SRI VIDYA COLLEGE OF ENGINEERING & TECHNOLOGY
VIRUDHUNAGAR
DEPARTMENT OF CIVIL ENGINEERING

QUESTION WITH ANSWERS

DEPT:CIVIL–IV **SEM:VII**

SUB.CODE/NAME:EN6501/Municipal Solid Waste Management.

UNIT4-Off-site Processing.
PART-A(2marks)

1. What is called Composting?

Composting is an effective method of solid waste disposal. In composting, biodegradable materials break down through natural processes and produce humus. The metabolism of micro-organisms breaks down the waste aerobically or an aerobically.

2.What are the reasons for modern compost systems are aerobic rather than Anaerobic compost systems?

Most modern compost systems are aerobic rather than anaerobic for several reasons:
1. Aerobic processes are not accompanied by the foul stench present at an unsealed anaerobic composting operation.
2. In crop production industries, composting is safer because temperatures do not reach that of pasteurization temperatures which exceed the thermal death point of most plants, animals and parasites.
3. Aerobic composting is more rapid than anaerobic composting.

3. Write down the carbon: nitrogen ratio favorable for decomposition?

An aerobic compost operation ideally is an optimal environment for the growth of aerobic organisms. The material to be composted is food. Therefore the "food" should have a carbon: nitrogen ratio favorable for decomposition. The microbes require a C: N of 25:1 to 30:1.

4. If the C: N is too low what happened in the composting.

If the C: N is too low(120:1), the ammonium compounds will volatilize into the air, causing an unpleasant odor. Various groups of organisms have different optimum temperatures (some prefer 25 0c,some 37 0c, and others 55 0c), though the optimal temperature for a process as a whole integrates the optimums of the various microbes.

5.What are the Types of Composting?

Types of Composting

The three main types of composting are: windrow, static pile, and in-vessel.

1. **Windrow:** A sludge/refuse mixture configured in long rows (windrows) that are aerated by convection air movement and diffusion, or by turning periodically through mechanical means to expose the organic matter to ambient oxygen.
2. **Static pile**: A stationary mixture is aerated by a forced aeration system installed under the pile.
3. **In-vessel composting**: Composting takes place in enclosed containers in which environmental conditions can be controlled. The waste decomposes into a harmless organic material that can be used as a soil conditioner and enhancer for agricultural applications.

6.Which Factors in Composting Operation?

The most important factors in composting operations are:

1. segregation of refuse and salvage
2. grinding or shredding of the material
3. carbon-nitrogen ratio
4. blending or proportioning of wastes
5. moisture content

7.What are the most important purposes for composting organic Wastes?

The two most important purposes for composting organic wastes are:

a. reclamation or conservation of the nutrient and fertilizer values of the waste, b. sanitary treatment and disposal to prevent the spread of disease.

8.What is called humus?

Compost is a brown material, the main constituents of which are humus. It has the following physical properties when applied to the soil:

- the lightening of heavy soil
- improvement of the texture of light sandy soil
- increased water retention
- enlarging root systems of plants.

9.What are the Character and Value of the Compost?

Character and Value of the Compost

Compost material is stable. It may undergo little or no further decomposition. It has a slightly musty or earthy odor. Color wise, it must be grayish or blackish. Its value is to serve as soil conditioner, lightness to the soil, promotes aeration and helps retain moisture by adding humus.

10.What is called composting pit?

Compost Pit

- It can be designed for individual houses or institutions. It is the easiest method of solid waste management system, if it is well managed. It is the most ideal method of dealing with wastes in homes and institutions like schools.
- Waste is normally deposited in the pit and covered within 24 hours with a thin layer of earth.

11.What is called incineration?

Incineration

Incineration is a process of burning the combustible components of garbage and refuse. Disposal of solid waste by incineration can be effectively carried out on a small scale in food service establishments as well as in institutions such as hospitals, schools etc.

12.What is called on-site incineration?

On-site Incineration

This term applies to incineration of refuse at home, office, apartment house, commercial building, hospital or industrial site. Refuse collection and disposal could be reduced satisfactorily by using on-site incineration. Generally, air pollution can be expected.

13.Give the Advantages of an incinerator?

Advantages of an incinerator

1. Less land is required for landfills
2. A central location is possible, allowing short hauling for the collection service.
3. Ash and other residue produced are free of organic matter, nuisance- free, and acceptable as fill material.
4. Many kinds of refuse can be burned. Even noncombustible materials will be reduced in bulk.
5. Climate or unusual weather does not affect it.

14.Give the disadvantages of an incinerator?

Disadvantages of an incinerator

1. Initial cost is high during construction.
2. Operating cost is relatively high.
3. Skilled employees are required for operation and maintenance.
4. There may be difficulty in getting a site.

15.Define Pyrolysis.

- **Pyrolysis** is a thermo chemical decomposition of organic material at elevated temperatures in the absence of oxygen (or any halogen). It involves the simultaneous change of chemical composition and physical phase, and is irreversible. The word is coined from the Greek-derived elements*pyro* "fire" and *lysis* "separating".
- Pyrolysis is a type of thermolysis, and is most commonly observed in organic materials exposed to high temperatures. It is one of the processes involved in charring wood, starting at 200–300 °C (390–570 °F)

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UNIT4-Off-site Processing

Part B-(16 marks)

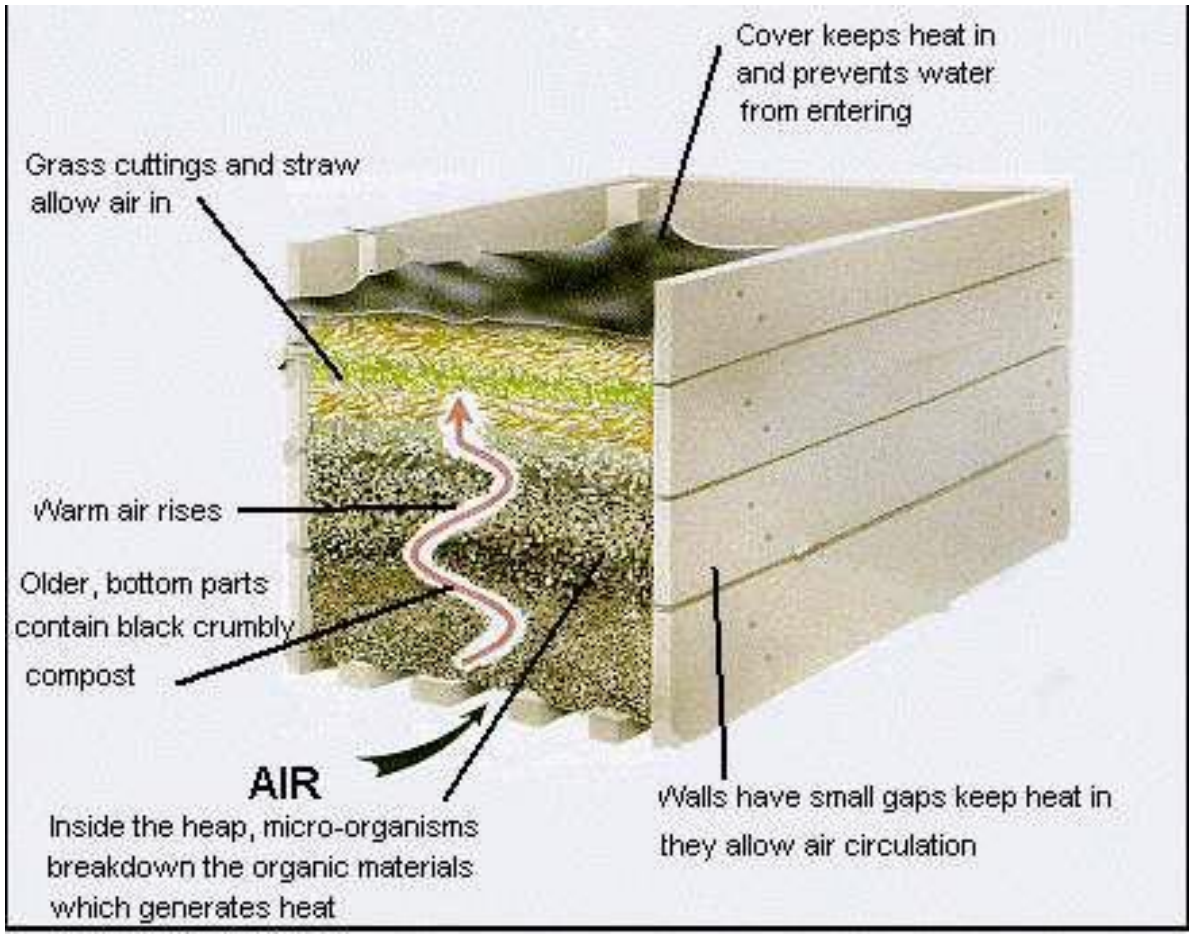
1.Explain the Composting process.

Composting

- Composting is an effective method of solid waste disposal. In composting, biodegradable materials break down through natural processes and produce humus. The metabolism of micro-organisms breaks down the waste aerobically or anaerobically.
- Materials that are non- biodegradable must be separated from the degradable materials and disposed of in some other manner.
- Some common non biodegradable materials are glass, plastics, rubber products, and metals. Once nonbiodegradable materials have been removed and only biodegradable waste has been established, it is brought to a grinder. Grinding increases the surface area of the waste and enhances biological degradation.

Most modern compost systems are aerobic rather than anaerobic for several reasons:

1. Aerobic processes are not accompanied by the foul stench present at an unsealed anaerobic composting operation
2. In crop production industries, composting is safer because temperatures do not reach that of pasteurization temperatures which exceed the thermal death point of most plants, animals and parasites.
3. Aerobic composting is more rapid than anaerobic composting.



An aerobic compost operation ideally is an optimal environment for the growth of aerobic organisms. The material to be composted is food. Therefore the "food" should have a carbon:nitrogen ratio favorable for decomposition. The microbes require a C: N of 25:1 to 30:1. If the C: N is too low (120:1), the ammonium compounds will volatilize into the air, causing an unpleasant odor. Various groups of organisms have different optimum temperatures (some prefer 25 0c, some 37 0c, and others 55 0c), though the optimal temperature for a process as a whole integrates the optimums of the various microbes.

The pH of aerobic composting varies depending on the organisms' need for oxygen. Aeration is important and is provided by turning the compost mechanically to expose it to oxygen to speed decomposition. Microbes must have moisture, and such is the case in composting. The amount of moisture needed varies with the composition of the material being composted. The moisture content should be approximately 45% to 50%. If the moisture is too low, microbial activity slows, and biological activity ceases at a moisture content of about 12%. If the moisture content is too high, it reduces the amount of free oxygen present and slows the process so that it may become anaerobic. Many times, sludge is added to waste for composting to provide microbial food and trace elements.

2.Explain the types of composting and operation steps in composting? A.
Types of Composting
The three main types of composting are: windrow, static pile, and in-vessel.
1. **Windrow:** A sludge/refuse mixture configured in long rows (windrows) that are aerated by convection air movement and diffusion, or by turning periodically through mechanical means to expose the organic matter to ambient oxygen.
2. **Static pile**: A stationary mixture is aerated by a forced aeration system installed under the pile.
3. **In-vessel composting**: Composting takes place in enclosed containers in which environmental conditions can be controlled. The waste decomposes into a harmless organic material that can be used as a soil conditioner and enhancer for agricultural applications.

B. Operation Steps in Composting
1. Removal of non-compostable wastes, (i.e. cans, glasses).

2. Grinding and shredding
- Helps to speed up bacterial action.
- Raw refuse is shredded before placed in piles, bins and digested before decomposition.

3. Blenching or proportioning of materials
- This is also to speed up the bacterial action.
- The optimum carbon nitrogen has to be 30 - 35:1
- Generally blending is considered to be unnecessary if the ratio is 25 - 30:1
- The optimum moisture content for aerobic composting is 40 - 60% depending on the character of the material.

4. Placement for composting - It can be placed on ground as open piles or windrows in a shallow pit. Height of windrows or piles should not be greater than 1.5 meter to 1.8 meter and not less than 1.07 meter to 1.2 meter. Width at the bottom of the windrow is 2.44 meter to 3.6 meters.

5. Turning - An aerobic condition is maintained by frequent turning. If the moisture content is high, it requires turning every 2 -3 days.

6. Temperature - It is an important factor and should range 50-70 0 C; usually 600C is satisfactory. Temperature will be the highest in the middle of pile or windrow. Excessive temperature (710C) is injurious to bacterial action. Excessive temperature is controlled by lowering the height of piles or windrows. If the area is cool, raise the height in order to maintain optimum temperature. If temperatures drop, the condition will be anaerobic.

3.Explain the Factors in Composting Operation. A.
Factors in Composting Operation
The most important factors in composting operations are:
1. segregation of refuse and salvage
2. grinding or shredding of the material
3. carbon-nitrogen ratio
4. blending or proportioning of wastes
5. moisture content
6. placement of materials in the composting pit
7. maintain temperature level to obtain rapid, nuisance-free decomposition
8. aeration to reduce high moisture content in composting materials
9. organisms involved
10. use of inoculate
11. physical or chemical reaction
12. climatic conditions (temperature, wind, rainfall)
13. destruction of pathogenic organisms
14. time required for composting
15. fly control
16. reclamation of nitrogen and other nutrients
17. testing and judging the condition of compost
18. quality of composts, which depends on nature of the material being composted
19. economic aspects of composting ,The final product of composting is compost - a mixture composed mainly of decayed organic matter, used as a fertilizer.

4.Explain the Uses and Constraints of composting.
Uses and Constraints
Compost improves soil moisture retention. It is a good soil conditioner. Compost, depending on the waste source and its composition, may be used as a soil amendment for agricultural soil and landscaping in municipal parks.

The two most important purposes for composting organic wastes are:
a. reclamation or conservation of the nutrient and fertilizer values of the waste
b. sanitary treatment and disposal to prevent the spread of disease.

Compost is a brown material, the main constituents of which are humus. It has the following physical properties when applied to the soil:
• the lightening of heavy soil
• improvement of the texture of light sandy soil
• increased water retention
• enlarging root systems of plants

Compost may also be used as a landfill cover, land reclamation, animal litter, and possibly animal feed. It may also be used as an additive to fertilizer as fuel, or in building materials.
The presence of toxic levels of pesticides, heavy metals, and pathogens should be determined and evaluated to ensure that the levels are compatible to the intended use of the compost.
The total composting time is determined by the material, process used, and exposure to the elements. Two weeks to as much as 18 months may be required for complete stabilization. For pathogen reduction purposes, the temperature of the mixture must be not less than 55 0C for at least 3 consecutive days.

5.Write shortly about Moisture Content of the Compost, Character and Value of the Compost.
Health Importance and Compost Pit.
A. Moisture Content of the Compost
• Moisture content is a critical factor in aerobic composting.
• If water content falls below 40% the speed of the process declines.
• If it falls below about 20% decomposition ceases.
• If it exceeds 55% water begins to fill the interstices between the particles of wastes, reducing interstitial oxygen and causing anaerobic conditions. This results in a rapid fall in temperature and the production of offensive odors.
B. Character and Value of the Compost
Compost material is stable. It may undergo little or no further decomposition. It has a slightly musty or earthy odor. Colorwise, it must be grayish or blackish. Its value is to serve as soil conditioner, lightness to the soil, promotes aeration and helps retain moisture by adding humus.
C. Health Importance
• Compost presents no health hazards.
• The heat produced will kill pathogenic bacteria and eggs of parasites.
• When composting is processed, fly breeding can be expected due to the mere fact it is done in a slightly open condition.

D. Compost Pit
It can be designed for individual houses or institutions. It is the easiest method of solid waste management system, if it is well managed. It is the most ideal method of dealing with wastes in homes and institutions like schools.
Waste is normally deposited in the pit and covered within 24 hours with a thin layer of earth. When it is full, it is left for bacteria to act upon it, which decomposes leaving humus that can be used as soil conditioner in farms. To be economical operating a twin pit is the best, as when one fills the other one is used as a component of the first humus.

6.Explain the incineration process.

Incineration

Incineration is a process of burning the combustible components of garbage and refuse. Disposal of solid waste by incineration can be effectively carried out on a small scale in food service establishments as well as in institutions such as hospitals, schools etc.

The disadvantage of this method is that only combustible materials are incinerated, hence there is a need for separation of the waste into combustible and non-combustible. The noncombustible waste needs separate disposal. Generally there are two types of incinerators, the open and the closed systems.

In the **open** system the refuse is incinerated in a chamber open to the air; while the **closed** system contains a special chamber designed with various parts to facilitate incineration.

It requires a chimney of appropriate height to provide a good flow of air through the combustion chamber. There are varieties of designs for small scale incinerators. A typical example of design is shown in Figure 4. The size can be varied depending on the volume of the refuse to be incinerated.

- The combustion chamber is laid with iron grids, at the bottom of which are air inlets in front and at the back.
- The front and back walls are with provision for installing a chimney.
- The feeding door has a baffle wall to facilitate refuse feeding.
- The base below the combustion chamber is for collecting.

On-site Incineration

This term applies to incineration of refuse at home, office, apartment house, commercial building, hospital or industrial site. Refuse collection and disposal could be reduced satisfactorily by using on-site incineration. Generally, airpollution can be expected.

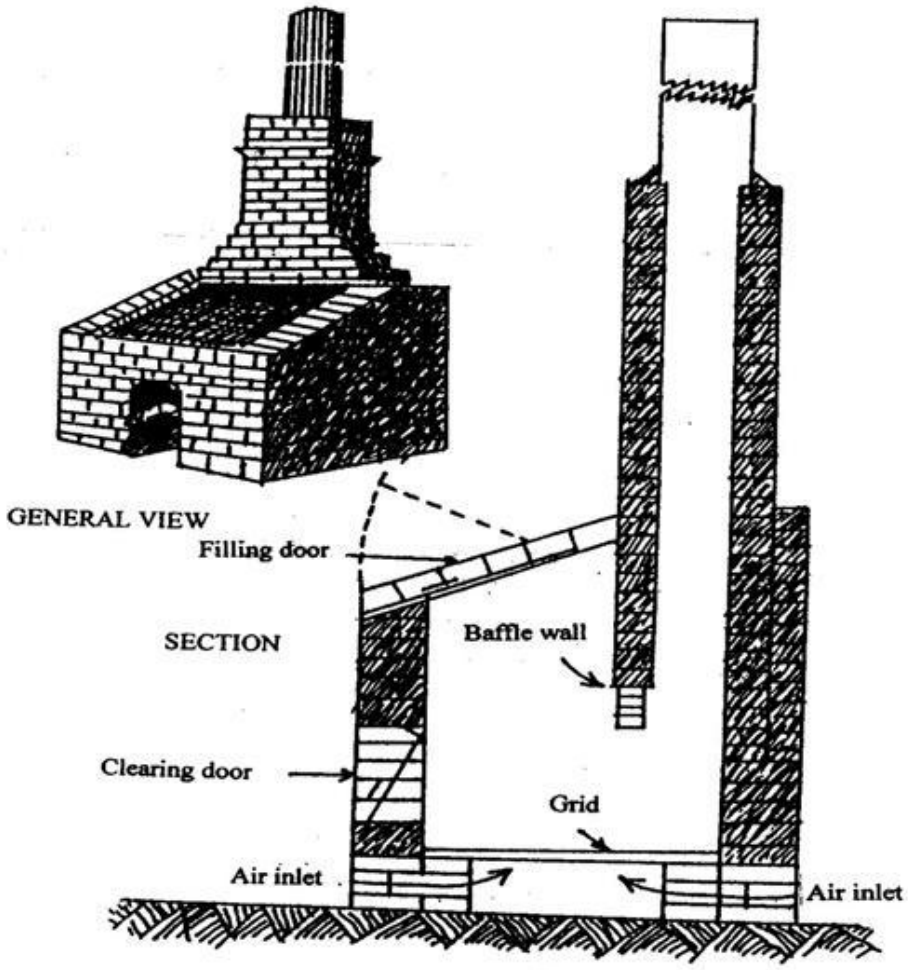
Advantages of an incinerator

1. Less land is required for landfills
2. A central location is possible, allowing short hauling for the collection service.
3. Ash and other residue produced are free of organic matter, nuisance- free, and acceptable as fill material.
4. Many kinds of refuse can be burned. Even noncombustible materials will be reduced in bulk.
5. Climate or unusual weather does not affect it.
6. Flexibility is possible - no restriction for its operation.

7. Getting income through the sale of waste heat for steam or power is possible.

Disadvantages of an incinerator

1. Initial cost is high during construction.
2. Operating cost is relatively high.
3. Skilled employees are required for operation and maintenance.



An example of this type is commonly seen in some institutions in Ethiopia. A typical design consists of the following dimensions: width = 110 cm; length =110cm; height in front = 135cm; height at back =150cm. Concrete base (chamber)= 60cm by 75cm by 10cm; top fueling door = 60cm by 60cm square, with thickness 5cm. With proper management and little fuel the incinerator can effectively burn dry as well as wet materials.

7.Explain Pyrolysis process.

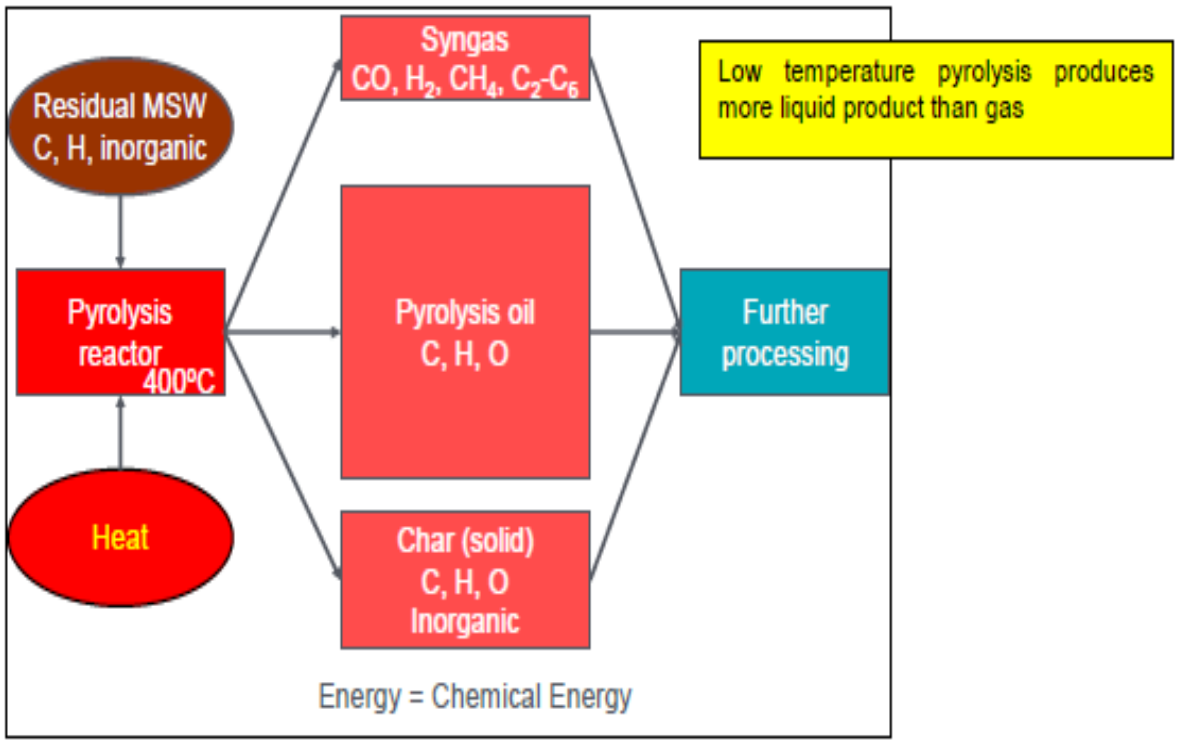
Pyrolysis is a process in which oxygen is excluded from the reactor, which is heated externally to produce the elevated temperature environment that causes the organic solids (waste input) to breakdown via physical and chemical processes into three products;

- **solid char,**
- **pyrolysis oil and**
- **pyrolysis gas,**

with the proportions of each being governed by the operating temperature within the pyrolysis reactor.

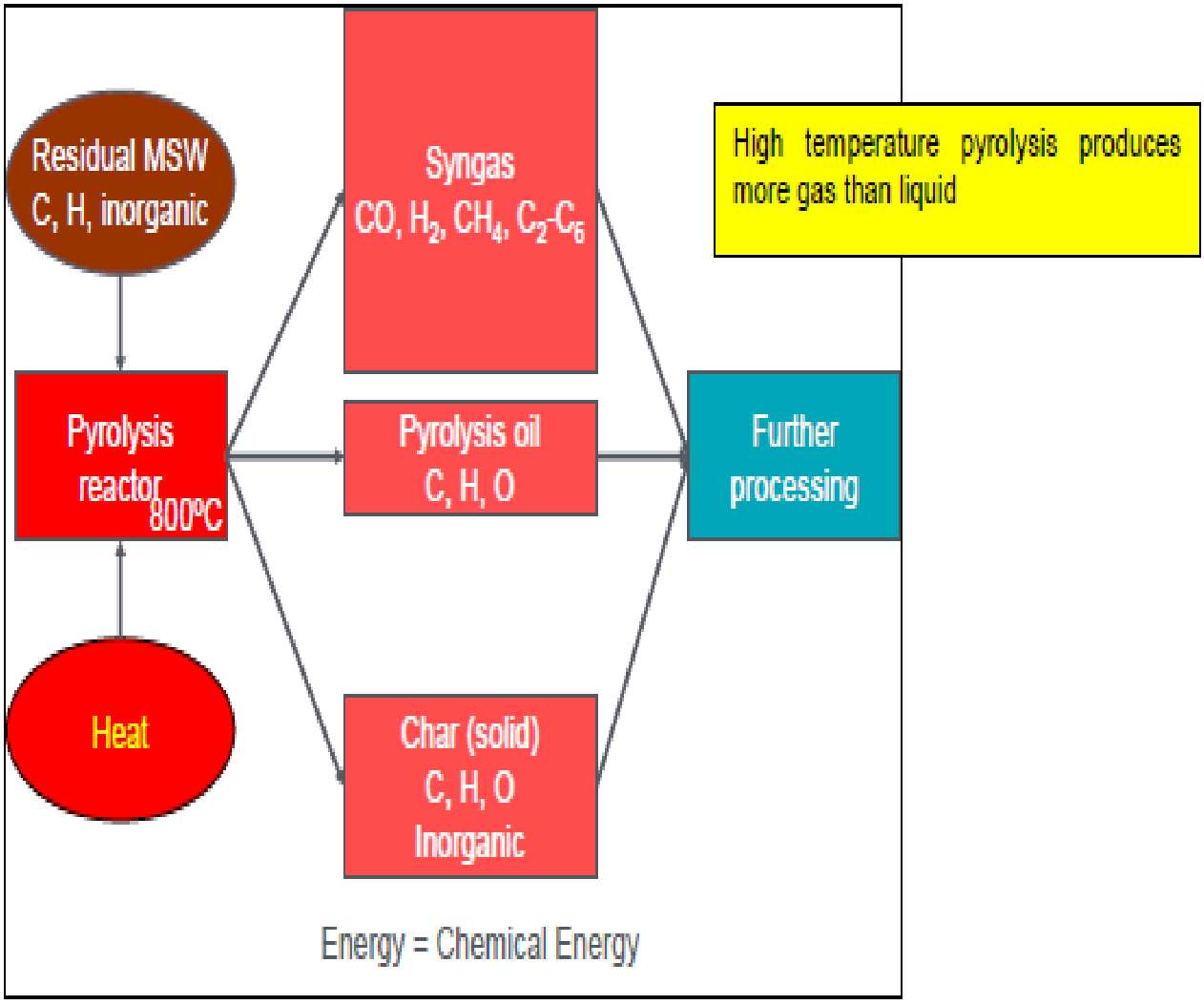
There is a certain amount of misunderstanding concerning the differences between pyrolysis and gasification with some people believing that they are the same. True pyrolysis is a low temperature thermal conversion technology that operates with an air free environment and produces a primary liquid product as well as gas and solid phase products. If pyrolysis is operated at high temperature (>800oC) then the primary product becomes syngas but the process will also produce liquid and solid phase products in lesser amounts.

Figure 2-21: Schematic representation of a low temperature pyrolysis process



By increasing the operating temperature the thermodynamics governing the reactions taking places cause a greater production of pyrolysis gas (syngas) at the expense of pyrolysis oil. The quantity of char produced at low and high temperatures does not vary greatly.

Figure 2-22: Schematic representation of a high temperature pyrolysis process



For biomass processing the lower temperature pyrolysis processes have been used with the objective of maximising the production of pyrolysis oil, referred to as bio-oil, which was seen as a pre-cursor to the production of many other chemicals in a bio-refinery context.

In a waste processing context the higher temperature pyrolysis processes have been developed in order to maximise the production of syngas, which is more easily converted to electricity. It is these processes that we will consider in this report and we will refer to them henceforth as gasification as the sole objective is to produce syngas like gasification.