WINTER – 13 EXAMINATION

Subject Code: **12244** **Model Answer**

Important Instructions to examiners:

1) The answers should be examined by key words and not as word-to-word as given in the model answer scheme.
2) The model answer and the answer written by candidate may vary but the examiner may try to assess the understanding level of the candidate.
3) The language errors such as grammatical, spelling errors should not be given more Importance (Not applicable for subject English and Communication Skills.
4) While assessing figures, examiner may give credit for principal components indicated in the figure. The figures drawn by candidate and model answer may vary. The examiner may give credit for any
equivalent figure drawn.
5) Credits may be given step wise for numerical problems. In some cases, the assumed constant values may vary and there may be some difference in the candidate's answers and model answer.
6) In case of some questions credit may be given by judgement on part of examiner of relevant answer based on candidate's understanding.
7) For programming language papers, credit may be given to any other program based on equivalent concept.

Q. No 1 A) a) (Two marks for primary and secondary sources each, Any four)

Following are the major sources of energy

Primary energy sources:

1. Crude oil
2. Hard coal
3. Natural gas
4. Cooking coal
5. Fuel wood
6. Oil shale
7. Nuclear energy

Secondary energy sources:

1. Bio fuels
2. Petroleum products
3. Coke-oven coke
4. Charcoal

Q. No 1 A) b) (Two marks for each use, any two)

Uses of coal:

1. For generation of electricity: Coal is used to generate almost half of all electricity produced. Power plants burn coal to make steam and the steam runs turbine to generate electricity.

2. For industries: A variety of industry use coal's heat and byproducts. Separated ingredients of coal are used in making plastics, tar, synthetic fibers, fertilizers and medicines. The concrete and paper industries also burns a large amount of coal
3. For making steels: Coal is baked in hot furnace to make coke, which is used to smelt iron ore into iron for making steels. It is the very high temperature created from the use of coke that gives steel the strength and flexibility.

Q. No 1 A) c) (Two marks each for advantages and disadvantages,)

Advantages of renewable energy sources

1. It is sustainable and will never run-out
2. Requires less maintenance
3. Reduces the cost of operations
4. Produces no waste products
5. No pollution

Disadvantages of renewable energy sources

1. Lower efficiency
2. Difficult to generate large quantity of power
3. Depends on weather conditions
4. Unpredictable and inconsistent
5. Cost is more

Q.No.1A) d) (One mark each, any four)

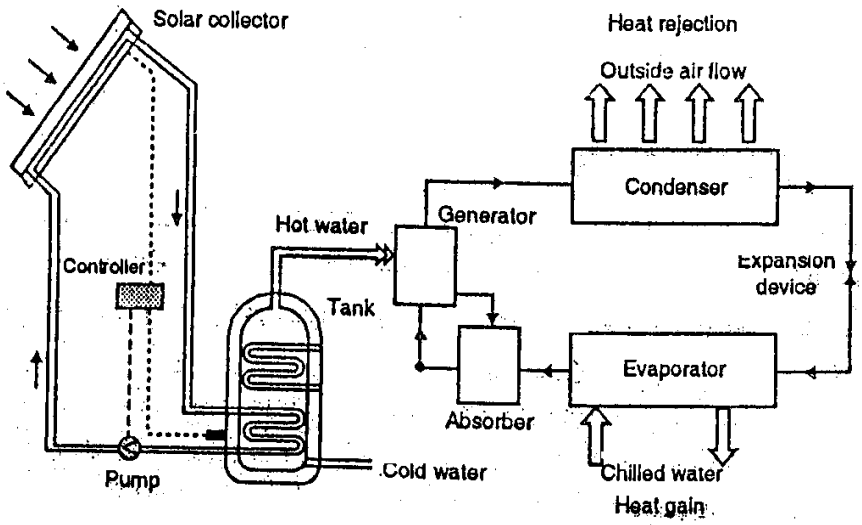
Different ways for improving boiler efficiencies (Any four)

- Reducing excess air
- Installing economizer
- Reducing scale and deposits
- Reducing blow down
- Recovering waste heat from blow down
- Stopping dynamic operation
- Reducing boiler pressure
- Operating at peak efficiency
- Preheating combustion air
- Switching from steam to air atomization
- Switching to lower cost fuel etc.

WINTER – 13 EXAMINATION

Subject Code: **12244** **Model Answer**

Q.No.1B) a) (Three marks each for figure and description)



Solar Space cooling: Figure shows detailed construction of solar space cooling. In the chiller refrigerant vapors from the evaporator is absorbed and pumped to generator. The refrigerant re vaporizes using the waste steam heat source. The refrigerant depleted solution then returns to the absorber via throttling device. The system uses a low temperature liquid refrigerant that absorbs heat from the water to be cooled and converts to a vapor in the evaporator section. This cold water is used for space cooling. Heat provided in the system is by solar collector in the form of hot water.

Q.No.1B) b) (six marks for appropriate explanation)

Thermo chemical conversion of biomass: It is the process of extracting energy from biomass fuel. Energy can be obtained by following methods from biomass.

1. Combustion: Bio mass is mainly found in three forms : solid fuels, liquid fuels & gaseous fuels. All fuels contain combustible constituents, the volatile matter & char. As the temperature of fuel rises, the volatile matter is thermo chemically released in the form of vapors. Due to thermo chemical degradation, solid fuels convert into char & inert matter.
2. Pyrolysis: It involves the heating of the original biomass in the near absence of air at 300OC to 500 O C . The biomass fuel for pyrolysis is wood.
3. Gasification: it involves the reaction of a solid fuel with hot steam and air and the subsequent production of a gaseous fuel by partial oxidation.

Q.No.2 a) **(One mark for each definition)**

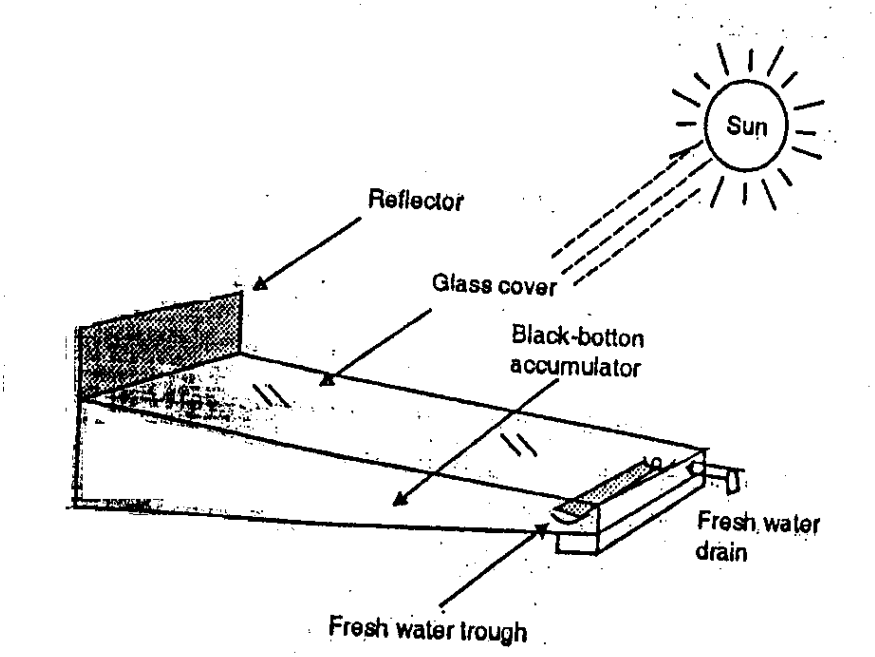
i) Hour angle (ω): The hour angle is the angular distance between the meridian of the observer and the meridian whose plane contains the Sun.

ii) Declination angle (δ) : If a line is drawn between the centre of the earth and the sun, the angle between this line and earths equatorial plane is called the declination angle.

iii) Solar Zenith angle (θz): It is complementary angle of suns altitude angle. It is a vertical angle between the sun's rays and a line perpendicular to the horizontal projection of the sun's rays.

iv) Solar incident angle (θ): It is the angle between the Sun's rays and imaginary line perpendicular to a collector surface.

Q.No.2 b) **(Two marks each for figure and description)**



Solar distillation: Figure shows the solar distillation process. Distillation is a process that can be used for water purification. The incident solar radiation is transmitted through the glass cover and is absorbed as heat by the black surface in contact with the water to be distillated. The water is thus heated and gives up water vapor. These water vapor collected and condensed on the glass

cover which is at lower temperature because it is in contact with the ambient air. The collected water runs down into a gutter from where it is fed to a storage tank.

Q.No.2 c) (One mark for each difference)

Differences of Horizontal axis wind Turbine and Vertical axis wind Turbine (Any four)

sr. No	Horizontal axis wind Turbine	Vertical axis wind Turbine
01	Optimum angle of attack is available	Have additional drag due to blades rotate into wind
02	The tall tower base allows access to stronger wind in sites	Do not have advantage of the stronger wind at higher elevation
03	Horizontal axis wind Turbine have difficulty operating in near ground due to tall structure	Can be located nearer the ground
04	Horizontal axis wind Turbine require an additional yaw control mechanism	Do not need to turn to face the wind
05	Proper foundation is required	No massive tower structure
06	Need high starting speed	Lower start up speeds

Q.No.2 d) (One mark for definition and one mark for each phase)

Energy Audit: An energy Audit is the first step in energy management programme. It shows how efficiently energy is being used and highlights opportunities for energy cost savings. It also shows ways to improve productivity.

Detailed Energy Audit Methodology: It is carried out in three phases.

Phase I – Pre Audit Phase:

1. Plan and organize
2. Walkthrough audit
3. Informal interview with energy /production/plant manager
4. Conduct of brief meeting , awareness programme with all divisional heads

Phase II -Audit Phase:

1. Primary data gathering ,process flow diagrams and energy utility diagrams
2. Conduct survey and monitoring
3. Conduct of detail trials/experiments for selected energy guzzlers
4. Analysis of energy
5. Identification and development of energy conservation opportunities

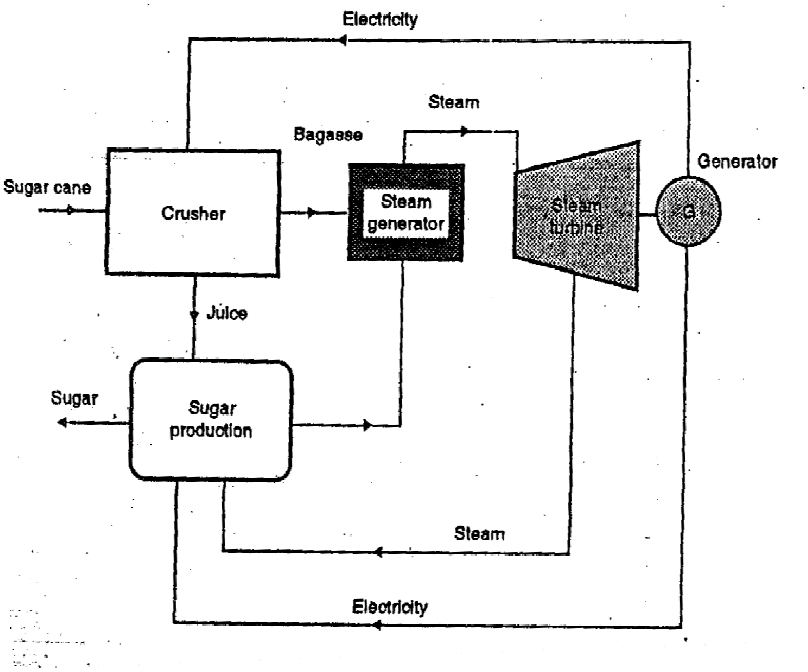
6. Cost benefit analysis
7. Reporting and presentation

Phase III – Post Audit Phase:

1. Implementation and follow up.

Q.No.2 e) (Two marks each for figure and description)

Co generation in Sugar factory: In sugar factory juice is extracted from cane and bagasses are burnt to generate steam. This steam is sent to steam turbine to generate electricity. Extracted steam and low pressure steam from turbine is used in the process of sugar manufacturing. In this way both electricity and steam, generated and used at the same place hence overall efficiency is increased.



Q.No.2 f) (One mark for each) (Any four)

Energy saving opportunities in compressed air system:

1. Ensure that air intake to compressor is not warm and humid
2. Clean air inlet filters regularly
3. Keep compressor valves in good condition

4. Install monomers across the filters and monitor pressure drop as a guide to replacement of elements
5. Minimize low load compressor operation
6. Use regenerative air dryers to remove moistures
7. Compressor FAD test must be done periodically
8. Reduce compressor delivery pressure wherever possible

Q.No.3 a) **(One mark for each) (Any four)**

Parameters of site selection of wind mill:

1) Availability of higher constant wind speed
2) Availability of wind at site through year
3) Altitude of the site
4) Availability of land
5) Connectivity to grid
6) Connectivity to the road
7) Easy access to locality/infrastructure
8) Ecology
9) Ground condition

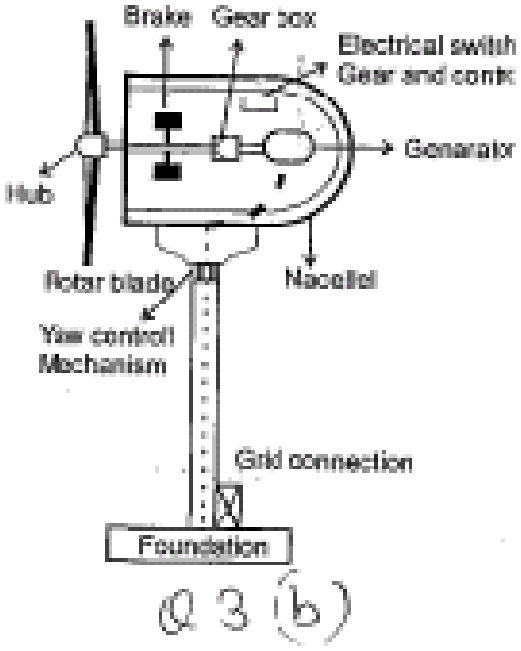
Q.No.3 b): **(Two marks each for figure and description)**

Figure shows horizontal axis windmill. It constitutes of turbine or rotor blades, hub, nacelle, yaw control mechanism and tower.

When the wind flows over a blade, rotor rotates. Shaft of rotor attached to step up gear box which increases the rpm. Gear box shaft is coupled with generator where mechanical energy is converted into electrical energy (Power).

WINTER – 13 EXAMINATION

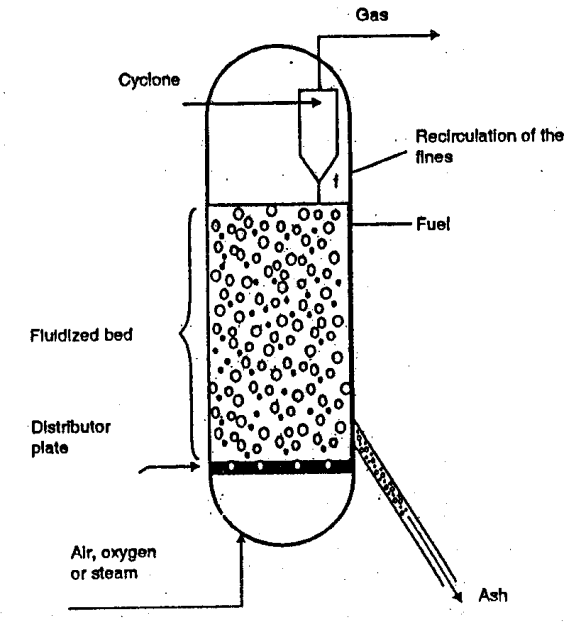
Subject Code: **12244** **Model Answer**



Horizontal axis wind mill

Q.No.3 c) Two marks each for figure and description)

Fluidised bed gasifier:-



Air is blown through a bed of solid particles at a sufficient velocity to keep these in a state of suspension. This is called as fluidization. The bed is originally externally heated and the feedstock is introduced as soon as a sufficiently high temperature is reached.

The fuel particles are introduced at the bottom of the reactor, very quickly mixed with the bed material and almost instantaneously heated up to the bed temperature. As a result of this treatment the fuel is pyrolysed very fast, resulting in a component mix with relatively large amount of gaseous materials.

Further gasification and tar conversion reactions occur in the gas phase. Most systems are equipped with an internal cyclone in order to minimize char blow-out as much as possible. Ash particles are also carried over the top of the reactor and have to be removed from the gas stream if the gas is used in engine applications.

Q.No.3 d) (**one mark each)**

Benefits of Biomass as energy:

1) Biomass can be used for fuels, power production and products that would otherwise be made from fossil fuels.

2) Biomass can reduce dependence on foreign oil.

3) Biomass energy supports agricultural and forest-product industries.

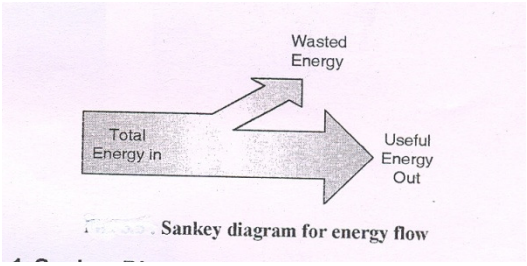
4) The use of biomass energy has the potential to greatly reduce greenhouse gas emissions.

Q.No.3 e) **(Two marks each for figure and description)**

Sankey diagrams: Sankey diagrams are a specific type of flow diagram in which the width of the arrows is shown proportionally to the flow quantity. They are typically used to visualize energy or material cost transfers between processes.

They are also commonly used to visualize the energy accounts or material flow accounts on a regional or national level. Sankey diagrams put a visual emphasis on the major transfers or flows within a system. They are helpful in locating dominant contributions to an overall flow. Often, Sankey diagrams show conserved quantities within defined system boundaries,

typically energy or mass, but they can also be used to show flows of non-conserved quantities such as energy. Sankey Diagrams drop their arrows when energy is being used.



Sankey diagram for energy flow

Q.No.4 A) a) (Two marks each for renewable and nonrenewable, any four)

Renewable energy sources available in India:

1. Wind power
2. Biomass
3. Solar applications of energy
4. Hydrogen
5. Fuel cells
6. Bio fuels

Non Renewable energy sources available in India:

1. Coal
2. Oil
3. Natural gas
4. Nuclear
5. Propane

Q.No.4A) b) (Four marks of proper elaboration)

Prospects of alternative energy sources:

The technical potential for the use of alternative energy sources is very large exceeding all other readily available sources.

India is blessed with a variety of renewable energy sources, the main ones being biomass, biogas, the sun, wind and small hydro power.

Municipal and industrial wastes can also be useful sources of energy, but are basically different forms of biomass.

New technologies such as biogas plants improved wood stoves, solar water heater, solar cookers, solar lanterns, street lights; pumps wind electric generators biomass gasifiers are becoming commercially available.

WINTER – 13 EXAMINATION

Subject Code: **12244** **Model Answer**

Q.No.4A) c) (Two marks each for figure and description)

Complete mix digester:

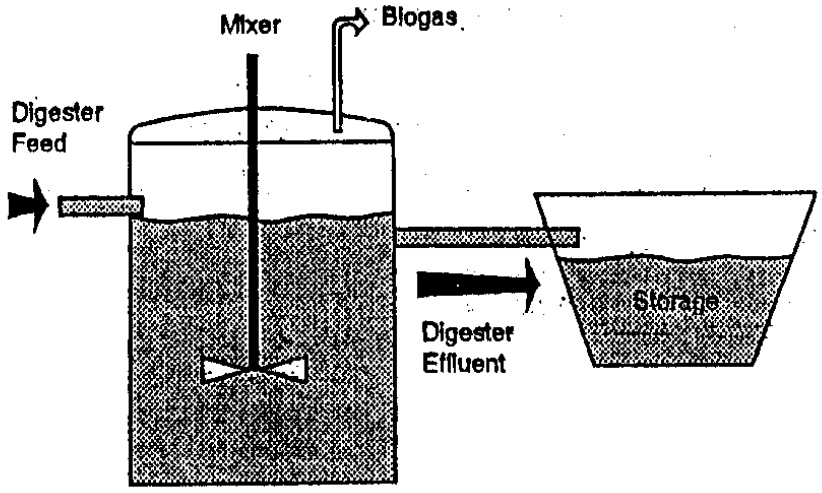
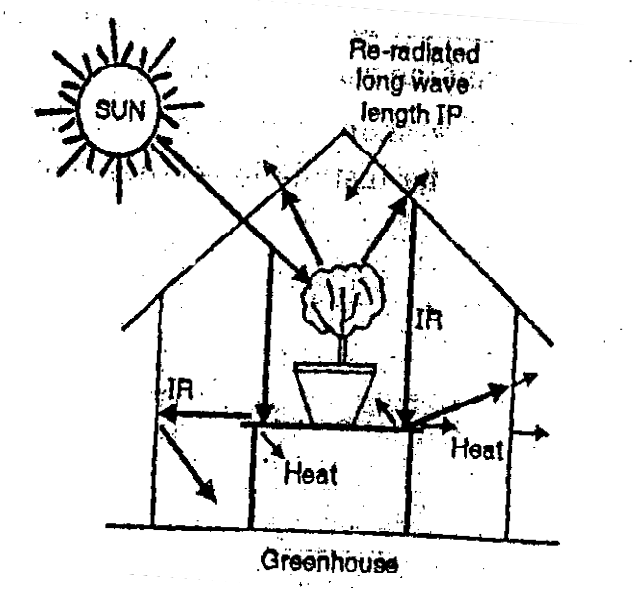


Figure shows a complete mix digester. It converts organic waste to biogas in a heated tank above or below ground. A gas mixer keeps the solids in suspension. The reactor is a circular steel or poured concrete container. During the digestion process, the manure slurry is continuously mixed to keep the solids in suspension. Biogas accumulates at the top of the digester.

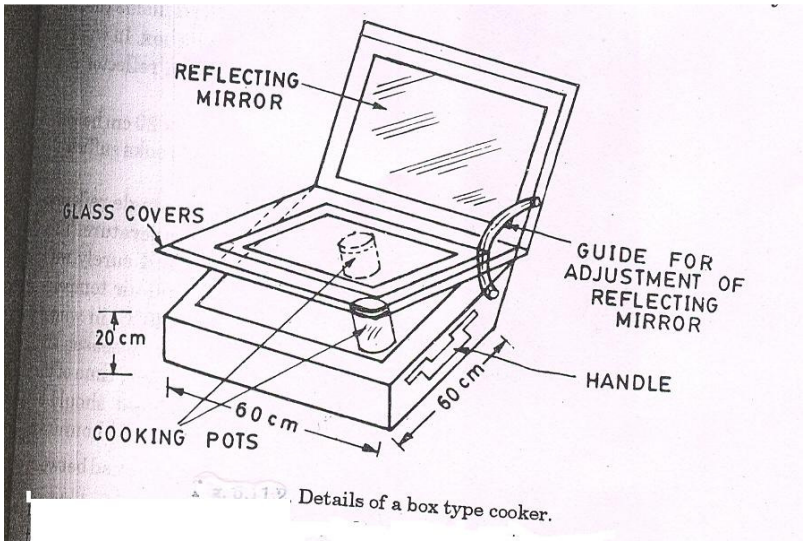
Q.No.4A) d) (Two marks for figure and description each)



Green house effect: Figure shows the greenhouse. It is an application of solar energy. Solar greenhouses are designed to utilize solar energy for both heating and lighting. It has thermal mass to collect and store solar heat energy and insulation to retain this heat for use during the night and on cloudy days. Green house is oriented to maximize southern glazing exposures. Its northern side has little or no glazing and is well insulated.

Q No.4 B) a) (Three marks each for figure and description)

Solar cooker (Box Type): Figure shows the box type solar cooker. The solar rays penetrate through the glass covers and absorbed by a blackened metal tray kept inside the solar box. Two glass covers are provided to minimize the heat loss. The loss due to convection is minimized by making the box air tight by providing a rubber strip all rounds between the upper lid and the box. When the cooker is placed in the sun, the blackened surface starts absorbing sun rays and temperature inside the box starts rising. The blackened cooking pots get heat energy and food will be cooked in a period of time. Mirrors are provided to increase solar radiation intensity. A small vent for vapor escape is provided in the sealing



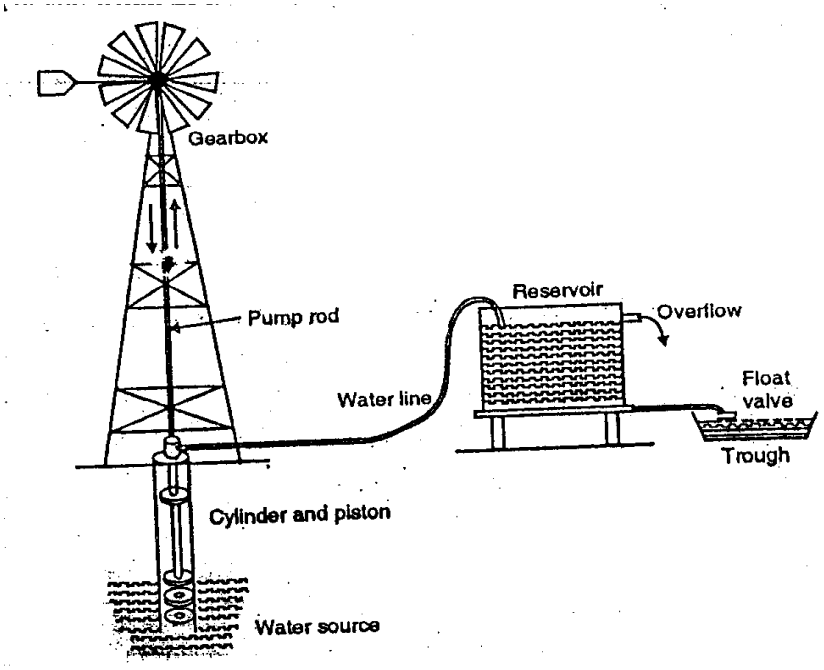
Details of a box type cooker.

WINTER – 13 EXAMINATION

Subject Code: **12244** **Model Answer**

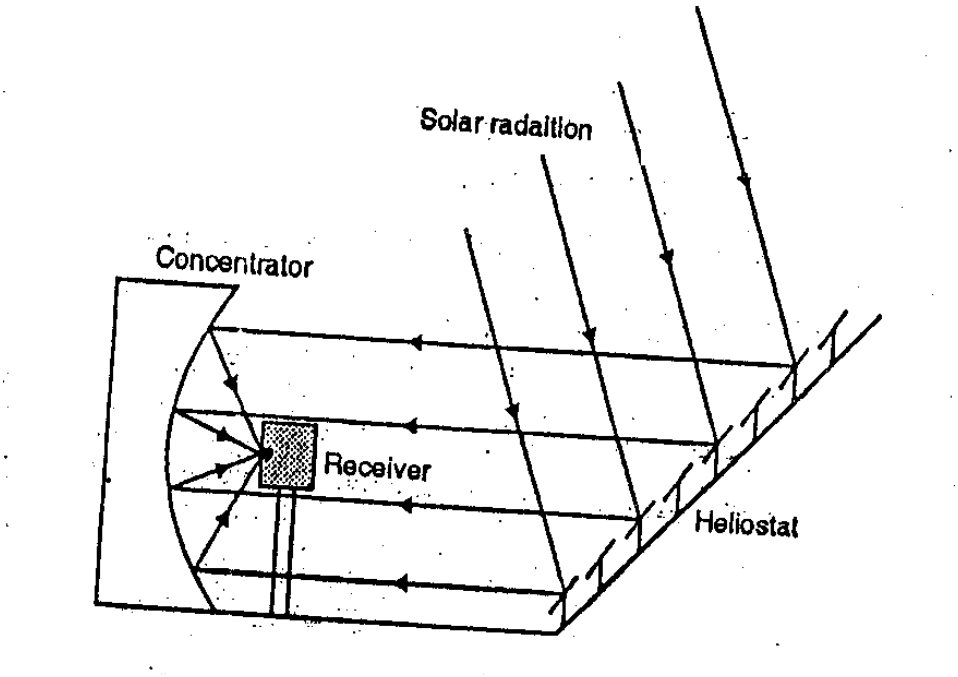
Q No. 4 B) b) (Three marks each for figure and description)

Reciprocating wind pump



Reciprocating wind pump: Figure shows a wind powered reciprocating pump. Wind blowing at a speed of 8-10 km per hour at a height of 10 meter rotates the blades of the windmill, which in turn drives the gear box. The gear box increases the speed of the rotation and converts the rotary motion into reciprocating motion. The reciprocating motion drives the pump rod which is connected to an appropriate size of pump at the other end, which pumps the water from the well. The tail provided at the opposite end of the rotor, guides the rotor to face perpendicular to the direction of the wind at all the times.

Q. No. 5 a) (Two marks for fig. & explanation each)
Solar Furnace:



Solar furnace consists of following parts i) Bank of heliostats ii) Tower iii) Target area iv) Furnace v) Parabolic mirror vi) Reflecting surface
A Solar furnace is a structure used to harness the rays of the Sun in order to produce high temperatures, usually for industries. This is achieved using a curved mirror that acts as a parabolic reflector. Solar radiations collected at heliostats are concentrated by concentrator on a focal point. The temperature at the focal point may reach 3000 ^{0}C and this heat can be used to generate electricity, melt steel or make hydrogen fuel.

Q. No. 5 b) (Two marks each for advantages and disadvantages, Any four)
Advantages of Wind Energy

1. It generates no pollution
2. It is friendly to the surrounding environment, as no fossil fuels are burnt to generate electricity.
3. It is quiet and does not present any significant hazard to birds or other wildlife.
4. Wind turbines take less space than the average power station.
5. It is free and ample in quantity.

6. Wind turbines are a great resource to generate energy in remote locations, such as mountain.

Limitations of Wind Energy

1. Unreliable
2. Less power generation
3. Expensive
4. More noise in nearby areas
5. Difficulty in transmission
6. Protest from people

Q .No. 5 c) Comparison of biomass with conventional fuels **(Any four) (One mark each)**

Sr. No.	**Biomass**	**Conventional fuel**
01	It is available in abundant quantity	Petroleum products are available at selected sites
02	It can be converted into several forms of energy	It can be converted only few types of marketable fuels
03	It is cheap compared to other energy sources	Petroleum products are costly fuels
04	Unused agricultural land can be used	Its exploration is costly
05	It is produced on a renewable basis	It leads to emission of carbon dioxide
06	It is very low in sulphur	It contains sulphur

Q. No 5 d) (One mark each , Any four)

Objectives of energy conservation: Following are the objectives of the energy conversion.

1. Protect the environment
2. Conserve the natural resources.
3. To promote and conserve energy efficiency.
4. Improve comfort and living conditions by changing energy behavior.
5. Improve community economy.
6. Reduction in cost of households and makes business increasing sustainability.
7. Developing harvesting phenomenon.

Q .No. 5 e) (One mark for definition and three for objectives, Any three)

Energy Management:

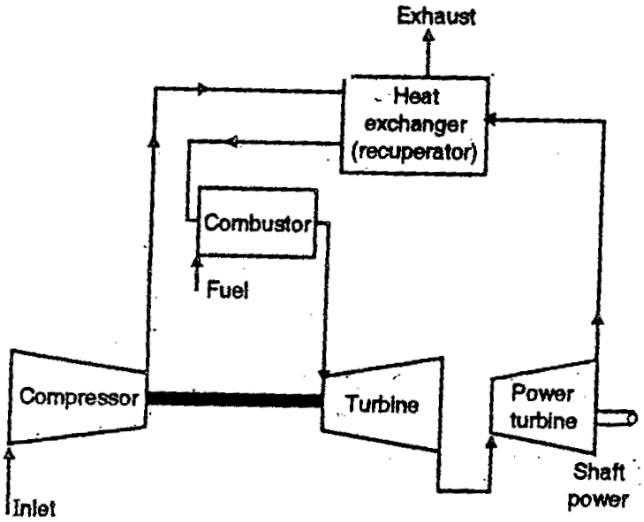
Now a day, with rising fuel costs and the opening of electricity and gas markets to alternative suppliers and climate change, the need to monitor and reduce energy consumption is receiving greater attention.

Energy Management is defined as "The judicious use of energy to maximize profits and enhance competitive positions"

Therefore any management activity that affects the use of energy falls under energy management. The objectives of energy management are

1) Conserving energy thereby reducing cost
2) Cultivating good communications
3) Developing and maintaining effective monitoring
4) Finding new ways to increase returns from energy
5) Developing interest in energy management programmes.

Q. No. 5 f) **(Two marks each for figure and description)**



Closed cycle gas turbine Cogeneration systems: Co-generation is procedure for generating electric power and useful heat in a single installation. The useful heat may be in the form of steam, hot water, or hot air. In the cogeneration system, a mechanical work is converted into electrical energy in an electric generator and the discharged heat, which would otherwise be dispersed to the environment is utilized for useful purpose.

The basic working principle of closed cycle gas turbine is same as open cycle. Exhaust gases coming out of turbine are used to heat compressed air before going to combustor. Waste heat of

outgoing gases is recovered using heat exchangers called as recuperator. This heat recovery increase efficiency of power generation.

Q. No. 6 a) (Two marks each for definition and explanation)

Return on investment: (ROI)

It is a rate of profit or sometimes just return, is the ratio of money gained or lost (realized or unrealized on an investment relative to the amount of money invested. The amount of money gained or lost may be referred to as interest, profit/loss, and gain/loss. Or net income/loss.

ROI is usually expressed as a percentage rather than decimal value.

- ROI is usually expressed as a percentage rather than decimal value.
- ROI does not indicate how long an investment is held.
- However, ROI is most often stated as an annual or annualized rate of return, and it is most often stated for a calendar or fiscal year.

$$ROI = \frac{\text{Annual Net Chash Flow}}{\text{Capital Cost}} \times 100$$

For instance, a Rs. 1,000 investment that earns Rs.50 in interest generates more cash than a Rs.100 investment that earns Rs.20 in interest, but the Rs.100 investment earns a higher return on investment.

Rs.50/Rs.1,000 = 5% ROI

Rs.20/Rs.100 = 20% ROI

Q.No.6 b) (Two marks each)

Reuse: Reuse is using an item more than once. This includes conventional reuse where the item is used again for the same function, and new-life reuse where it is used for a new function. It can have financial and environmental benefits, either of which can be the main motivation for it

Recycle: It involves processing used materials into new products in order to prevent the waste of potentially useful materials, reduce the consumption of fresh raw materials, reduce energy usage, reduce air pollution (from incineration) and water pollution (from land filling) by reducing the need for conventional waste disposal and lower greenhouse gas emissions as compared to virgin production.

Q.No.6 c) (Four marks for proper elaboration)

Energy management cell: Every industry should have a dedicated energy management cell. It should provide necessary structure and formalize the process of energy conservation. The cell should interact with manufacturing and other divisions like production engineering maintenance utilities and even finance.

The cell should carry out the activities like planned internal and external energy audits, conceptualization and implementation of projects. The cell will be the focal point for effective energy management in the plant

Energy management is a Mission with a Target. It needs coordinated effort by team of energy conscious people with a milestone to be established.

Q.No.6 d) (Two marks each for definition and list)

Critical thickness of insulation: When heat loss through insulation is a conductive heat transfer, There are instances when adding insulation actually increases heat loss. It is a concern in insulating pipes and wires. The thickness at which insulation begins to decrease heat loss is known as critical thickness of insulation.

Materials for insulation (Any Two)

1. Thermocoal
2. Polyeurethene foam (PUF)
3. Fibrous or granular forms of calcium Aluminous siliceous materials
4. Mineral wools calcium silicate
5. Glass wool
6. Rock mineral wool
7. Nitric rubber

Q.No.6 e) (Two marks each for figure and description)

Economizer: In case of boiler system, economizer can be provided to utilize the flue gas for preheating the boiler feed water. For every 22 ^{o} C reduction in flue gas temperature by passing through an economizer there is 1 % saving of fuel in the boiler. There is heat exchange between outgoing flue gases and incoming feed water.

WINTER – 13 EXAMINATION

Subject Code: **12244** **Model Answer**