Design the reactor that will be used in the proposed technology.

a. What is the type of reactor to be used?

The reactor is the heart of any pyrolysis process. Reactors have been the subject of considerable research, innovation and development to improve the essential characteristics of high heating rates, moderate temperatures and short vapour product residence times for liquids. Therefore, the type of reactor to be used in our proposed technology is *fluidized- bed reactor*. Generally, a fluidized- bed reactor consists of a fluid- solid mixture that exhibits fluid like properties. This is achieved by the introduction of pressurized fluid through the solid particle substance. Fluidized- bed reactors appear to be popular for fast pyrolysis as they provide rapid heat transfer, good control for pyrolysis reaction and vapour residence time. Fluidized- bed reactor have extensive high surface area contact between fluid and solid per unit bed phase. And good thermal transport inside the system.

b. What is the size of the reactor?

For the size of the reactor, we assume it as lab scale unit. The unit, consisted of a vertical riser type reactor (7.08 mm ID), a fluid bed generator reactor (77.9 mm ID), a stripper (26.6 mm ID) and a lift line (9.45mm ID). The riser height is 165cm. To calculate the volume of the reactor for fluidized bed reactor:- (L = height of bed)

$$V_R = \frac{\pi D^2}{4} L$$

$$= \frac{\pi (77.9 \times 10^{-3})^2}{4} (165 \times 10^{-2})$$

$$= 0.00786 \text{ m}^3$$

$$= 7.86 \text{ L}$$

Rounding off to the nearest integer,

$$\mathbf{V = 8.0\ L}$$

c. Operating temperature and pressure?

The operating temperature and pressure are the most important aspect of operational control for pyrolysis processes. Material flow rates, both solid and gas phase, together with the reactor temperature and pressure control the key parameters of heating rate, peak temperature, residence time of solids and contact time between solid and gas phases. In our proposed technology, the operating temperature is usually at *400- 550°C* but dependent on equipment and other conditions. For fast pyrolysis the peak liquid yields are generally obtained at a temperature of around 500°C (Bridgwater et al, 1999).

The operating pressure is at high pressure *(1-20 bar)* for our propose technology.

d. Does it require any heating/cooling? How do you provide that?

For pyrolysis process, it *requires heating* to operate. For pyrolysis process of organic matter to occur, it consists both simultaneous and successive reactions when organic material is ***heated*** in a non-reactive atmosphere and the process is very complex. The thermal decomposition of organic components in biomass occurs at 350 °C–550 °C and goes up to 700 °C–800 °C in the absence of air/oxygen. Under pyrolysis conditions, the long chains of carbon, hydrogen and oxygen compounds in biomass will break down into simpler molecules in the form of gases, condensable vapours (tars and oils) and solid charcoal. The rate of decomposition of these components is depending on the process parameters of the reactor (pyrolysis) temperature; biomass heating rate; pressure; reactor configuration and feedstock.

e. Produce a mechanical drawing of the reactor

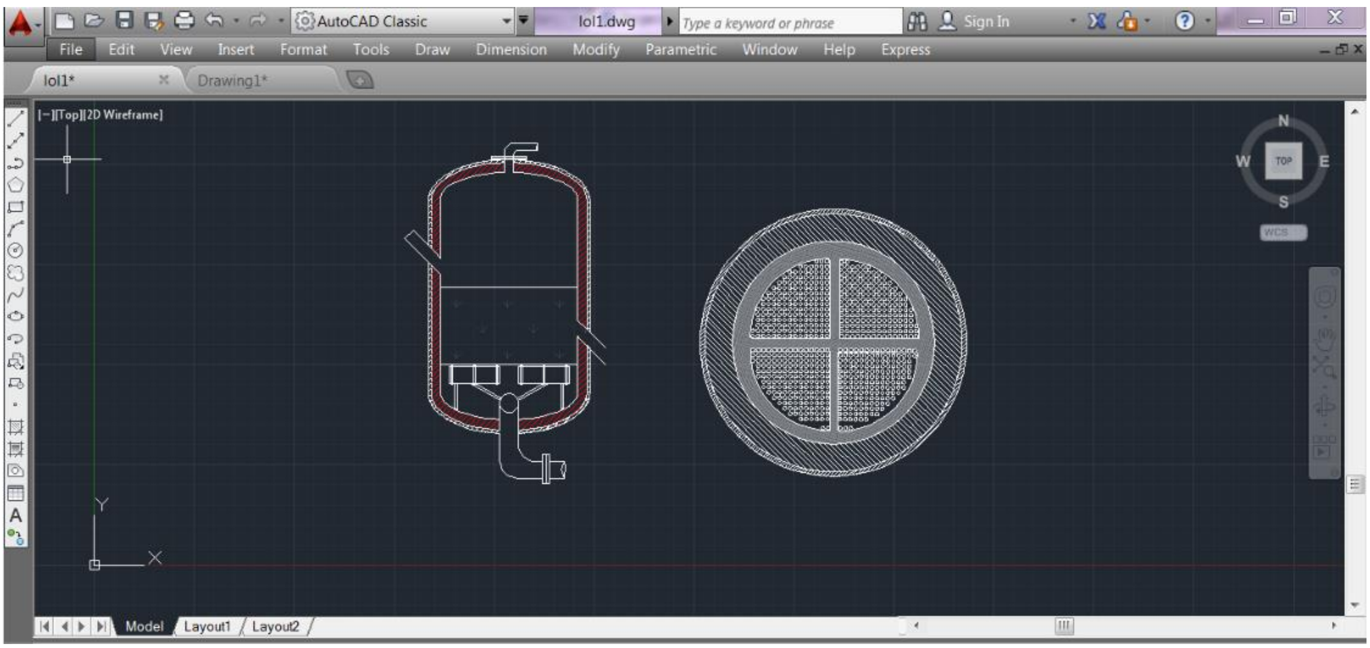

Diagram 1: The diagram shows the AUTOCAD drawing for the pyrolysis technology.

Description: The figure shows a sectional side elevation of a fluidized bed reactor for pyrolysis. The figure also shows the sections across and below segments.

f. Cost of the reactor (Refer to Coulson & Richardson Volume 6 or any chemical engineering design textbook to get the formula)

The formula to calculate the fluidized bed reactor cost is as below:

Fluidized bed reactor cost = $\$2.29\times10^5$ $[\text{volume of reactor (m3)}]^{0.67}$

(1$ = RM 4.07)

From the volume we calculated in the reactor sizing, the volume is 0.00786 m^3

By applying into the equation:

Cost = $\$2.29 \times 10^5 (0.00786\ m^3)^{0.67}$

=$ 8907.76 = **RM 36 254.58**

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