Optimization Reactor Sizing

$$A = \pi \ x \ D \ x \ (L + 2\pi r^2)$$

Whereas: D= vessel diameter
L= vessel height

$$f(DxL) = Dx \ (L + \frac{D^2}{2})$$

For a given volume, V= 0.002006268 m³, the diameter of the length are related by:

$$V = \pi r^2 L \text{ Or } V = \frac{\pi}{4} D^2 \ x \ L$$

$$\text{and } L = \frac{4V}{\pi D^2}$$

Hence, the objective function becomes:

$$f(D) = \frac{4V}{\pi D} + \frac{D^2}{2}$$

Next, by setting differential of the function to be zero for the minimum value of diameter and height to be calculated and used:

$$-\frac{4V}{\pi D^2} + D = 0$$

$$D = \sqrt[3]{\frac{4V}{\pi}} = \frac{\sqrt[3]{4 \ x \ 0.002006268 \ m^3}}{\sqrt[3]{\pi}} = 0.1367 \ m$$

Hence, by taking optimum value of diameter:

$$L = \frac{4V}{\pi D^2} = 4 \ x \ 0.002006268 \frac{m^3}{\pi \ x \ (0.1367 \ m)^2} = 0.1367 \ m$$

Therefore, for a cylindrical diameter reactor, we will use the minimum surface of L=D=0.1367 m. This is because we want to make cylinder reactor with an optimum volume of 0.002006268 m³. By using the optimum value of height and diameter of reactor, we can retain the function and efficiency of the reactor. On the other hand, we can minimize the operation costing to build the reactor since we need to optimize the usage of the whole reactor and its operations.