plastic Fuel

Depolymerised product of waste plastic is plastic fuel. Plastic is made from crude oil. If we break down waste plastic using the right catalyst we get liquid hydrocarbons. Fractional distillation of these liquid hydrocarbons gives the plastic fuel. Every kind of plastic is raw material for the production of plastic waste. 600 mL to 700 mL of petrol and 850 mL of diesel or 450 mL of perfumes are produced from 1 kg waste plastic. LPG is the bi-product.

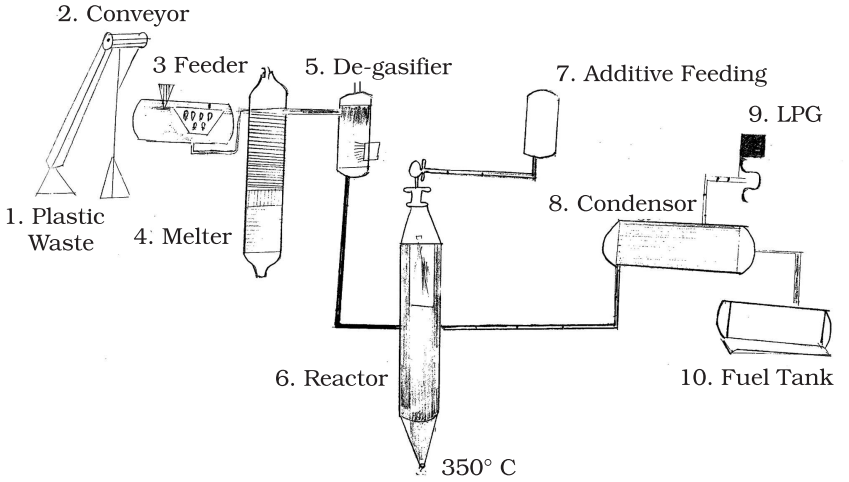


Fig. 11.1: Process Flow

Garbage into Oil

Garbage from factories, houses, hospitals, etc., is collected. Water and garbage are dumped into a grinder and pulverized into a slurry. The slurry is then heated to 260 C and subjected to 275 kg of pressure. In the first reactor the heated and pressurised mixture is depolymerised and the mixture is sent to flash tank. The pressure is released in the flash tank. The resulting steam is recaptured to power the system. Minerals sinks to the bottom and flow into a separate tank. Organic materials move to the second reactor. In the second reactor, 500 C temperature breakdown the organic materials and then moves into a drum. The hot fluid moves into a distillation tank where it cools and condenses. Organic materials and water gets separated. The water sinks to the bottom. The crude oil moves into the storage tank.

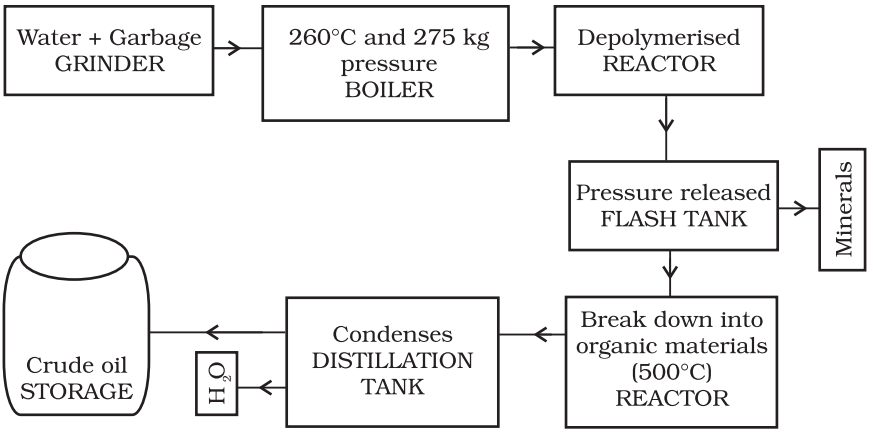
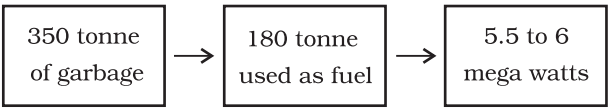


Fig. 11.2: Energy Plant

Power from Garbage

Garbage collected by municipalities is sent to the plant. Cloth, glass pieces and stones are separated by hand from the garbage collected. It is sent to the first roller (35 mm to 40 mm holes) to filter the sand. The garbage from the roller is cut into pieces in the crusher. For further filtration the garbage is sent through the second roller (5 mm to 10 mm). The filtered garbage is again sent through another crusher. Fluff from the crusher is mixed with husk (70% fluff + 30% husk). This is then sent to the boiler where the water pipes are attached. Steam produced from pipes turns the turbines and electricity is produced (11 KV). Through step-up transformer 33 KV is produced which is sent to the electricity board.



Bi-products

(i) Discarded portions from the two rollers are used for land filling and used by the farmers also.

(ii) Bricks are made from the ash generated from the boiler.

Applications

It is used in construction of roads, construction of buildings, production of energy, oil and LPG.

Advantages

(i) Plastic-bitumen roads are strong, durable (can last upto 10 years) and eco-friendly. Relieves the earth from all types of plastic wastes. Though construction cost increases up to 6%, the longevity of roads also increases.

(ii) Construction of plastic walls reduces the cost of construction of buildings and relieves the earth from plastic bottles.

(iii) Garbage oil plant is self-sustaining and produces crude oil. The by-product, water, is used for running the plant. There is no emission that causes pollution.

(iv) Production of plastic fuel is one of the solutions for energy crisis. Its by-product is LPG, which is very useful. It shrinks the disposal problem and dangerous effects of waste plastics and reduces plastic waste on earth. The fuel is used for running generators, replacement for naphtha in power generation, to power automobiles but without pollution.

(v) It increases job opportunities.

12

A Unique Air Filtration System

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Introduction

Our environment is gradually becoming polluted by CO_2, SO_2 etc., gases from different sources. Being aware of that, serious effective step should be taken to prevent these gases from being released or to reduce their amount for a healthy environment. Automobile industries or other industries will continue to flourish but we have to take an innovative measure to reduce pollution of our environment.

Scientific Principle Involved

Pollutant gases are converted into salt.

Materials Required

Pollutant gases such as CO_2, SO_2, etc., from industry, factory or automobiles.

Construction and Working

Pass the pollutant gases through calcium hydroxide solution. These gases will react and some of the CO_2 and SO_2 will be precipitated as $CaCO_3$ or $Ca(SO_4)_3$ [calcium carbonate or calcium

sulphate]. That is, amount of gases reduce. If this process is repeated again and again percentage of CO_2 and SO_2 will reduce further more. If this CO_2 passes through Na_2CO_3 solution it will convert into sodium hydrogen carbonate ($NaHCO_3$) salt.

Later we can pass this gas through NaOH solution. Then CO_2 will react with NaOH and become precipitate as Na_2CO_3 which will convert into ($NaHCO_3$). In the same way SO_2 will precipitate as sodium sulphate or bisulphate.

In this way two pollutant gases will be converted into salt and give rise to comparatively better air (i.e., reduced amount of CO_2 and SO_2).

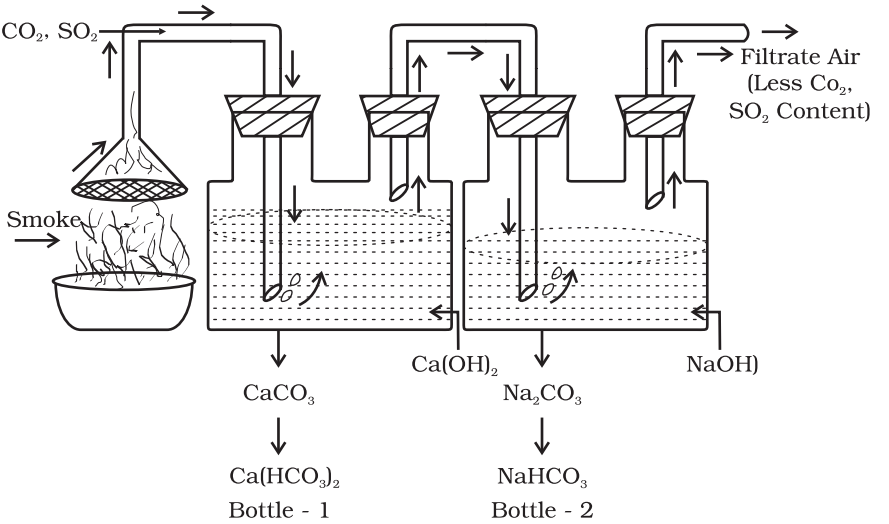

Fig. 12.1: Air Filtration System

Reactions

Bottle 1

(i) $Ca(OH)_2 + CO_2 \rightarrow CaCO_3 + H_2O$

(ii) $CaCO_3 + H_2O \rightarrow Ca(HCO_3)_2$

Bottle 2

(i) $2\ NaOH + CO_2 \rightarrow Na_2CO_3 + H_2O$

$\downarrow$

Used for washing clothes and utensil, vessels, etc.

(ii) $Na_2CO_3 + H_2O + CO_2 \rightarrow 2\ Na(HCO_3)$

$\downarrow$

Used as baking powder

ADVANTAGES

(i) The model not only reflects the air purification but also it exhibits that the by-product like Na_2CO_3 (sodium carbonate) is a useful compound which can be used for washing clothes or washing kitchen utensils.

(ii) When CO_2 gas is passed through Na_2CO_3 solution CO_2 will precipitate as sodium hydrogen carbonate ($NaHCO_3$). This compound is also used as baking powder.

(iii) When a net is used in the mouth of the chimney i.e., collecting tube, a huge amount of smoke dust carbon is collected which can be used in the production of ink, shoe polish, etc.

13

Vehicular Exhaust Filter

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Introduction

We know that many vehicles are increasing air pollution which increases global warming or the temperature of the earth. Many steps have been taken to reduce the emission level of gases coming out from the vehicle exhaust. We can see in heavy traffic areas the level of air pollution is very high. We feel uncomfortable and even feel itching in our eyes in such areas. Increasing air pollution is a danger sign for all living organisms on earth. Exhaust gases coming out from all types of automobiles contains mainly carbon mono oxide, carbon dioxide, nitrogen dioxide, hydrocarbons, sulphur dioxide and other harmful gases. These gases are very harmful for our environment and ecological system. This project is an attempt to solve the problem of high pollution level in cities due to automobiles in heavy traffic areas. This project helps us to reduce the air pollution caused by the vehicles.

Scientific Principles Involved

In the cooling chamber two aluminium plates which have charge on them attract dust particles. The exhaust gases pushed by the exhaust fan on the nets made of synthetic fibers and solution of

sodium hydroxide (NaOH) is sprayed by the sprayer. NaOH reacts with the harmful exhaust gases and neutralizes them. This way, the level of polluted air is very low.

Materials Required

Bottles of two litre capacity, T-shape water pipe joint, two exhaust fans, aluminium foil, NaOH solution, sprayer, battery, etc.

Construction and Working

In this project the exhaust gases are collected in the cooling chamber (the shape of the cooling chamber is like a frustum) where due to the expansion of gases their temperature becomes low. In the cooling chamber there are two aluminium plates which create charge on them and attract the acidic/basic dust or harmful particles and then an exhaust fan sucks the gases and pushes the gases in NaOH treatment chamber. We can identify it in Fig. 13.1(a) where the NaOH reacts with harmful gases and make them neutral. There is a machine called sprayer placed near the exhaust fan which sprays NaOH on the nets of synthetic fibers after every 2 km distance period when the vehicle is running.

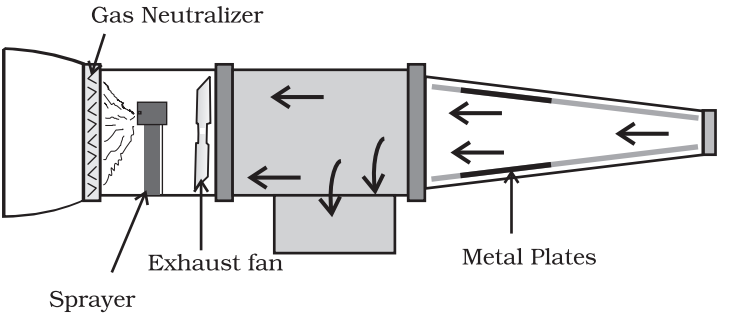

Fig. 13.1(a): Vehicular Exhaust Filter

In the vertical chamber the remaining dust particles are separated by exhaust fan which pushes the gases on a filter so the heavy solid harmful particles settle down. Then the remaining gases are again treated with NaOH. We can identify it in Fig. 13.1(b). Finally, cool and fresh air with very low air pollution comes out and spread out in the environment.

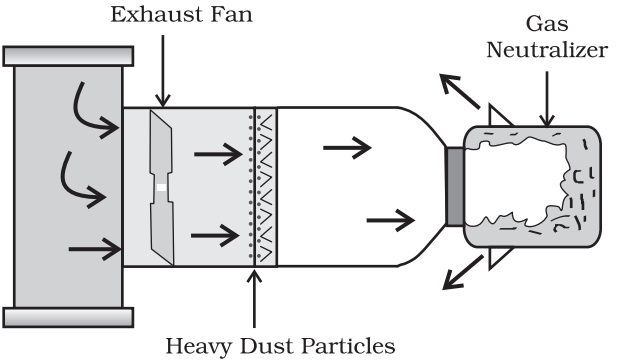

Fig. 13.2(b): Vehicular Exhaust Filter

Removal of harmful particles/chemicals: Take out the nets of synthetic fibers and wash them in NaOH solution to remove solid sediments and harmful chemicals periodically.

Result

It ensures lowering of the pollution level in air due to automobiles. So we can save our earth from pollution.

14

Fuel-less Multifunctional Home Machine

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Introduction

This machine is designed for the purpose of saving fuels. Petroleum products like diesel, petrol, kerosene, coal and other gases will be exhausted soon and people will face a major energy crisis. To solve such a crisis, the fuel-less multifunctional home machine will help a part. It performs more work with less energy within a short period of time. One additional benefit of this machine is the water purifier box using sunlight. When the impure water from river, sea, pond, etc., contained in the box is exposed to sunlight, it evaporates and the vapour so obtained is collected drop-wise to the outside container of the box. It is the purest water which we need every day. This machine also has a knife sharpener and hence it may be named as 6-in-1 machine.

Scientific Principles Involved

When a muscular energy is used to rotate a fuel-less multifunctional machine, it leads to generation of electricity, rotation of a table fan, rotation of spinning wheel with jenny, up-down movement of pounders at the same time.

Evaporation of impure water by solar energy produces pure water.

Materials Required

Wood, chain, DC generator, table fan, bulb, spinning wheel, mortar with pounders, etc.

Construction and Working

It consists of a pedal connecting to a main axis with a chain, a D.C. armature to generate D.C. electricity, a table fan to produce cold wind, a pair of mortar with pounders, a spinning wheel with a jenny and a solar water purifier machine.

When the main axis of the fuel-less multifunctional machine is rotated (moved) using muscular energy, it performs different works viz., generation of electricity, rotation of a table fan, rotation of spinning wheel with jenny, up-down movement of pounders at the same time. A separate part to obtain pure water by evaporation method using solar energy is also attached to this machine. Even when this machine is not in use, pure water is produced automatically from the water purifier by evaporating the impure water such as river, sea, pond, etc., at room temperature or during sunshine. The vapour so produced is condensed at the inner roof of evaporation box and collected to another container outside the box.

Applications

This fuel-less multifunctional home machine can be used in many purposes such as generation of electricity, production of purest drinking water, rotation of a table fan for the production of cold wind during summer, crushing of grains in the mortar, spinning and as sharpener, etc.

Advantages

(i) It saves non-renewable fuels as it uses not a single drop of oil when it works.

(ii) It gives high efficiency with less effort.

(iii) It does not pollute and is eco-friendly.

(iv) It gives purest drinking water for health.
(v) It performs more work with less time.
(vi) A person can perform six works at the same time.

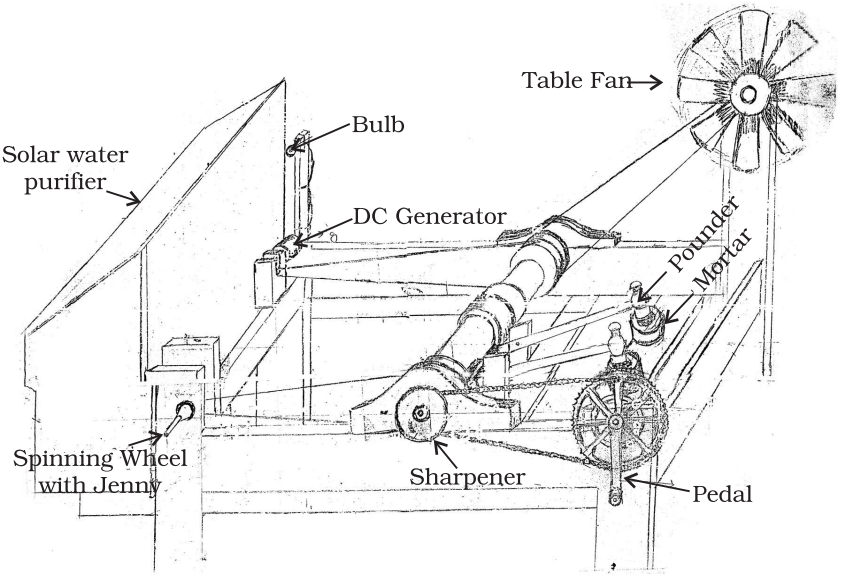

Fig. 14.1: Fuel-less Multi-Functional Home Machine

Future Prospect

It may replace most of the machine which use petroleum products in future.

15

Modern Solar Sprayer

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Introduction

As of today, fossil fuel is the main source of energy. Massive population and industrialisation consume huge amount of fossil fuel everyday which reduces the total quantity of fossil fuel and within few years, all coal will be exhausted from the earth if the trend continues. So now we give emphasis on the use of solar energy as an alternate source of energy. Sun is the source of solar energy. The earth receives nearly 4000 KW of energy from the Sun on a daily basis which is approximately 100 times the total energy consumption of the world per year. As most parts of India get good amount of sunshine throughout the year, solar energy will be a good source of energy. As the solar energy will be the main source of energy in future so it is essential to know the process by which we can convert solar energy to other forms of energy as per our requirement. Here we discuss about the process "Solar Photovoltaic Technology (SPV)". An eco-friendly and economic alternative source of energy is the need of the hour.

'Agriculture' is the backbone of our nation. Our economical status will be increased by increasing agricultural products. So we need to encourage the farmers. Emphasis must be given to meet the needs of the farmer by manufacturing new hi-tech

agricultural equipments run by solar energy. Hi-tech modern solar sprayer is now the only friend of farmers.

Scientific Principles Involved

Solar Photo Voltaic Technology (SPV): The principle of SPV is that when sunlight falls on solar cell electric voltage and current is generated. The solar energy is converted to electrical energy and to convert the energy from the energy collected in charging cell, electric energy is converted into mechanical energy, sound energy and light energy. A single solar cell generate 1 watt of power and even more depending on its conversion efficiency. Power thus generated is fed to the battery and can be drawn when actually needed. The solar cell works best at ambient temperature of around 25 C. Higher temperature reduces its power producing capacity.

Materials Required

Solar plate (12.0 Volt D.C., 10 watt 2.25 Ampere), cell (12 Volt D.C.), electric pump, 15 litre plastic tank, stainless steel light weight fine frame, belt, fiber, glass, fan, FM Radio kit, small speakers, wire, inverter, circuit, transformer, rubber pipe, switch board, plastic box, control switch, paddle pump, compressor, etc.

Construction and Working

First of all, make light weight stainless steel frame with "I" shape. The solar plate is fitted at the top. Then a plastic tank with a capacity of 15 litre is fitted at the bottom of the frame. A motor working with 12 Volt is tightly fitted at the bottom of the tank. The rubber pipe is fitted at the pump through which the liquid comes out of the pump. A nozzle with small hole pipe is fitted with the liquid coming out by that pump. A nozzle with small hole pipe is fitted at the outside of the frame. Electric current coming from the solar energy (solar plate) is fitted with battery with positive pole and negative pole. FM kit, radio, switch, plug, board, transformer and inverter are joined at the side. Two small speakers are joined at both sides. The connection of the battery is joined with the motor pump by the control switch. Now the electric

current meets the motor pump by switching on the control switch and this motor pump forces sprays the liquid from the tank going through the nozzle from the rubber pipe.

For the taller trees which are more than 3 metre upto 10 metre insecticides or hormones can be sprayed manually or by electricity. Besides this can be it used to spray colours in vehicles. It can also be used to spray two or three-storeys building.

A :Stand
B :Compressor
C :Tank 1
D :Filtering Funnel
E :Stop
G :Sprayer 1
H :Solar Plate
I :Belt
J :Sprayer 2
L :Battery,
M :FM Radio
N :Tank 2
O :Paddle pump

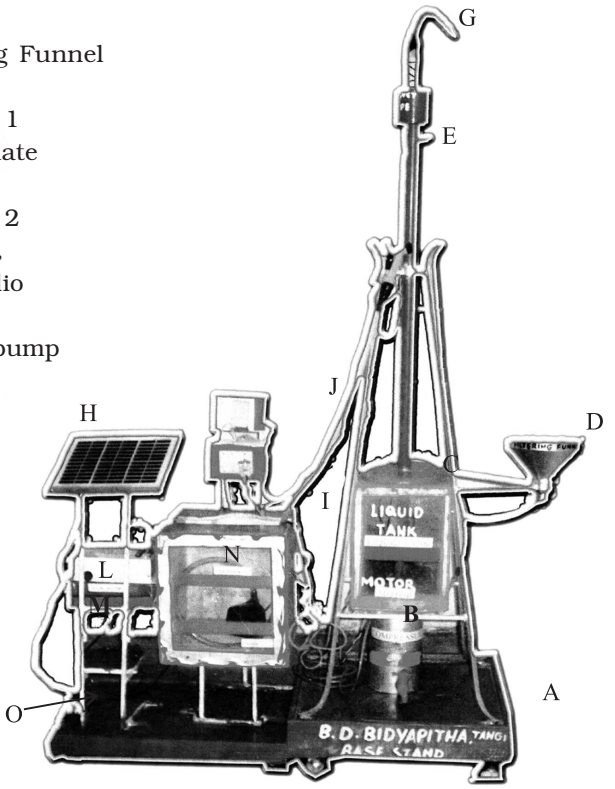

Fig. 15.1: Modern Solar Sprayer

APPLICATIONS

(i) Spraying of pesticides, insecticides, hormones, manures in the agricultural crops and in the tallest tree up to 10 metre.

(ii) Spraying of limited water in the vegetable.

(iii) Charging battery while going to the farm at night.
(iv) Emergency light at home during night.
(v) By using special types of horns or alarms, it is easy to stop the damage of the crops by the animals and birds.
(vi) Spraying colours to vehicles and building safely.
(vii) Pressure check up vehicles can be done.

Advantages

Man and petrol energy is saved because it is conducted with the solar energy.

Conclusion

It is concluded that emphasis must be given on the use of solar energy in future. It is high time to think seriously about eco-friendly, economically valuable and sustainable energy sources such as "Solar Energy".

16

Solar Air Conditioner

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Introduction

Now-a-days the scorching Sun rays are affecting so much that without an AC life is very difficult in many parts of the country. Affording an AC in rural area is a big deal for the farmers and so fighting with the heat is just a challenge for them.

To fulfill the demand of rural people and help them cope with hot climate we are preparing a low-cost AC, i.e., Solar Air Conditioner.

Rationale Behind Construction of the Exhibit

Sky is the limit for today's generation and lifestyles in terms of requirements. The day-to-day demands of the people are disastrous to our ozone layer. The continuous use of perfumes, AC, refrigerators are releasing CFCs (chlorofluorocarbons) in high rate which contributes to ozone hole. Through the ozone hole, the harmful sun rays are striking on human which cause a variety of diseases like skin diseases, skin cancer, etc. This project is an attempt to solve those problems. Additional benefit of solar AC is that it is affordable by all, mainly by the rural people. In this

present model the air is circulated through chambers to cool/warm them. This air is then used in houses in winter/summer season. With some simple principles, the air is cooled and also heated.

Scientific Principles Involved

Cooling chamber to cool the house during summer season and heating chamber to make the house hot during winter season are based on the basic principle of cooling and heating of air.

Materials Required

Cooling chamber, heating chamber, metallic pipes, thermocol, air tight house and metallic boxes.

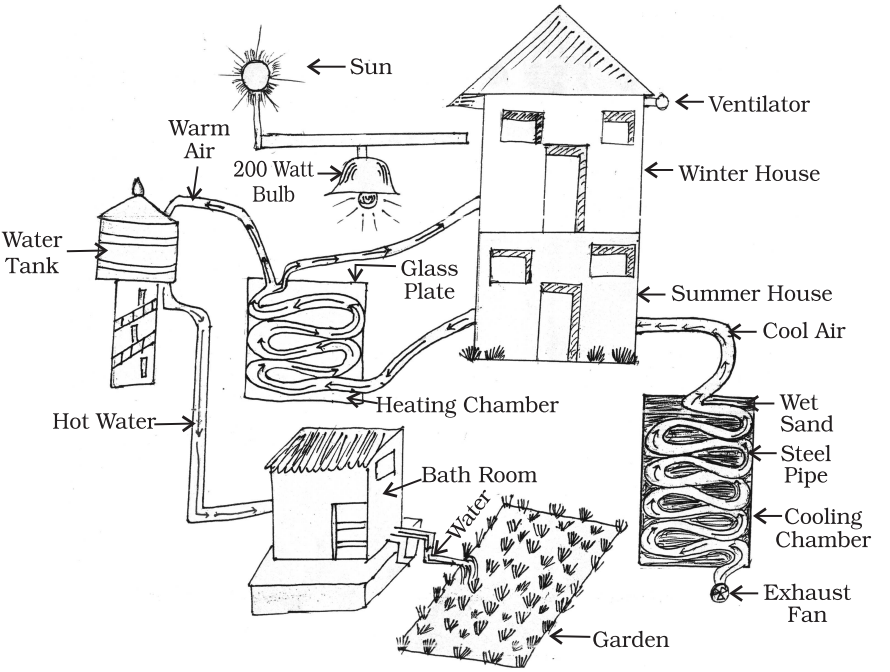

Fig. 16.1: Solar Air Conditioner

Construction and Working

(i) *Cooling Chamber*: It is made up of metallic box in which metallic pipes are connected and some wet sand has been put to make the air cool.

(ii) *Heating Chamber*: It is made up of a metallic box in which the upper part is covered with a glass. So when the Sun rays fall on the glass the air becomes hot.

(iii) *Air Tight House*: Two air tight houses are made up of thermocol – the lower house is used during summer season and the upper house is used during winter season. There is a small ventilator in the summer house (upper house).

The outside air from the surrounding enters through the metallic pipe into the cooling chamber and through the wet sand and coiled metallic pipe in the chamber the air becomes cooled. Then the air goes to the lower house through pipe. This house can be used during summer season. Then the air goes to the heating chamber and with the help of sunrays (as we cannot use the Sun directly, so, 200 Watt bulb will replace the use of the sun) the air becomes hot and then the air goes to the upper house which can be used in the winter season.

Since, it is a multipurpose project, a small pipe is connected from the heating chamber to the water tank and then the hot water is directly used for various purposes. For example, the hot water is used for bathing purpose and also used for watering the plants in the garden.

17

Extraction of Fluorine Free Water by Using Low-Cost R.O. System

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Introduction

Air, water, food, shelter, etc., are the basic needs for the existence of living world. Out of these, water is the most essential for all living beings, in terms of drinking, cooking, bathing, washing, irrigation, sustenance of aquatic life, photosynthesis, etc. Water covers 3/4th of total area of the earth surface. It can be again classified into two types like fresh water and saline water. Human beings consume fresh water in the form of potable water. The water consumed by human being is used for different bio-chemical reaction as well as smooth conduct of metabolic process. But water, on the other hand, is treated to be the universal solvent. Most of the ionic compound, polar covalent compounds, different gases, etc., remain in it in dissolved form. One of the most pollutant element, fluorine, present in ground water causes large scale damage to the skeletal system of our body. The fluorine water causes disease like fluorosis which directly affects our teeth and bones. The loss of calcium from teeth and bone in the form of CaF_2 (Calcium fluoride) might lead to falling and decaying of teeth, bone cancer, bending and collapsing of vertebrae, abnormal mental growth, osteoporosis, etc.

The ground water of states like Rajasthan, Himachal Pradesh, Jammu & Kashmir, Haryana, Bihar, Chhattisgarh, Odisha, West Bengal, etc., are badly affected due to contamination of water by fluorine. The ground water concentration of fluorine lies between 1.5 ppm and 20 ppm, which is much higher than the normal level, i.e., 0.005 ppm. In Odisha, 854 villages in 16 districts are suffering acutely due to the presence of fluorine in ground water. The fluorine pollution is due to the contamination of ground water by industrial waste, depletion of fluoride bearing rocks, etc. The worst affected districts of Odisha are Angul, Khorda, Nayagarh, Nuapada and Puri.

Scientific Principles Involved

The scientific principles involved in this project are that of sedimentation and Reverse Osmosis (RO). Reverse Osmosis means the movement of water from high concentration to low concentration.

Materials Required

Sedimentation tank, threads, calcium oxide, RO tank, plastic pipes, plastic plate, filtration tank, bandage cloth, plaster of paris, improvised candles, etc.

Construction and Working

First Tank

(i) It is called the storage-cum-concentration (sedimentation) tank. The size of the tank is 1.5' 1' 1' which is made up of corrugated sheet (here it is made of wooden ply).

(ii) The upper part of the tank is open and the tank is completely painted black from all sides to absorb more heat from sun rays.

(iii) The bottom surface of it is little inclined and laid with copper plate. The upper part of the tank is covered with glass plate.

(iv) The tank has three outlets. Through one outlet the fluorine added water enters the tank. Through the second outlet partly separated (about 70%) fluorine water enters into the reverse osmosis container and through the third outlet calcium fluoride (CaF_2) is removed from time to time.

(v) Inside the tank some packets of calcium oxide (CaO) is suspended with the help of threads. The packets are made up of semi-permeable non-woven zipper cloth.

Second Tank

(i) This is called reverse osmosis tank and precisely known as RO tank.

(ii) This container is made of nylon. Inside it two co-axial PVC pipes have been taken with different cross-section and their height is about 8".

(iii) Both the pipes are pricked with several pores, i.e., the pipes are well perforated. Around the inner pipe the non-woven zipper cloths are wrapped several times, such that the space between both the pipes can be filled with the semi-permeable non-woven zipper cloths.

(iv) The inner space of the inner pipe is fitted with the pipe, which have been connected already with first tank.

Third Tank

(i) This is called improvised filtration tank with low-cost improvised filtering candle which is four in number.

(ii) Each candle is made up of plastic pipe with cross-section of 1/2" and a bandage cloth which is soaked in plaster of paris and activated charcoal.

(iii) Length of each pipe is about 6" and perforated about the height 4". Then the water-soaked plaster of paris treated bandage is wrapped around each pipe several times. In between a definite turn of wrapping few activated charcoal is put into it.

(iv) The prepared improvised candle is made dry and placed in their appropriate holes. At the bottom all the candles are connected together with a single outlet to obtain fluorine free zero bacteria water.

Working

(i) Firstly the fluorine contaminated water is pumped into the storage-cum-concentration (sedimentation) tank, where it should be exposed to sunlight for about 1 to 2 hours. Here the black surface of the tank absorbs maximum heat from infrared zone. As a result the temperature of the whole water

in the tank reaches upto 70 C to 80 C. At this temperature the fluorine in the water react with calcium oxide (CaO) which is suspended by thread in semi-permeable membrane packets. As a result of this reaction insoluble calcium fluoride (CaF_2) is formed. Also the high temperature accelerates and concentrates the formation of CaF_2 and deposit it at the bottom in sediment form.

(ii) 70 per cent of whole sediments can be separated from time to time from its third outlet at the base region of the first tank. But the remaining amount of CaF_2 still present in water is harmful to our body. This should be then transferred in the second RO tank.

(iii) Due to reverse osmosis the remaining CaF_2 in water is filtered properly by non-woven zipper cloths. As a result the filtered water is completely free from fluorine. In some cases very negligible amount is left which is not harmful to the body.

(iv) From the RO container the fluorine-free water is then taken into improvised filtration tank. Here the water further undergoes filtration by improvised candles and then taken collectively at the bottom by a connecting pipe. The water which is finally obtained is pure, fluorine-free and with zero bacteria. The pH value of this water will lie between 6.5 and 7.

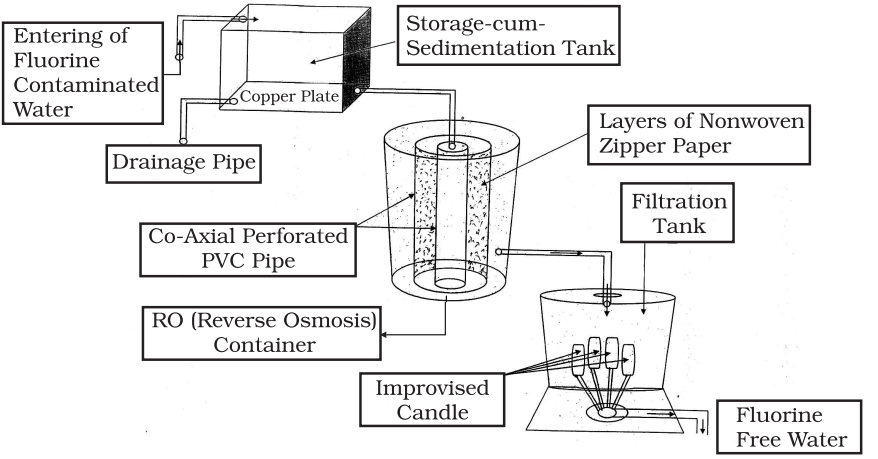

Fig. 17.1: Low-Cost R.O. System

Flow Chart for Fluorine Free Water

Water from well or underground

↓

Storage-cum-precipitation tank

↓

Action with CaO and produce CaF_2

↓

$$2CaO + 2F_2 \rightarrow 2CaF_2 \downarrow + O_2$$

↓

70% of CaF_2 is deposited at the bottom of the tank and it should be separated at intervals

↓

RO tank (container)

↓

RO made through non-woven zipper cloths to remove remaining CaF_2

↓

Filtration Tank (Self-made improvised candle)

↓

Fluorine free zero bacterial water with pH value 6.5 – 7

Advantages

In comparison to commercially available RO system, this improvised manual RO system is very cheap. The total cost of construction of this RO system for a family comprising five members is about Rs 2,000. Therefore it can be established by anyone with any income.

Applications

(i) It can be used at home, offices, educational institutions, community halls, hotels, hospitals, etc.

(ii) On large scale we can also get fluorine free water by using multiple numbers of RO systems connected to a big tank.

18

Satellite Projection

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Introduction

The model explains the basic principle of projection of a satellite with the help of rocket without polluting the environment.

Scientific Principle Involved

Newton's law of gravitation, specifically the third law has been applied for the development of this model. According to this law, every object in universe attracts every other object in the universe with a force which is directly proportional to product of the masses of two body and inversely proportional to the square of distance between them. Using this principle the satellite is projected.

Materials Required

Used plastic bottles, water, bicycle pump, etc.

Construction and Working

Sources of Gas

Several methods for launching a rocket are used including:

(i) A standard bicycle/car tire pump, capable of reaching at least 75 psi (520 kPa).

(ii) Water pressure forcing all the air in an empty water hose into the rocket. Pressure is the same as the water main.

(iii) An air compressor, like those used in workshops to power pneumatic equipment and tools. Modifying a high pressure (greater than 15 bar/1500 kPa/200 psi) compressor to work as a water rocket power source can be dangerous, as can using high-pressure gases from cylinders.

(iv) Compressed gases in bottles, like carbon dioxide (CO_2), air, and nitrogen gas (N_2). Examples include CO_2 in paintball cylinders and air in industrial and SCUBA cylinders. Care must be taken with bottled gases as the compressed gas expands, it cools (see gas laws) and rocket components cool as well. Some materials, such as PVC and ABS, can become brittle and weak when severely cooled. Long air hoses are used to maintain a safe distance, and pressure gauges (known as manometers) and safety valves are typically utilised on launcher installations to avoid over-pressurizing rockets and having them explode before they can be launched. Highly pressurised gases such as those in diving cylinders or vessels from industrial gas suppliers should only be used by trained operators, and the gas should be delivered to the rocket via a regulator device (e.g. a SCUBA first-stage). All compressed gas containers are subject to local, state and national laws in most countries and must be safety tested periodically by a certified test centre.

(v) Ignition of a mixture of explosive gases above the water in the bottle; the explosion creates the pressure to launch the rocket into the air.

Nozzles

Water rocket nozzles differ from conventional combustion rocket nozzle in that they do not have a divergent section such as in a de Laval nozzle. Because water is essentially incompressible the divergent section does not contribute to efficiency and actually can make performance worse. There are two main classes of water rocket nozzles:

(i) Open also sometimes referred to as “standard” or “full-bore” having an inside diameter of 22mm which is the standard soda bottleneck opening.

(ii) Restricted which is anything smaller than the "standard". A popular restricted nozzle has an inside diameter of 9mm and is known as a 'Garden Nozzle' named after a common garden hose quick connector used to make them.

The size of the nozzle affects the thrust produced by the rocket. Larger diameter nozzles provide faster acceleration with a shorter thrust phase, while smaller nozzles provide lower acceleration with a longer thrust phase.

It can be shown that the equation for the instantaneous thrust of a nozzle is simply:

$$F = 2PA_t$$

Where F is the thrust, P is the pressure and A_t is area of the nozzle.

Fins

Fins are extremely important on a water rocket. They ensure stability, and it is very likely that your water rocket flies higher with fins than without. Fins decrease drag, which is a huge advantage when it comes to the height that your rocket will fly. A second thing that is very important is where you position the fins. It is best if they are placed near the back of the bottle where the centre of mass is found. A water proof, stable light material to make the fins would be 'Coroplast'. This is a cardboard like material that is almost indestructible. The only negative it has that it is harder to glue, but with the right glue it is possible.

As the propellant level in the rocket goes down, it can be shown that the centre of mass initially moves downwards before finally moving upwards again as the propellant is depleted. This initial movement reduces stability and can cause water rocket to start tumbling end over end, greatly decreasing the maximum speed and thus the length of glide (time that the rocket is flying under its own momentum). To lower the centre of pressure and add stability, fins can be added which bring the centre of drag further back, well behind the centre of mass at all times, ensuring stability.

The fins on a rocket are important for stability during flight. They should be placed near the rear of the rocket.

Aerodynamic drag acts on the fins as well as on the rocket body. Fins add to the frontal surface area on which the drag force

acts (and therefore should be designed not to add too much drag). The drag forces on all frontal surfaces of the rocket can be resolved into one force acting at the centre of pressure (fluid mechanics). This acts to oppose the forward motion, but if the rocket nose is not pointed in the direction of its motion at a given time (perhaps due to wobbling or instability), then there will be a torque, due to the resolved drag force, acting around the centre of gravity. This torque will stabilize the rocket by returning its nose to the direction of travel.

Since the torque is the cross-product of the drag force magnitude and the moment arm, torque can be maximized without increasing drag force by increasing the moment arm. The larger the distance between the centre of gravity and the centre of pressure, the greater the moment arm on the restoring torque. Therefore, it is desirable to have the centre of pressure, and therefore the fins, as far as back as possible on the rocket body.

The lift force acts to push the back end of the rocket so that the nose will face the flight direction, and the drag force does the same, even though it is pointing orthogonally to the lift force.

How a Water Rocket Works?

(i) Compressed air is added which creates a bubble that floats up through the water and pressurizes the air volume in the top of the bottle.
(ii) The bottle is released from the pump.
(iii) The water is pushed out the nozzle by the compressed air.
(iv) The bottle moves away from the water because it follows Newton's Third Law.

The bottle is partly filled with water and sealed. The bottle is then pressurised with a gas, usually air compressed from a bicycle pump.

Water and gas are used in combination, with the gas providing a means to store potential energy, as it is compressible, and the water increasing the mass fraction and providing greater force when ejected form the rocket's nozzle.

The seal on the nozzle of the rocket is then released and rapid expulsion of water occurs at high speeds until the propellant has been used up and the air pressure inside the rocket drops to

atmospheric pressure. There is a net force created on the rocket in accordance with Newton's third law. The expulsion of the water thus can cause the rocket to leap a considerable distance into the air.

In addition to aerodynamic considerations, altitude and flight duration are dependent upon the volume of water, the initial pressure, the rocket nozzle's size, and the unloaded weight of the rocket.

Typically launch pressure vary from 75 to 150 psi (500 to 1000 kPa). The higher the pressure, the larger the stored energy.

Predicting Peak Height

If aerodynamic drag and transient changes in pressure are neglected, a closed-form approximation for the peak height of a rocket fired vertically can be expressed as follows:

$$h = \left(\frac{M_i}{M_R}\right)^2 \left(\frac{Pi}{P_g}\right)$$

(h = peak height reached, M_i = Initial mass of water only, M_R = Rocket mass when empty, P_i = Initial gauge pressure inside rocket, P = air density, g = acceleration due to gravity)

Assumptions for the above Equation:

(i) Water is incompressible.
(ii) Flow through the nozzle is uniform.
(iii) Velocities are rectilinear.

(iv) Density of water is much greater than density of air.
(v) No viscosity effects.
(vi) Steady flow.
(vii) Velocity of the free surface of water is very small compared to the velocity of the nozzle.
(viii) Air pressure remains constant until water runs out.
(ix) Nozzle velocity remains constant until water runs out, and
(x) There are no viscous-friction effects from the nozzle (see Moody chart).

Safety

Water rockets employ considerable amounts of energy and can be dangerous if handled improperly or in cases of faulty construction or material failure. Certain safety procedures are observed by experienced water rocket enthusiasts:

(i) When a rocket is built, it is pressure tested. This is done by filling the rocket completely with water, and then pressurizing it to at least 50 per cent higher than anticipated pressures. If the bottle ruptures, the amount of compressed air inside it (and thus the potential energy) will be very small, and the bottle will not explode.
(ii) Using metal parts on the pressurized portion of the rocket is strongly discouraged because in the event of a rupture, they can become harmful projectiles. Metal parts can also short out power lines.
(iii) While pressurising and launching the rocket, bystanders are kept at a safe distance. Typically, mechanisms for releasing the rocket at a distance (with a piece of string, for example) are used. This ensures that if the rocket veers off in an unexpected direction, it is less likely to hit the operator or bystanders.
(iv) Water rockets should only be launched in large open areas, away from structures or other people, in order to prevent damage to property and people.
(v) As water rockets are capable of breaking bones upon impact, they should never be fired at people, property, or animals.
(vi) Safety goggles or a face shield are typically used.
(vii) A typical two-litre soda bottle can generally reach the

pressure of 100 psi (690 kPa) safety, but preparations must be made for the eventuality that the bottle unexpectedly ruptures.

(viii) Glue used to put together parts of water rockets must be suitable to use on plastics, or else the glue will chemically "eat" away the bottle, which may then fail catastrophically and can harm bystanders when the rocket is launched.

Projection of Satellite

According to Newton's Law of gravitation, every object in universe attracts every other object in the universe with a force which is directly proportional to product of the masses of two body and inversely proportional to the square of distance between them. Using this principle the satellite is projected.

First the satellite is fixed at the tip of the rocket. Then the rocket is projected. When the rocket reaches a certain height, the satellite is projected horizontally with a horizontal critical velocity, so that the satellite revolves around the earth in a circular orbit.

If the horizontal velocity of the satellite is less than critical velocity then the satellite will revolve in a elliptical path, and if the satellite comes in contact with the earth's atmosphere then it will loose its energy and finally spindle down to earth's surface.

If the horizontal velocity of the satellite is equal to the critical velocity then the satellite will revolve in an elliptical path.

If the horizontal velocity of the satellite is equal to the escape velocity then the satellite will revolve in a parabolic path.

If the horizontal velocity of the satellite is greater than the escape velocity then the satellite will escape the gravitation force of the earth and will be escaped in the space.

19

अग्निसूचक-सह-अग्निशामक यंत्र

विद्यार्थी
साक्षी कुमारी

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अध्यापक
अरविन्द कुमार चौधरी

सिद्धांत

ताप वृद्धि के फलस्वरूप गैसीय आयतन में प्रसार के कारण परिपथ पूर्ण होने पर अग्निसूचक के सायरन का बजना तथा तत्क्षण प्राप्त CO_2 के अग्नि का शमन होना।

रासायनिक समीकरण

$CaCO_3 2HCI \rightarrow CaCI_2 + H_2O + CO_2$

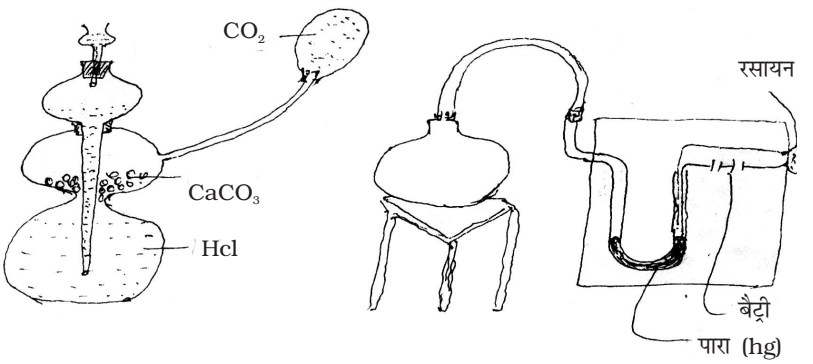
आवश्यक उपकरण

चूना पत्थर ($CaCO_3$), हाइड्रोक्लोरिक अम्ल (HCl), रबर पाईप, बैटरी, पारा, सरेस पत्र, साइरन, बैलून, धातु का वायुरुद्ध बर्तन, विद्युत तार एवम् कीप्स उपकरण।

क्रियाविधि

उपकरण को ऐसे स्थान पर रखा जाता है जहाँ आग लगने की संभावना रहती है। आग लगने पर यंत्र स्थित धातु के बर्तन का तापमान बढ़ जाता है जिससे उसके अन्दर वायु गर्म हो जाती है और उसका आयतन बढ़ जाता है। गैस के आयतन के प्रसार के कारण यंत्र के बर्तन से जुड़ी U नली की भुजा में भरे पारे पर वायु का दबाव बढ़ने लगता है। बढ़ते हुए दबाव के कारण नली की दूसरी भुजा में पारे की सतह ऊपर उठती है जिससे यंत्र की इस भुज से संलग्न विद्युत परिपथ

पूर्ण होता है और सायरन बजने लगता है और हमें आग लगने की सूचना प्राप्त होती है।



चित्र 19.1: अग्निसूचक-सह-अग्निशमक यंत्र

साथ ही धातु के बर्तन के पास में रखा CO_2 गैस से भरा गुब्बारा तापमान बढ़ने के कारण फट जाता है एवं CO_2 गैस अग्नि का कुपोषक होने के कारण आग को बुझाने का कार्य प्रारम्भ कर देती है।

उपयोगिता

(i) आग लगने की तत्क्षण सूचना प्राप्त होती है।

(ii) बिना किसी की प्रतिक्षा किये आग बुझाने का काम भी यंत्र द्वारा स्वत: प्रारम्भ हो जाता है।

(iii) रख-रखाव में सुविधा।

(iv) कम लागत।

(v) प्रदूषण रहित।

(vi) अन्यत्र ले जाने में सुगम।

20

कीट नियंत्रण के पर्यावरण-अनुकूल उपाय

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भूमिका

फसलों को सदैव कीटों के प्रकोप से कुछ न कुछ हानि होती रही है, परंतु कभी-कभी यह हानि इतनी अधिक हो जाती है कि फसल को आर्थिक दृष्टि से उगाना संभव नहीं रह जाता। कीटों द्वारा होने वाली हानि को कम करने के लिए कीटनाशियों का प्रयोग काफी दिनों से किया जाता रहा है जिससे कई समस्या ने जन्म लिया, जैसे कीट की रसायनों के प्रति सहिष्णुता बढ़ना, कम हानिकारक कीटों का अधिक हानिकारक हो जाना, वातावरण प्रदूषित हो जाना, खाद्य पदार्थों में रसायनों के अवशेष पाया जाना, मित्र कीटों का नष्ट हो जाना। इन समस्याओं से छुटकारा पाने के लिए वैज्ञानिकों द्वारा जैविक व वानस्पतिक कीटनाशियों के प्रयोग का सुझाव दिया गया। यह प्रदर्श कीट नियंत्रण के पर्यावरण अनुकूल उपायों को दर्शाता है।

नीम महोगिनी समूह के मिलियेसी कुल का पौधा है। यह भारतीय उप-महाद्वीप से पूरे विश्व में फैला है तथा अपने गुणों के कारण इसे कल्प की श्रेणी में रखा गया है।

प्रदर्श निर्माण का बौद्धिक उद्देश्य

इस प्रदर्श का उद्देश्य निम्बोली से पर्यावरण के अनुकूल कीट नियंत्रक तैयार करना है।

निम्बोली के उपयोगी रसायन

(i) अजाडिरेक्टिन: आज पर्यावरण-अनुकूल कीटनाशकों में इस रसायन का सर्वाधिक उपयोग हो रहा है। यह कीटों की आहार प्रक्रिया में बाधा डालकर उनके जीवन चक्र को समाप्त करता है।

(ii) निम्बीडीन और निम्बिन: बीज के गूदे में इसकी मात्रा 2 प्रतिशत तक होती है तथा इसमें कीटनाशक के साथ फंफूदी व जीवाणुनाशक गुण भी होते है।

(iii) मेलेयानिट्याल एवं सैलेनिन: यह कीटों को पत्तियां खाने से रोकता है।

प्रदर्श निर्माण में प्रयुक्त वस्तुएँ

निम्बोली, नीम के पत्ते, नीम की छाल, हार्ड बोर्ड, चार्ट-शीट, टेप-रोल, फैवीकोल आदि।

प्रदर्श की संरचना एवं कार्यप्रणाली

निम्बोली एकत्र करना: निम्बोलियां पक कर पीली होने लगें तो इनका उपयोग सर्वोत्तम होता है। इस समय इनमें अजाडिरेक्टिन (कीटनाशक तत्व) की मात्रा सर्वाधिक होती है। टूट कर जमीन पर गिरी हुई निम्बोलियों को बीनना उत्तम है परन्तु इन्हें झाड़ू लगाकर एकत्र न किया जाये क्योंकि इससे बीज में हानिकारक कवकों व जीवाणुओं के संक्रमण की सम्भावना रहती है जो बाद में बीज व तेल को खराब कर सकते हैं। राजस्थान में नीम पकने का समय वर्षा के आस-पास रहता है अत: चार से सात दिन में एक बार निम्बोलियों को एकत्र कर लेना उत्तम है।

छिलका या गूदा छुड़ाना: निम्बोली के पूरे फल को सुखा कर संग्रहण करना अधिक लाभप्रद है। किंतु वर्षा हो रही हो तो गूदा वर्षा से लसलसे गूदे को पानी डालकर धो देते हैं ताकि गूदा व छिलका बीज से अलग हो जाए। यदि निम्बोली एकत्र करते समय वर्षा न हो रही हो तो निम्बोलियों को बिना धोये ही सुखाना चाहिये।

बीज या निम्बोली सुखाना: वर्षाकाल में निम्बोली का छिलका और गूदा हटा कर बीज को अधिक गर्म सतह पर धूप में सुखाना ठीक नहीं होता किंतु नमी को जल्द सुखाना भी आवश्यक है। अत: इनको टाट, बोरी, कपड़ा या चटाई पर बिछाकर हल्की धूप व छाया में सुखाना चाहिये। पक्का फर्श, प्लास्टिक शीट, लोहे की शीट धूप में अधिक गर्म हो जाती हैं अत: बीज को इन पर सुखाने से बचना चाहिये।

भण्डारण: गिरी पुरानी होने पर तेल की मात्रा कम होने लगती है। अत: यदि बीज से तेल निकालने की सुविधा उपलब्ध हो तो तीन माह बीतने से पहले तेल

निकाल लेना चाहिए। छोटे स्तर पर पूरी सूखी हुई निम्बोली अथवा बीज को पीसने के बाद छान लेना चाहिए तथा धूप, नमी और गर्मी से बचाकर सूखे ठण्डे छायादार स्थान पर प्लास्टिक के बैग अथवा पुराने मटकों में भरकर रखना चाहिए।

निम्बोली से कीटनाशक तैयार करना: कीटनाशक गुणों के कारण नीम किसानों के लिए बहुत उपयोगी है। कीटनाशक के रूप में इसका प्रत्येक भाग उपयोगी है लेकिन इसके फल जिन्हें निम्बोली के नाम से जाना जाता है, सर्वाधिक उपयोगी होते हैं। नीम के फल जून से अगस्त माह के मध्य तक पक कर पेड़ से गिरने लगते हैं। पके फलों में औसतन 23.8% छिलका, 47.5% गूदा, 18.6% कवच व 10% गिरी निकलती है। किसान निम्बोली को एकत्र कर इन्हें वर्ष भर पर्यावरण-मित्र कीटनाशक के रूप में काम में लिया जा सकता है। कीटनाशक बनाने के लिए निम्बोली के बीजों को मसाला चक्की या मिक्सर में पीस कर इसका चूर्ण बनाया जाता है। इस के पाउडर या इसके घोल का छिड़काव भी किया जा सकता है।

प्रदर्श का उपयोग

कीटों पर नीम का प्रभाव: नीम में चार प्रकार के प्रमुख तत्व लामोनायडस, अजाडिरेक्टिन, सेलेनिन मिलिपनटोल तथा निम्बीन पाये जाते हैं। इनकी मात्रा वृक्ष की अपेक्षा फल व गूदे में अधिक होती है। इनके प्रयोग से कीटों पर निम्नलिखित प्रभाव पड़ते हैं:

(i) यह कीटों को प्रतिकर्षित करता है।
(ii) कीटों की अण्डे देने की क्षमता कम अथवा समाप्त हो जाती है।
(iii) कीट के अण्डों का विकास रुक जाता है तथा इनका जीवन चक्र पूरा नहीं हो पाता।
(iv) कीटों व सुंडियों पर इसका सीधा असर होता है।
(v) अवयस्क कीटों व सुंडियों में निर्मोचन क्रिया रुक जाती है।
(vi) लैंगिक प्रक्रिया रुक जाती है।
(vii) कीटों में नपुंसकता आ जाती है।
(viii) भोजन नली में अवरोध पैदा हो जाता है।
(ix) कीटों में काइटिन नामक पदार्थ का बनना प्रभावित होता है जो बाह्य त्वचा व अन्य अंगो का सुरक्षा आवरण होता है।

नीम उत्पादों का कीटों पर प्रभाव

क्र.स.	*कीट*	*नीम का असरकारक प्रभाव*
1.	मेडिटेशियन फल मक्खी	वृद्धि रुक जाती है एवं घातक प्रभाव पड़ता है।
2.	ओरियण्टल फल मक्खी	कृषि कोष का विकास रुक जाता है एवं सुंडी पर घातक प्रभाव।
3.	फेस मक्खी	वृद्धि रुक जाती है एवं घातक प्रभाव।
4.	हार्न मक्खी	वृद्धि रुक जाती है एवं घातक प्रभाव।
5.	घरेलू मक्खी	भोजन नली बाधित होने के अतिरिक्त निर्मोचन क्रिया पर भी प्रतिकूल प्रभाव पड़ता है।
6.	जई के तने की मक्खी	भोजन ग्रहण करने में परेशानी का अनुभव होता है
7.	घरेलू मच्छर	सुंडी पर घातक प्रभाव पड़ता है।
8.	जूँ	मर जाती है।
9.	फिली	भोजन नली बाधित हो जाती है एवं वृद्धि रुक जाती है।
10.	पीले ज्वार का मच्छर	सुंडी मर जाती हैं तथा निर्मोचन क्रिया अवरुद्ध हो जाती है।
11.	खपरा बीविल	भोजन नली बाधित हो जाती है एवं निर्मोचन क्रिया बाधित हो जाती है।
12.	वेन एफिड	निर्मोचन क्रिया प्रभावित हो जाती है।
13.	राईज गाल मिज	घातक प्रभाव पड़ता है।
14.	डायमण्ड बैक मॉथ	भोजन नली बाधित हो जाती है, कृमि कोष एवं सुंडी की वृद्धि रुक जाती है।
15.	दीमक	भोजन नली रुक जाती है एवं भोजन ग्रहण करना मुश्किल हो जाता है।

अनाज संरक्षण में नीम का प्रयोग: नीम की पत्तियों में कीटनाशक के गुण होते हैं। नीम की हरी पत्तियों को छाया में हल्का सुखाकर अनाज रखने वाली कोठी/टंकी में एक परत बिछा देनी चाहिए। तत्पश्चात उसमें 6–10 इंच मोटी कीटमुक्त सूखे अनाज की परत डालनी चाहिए। इसी क्रम में सूखी पत्ती बिछाते हुए ऊपर तक कोठी/टंकी को भर देना चाहिए। टंकी भर जाने के बाद नीम की पत्तियों की एक तह बिछा कर उसे अच्छी तरह से बंद कर देना चाहिए। इस प्रकार अनाज काफी समय तक सुरक्षित रखा जा सकता है।

उपयोगी तरीके

(i) 10 ग्राम निम्बोली पाउडर प्रति लीटर पानी में मिलाकर छिडकाव करने से पत्ती खाने वाले कीट पौधों से दूर रहते हैं।

(ii) सरसों अथवा अन्य फसलों में मोयला/चैपा के प्रकोप को खत्म करने के लिए पानी में घोल बनाकर छिडकाव करना कारगर है।

(iii) 15 mL निम्बोली तेल या 100 g पाउडर को 4 L पानी में घोलकर छिडकाव से आबू व कपास में एफिड का नियंत्रण किया जा सकता है।

(iv) सब्जियों की पौध तैयार करते समय पौधशाला में बुवाई पूर्व मृदा में मिलाने से सूत्र कृमि, कटवर्म व अन्य सूक्ष्मजीवों का कोमल पौधों पर प्रकोप नही होता।

(v) टमाटर व बैंगन की खेती में निम्बोली पाउडर से मृदा उपचार करने से मेलोडोगाइनी प्रजाति के सूत्र कृमि नियंत्रित होते है।

(vi) सफेद मक्खी, जैसिड, एफिड एवं बग्स के नियंत्रण हेतु 10 L पानी में 100 g निम्बोली या तीन चम्मच निम्बोली तेल व तीन चम्मच कपडे धोने के सोड़े का मिश्रण बनाकर छिडकाव करते हैं।

(vii) निम्बोली पाउडर का 100 g प्रति लीटर पानी में घोल बनाकर, सूरजमुखी और मक्का की फसल पर छिडकाव करने से तोता, गौरया, कौवा आदि पक्षियों से नुकसान को कम किया जा सकता है।

(viii) भण्डारण में कीटों के नियंत्रण के लिए 1–2 kg प्रति क्विंटल के हिसाब से निम्बोली पाउडर के उपयोग द्वारा गेंहू, ज्वार, मक्का की साल भर सुरक्षा की जा सकती है।

(ix) एक किलोग्राम निम्बोली पाउडर प्रति क्विंटल मूंग, चना, मटर एवं अन्य दालों में मिलाकर रखने पर 6 से 12 महीने तक सभी संग्रहित अनाज कीटों से सुरक्षित रहते हैं।

(x) नीम का तेल 500 mL प्रति क्विंटल चने में मिलाकर रखने पर यह 6 महीने तक पल्स बीटल से सुरक्षा करता है।

(xi) गृह वाटिका में विभिन्न कीटों के नियंत्रण हेतु प्रति लीटर पानी में 10 से 15 g निम्बोली पाउडर मिलाकर 15 से 20 दिन के अन्तराल पर छिडकाव करते रहने से विभिन्न रसचूसक कीटों: चैपा, तैला, सफेद मक्खी आदि का नियंत्रण हो जाता है।

NOTES

विद्यया ऽमृतमश्नुते

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