

## Exercise 5

## Packed Bed Ceramic Absorber

A **packed bed ceramic absorber** of 2 feet inner diameter, 13 feet height, 1.125" thickness shell is available in a plant. Tower sections are stack-packed with ceramic cross-partition rings of 0.75 inch nominal size. Other dimensions of absorber are given below.

### Details of column

#### Vapor Inlet section

Height of inlet section = 30inch

Inside diameter of vapor inlet nozzle = 6inch

Inside diameter of liquid outlet nozzle = 2inch

#### Top Cover section

Overall height = 7inch

Hemispherical end, with liquid inlet (2inch ID) at the center and vapor outlet (6inch ID) at a side



#### Intermediate sections

Between inlet and cover sections, there are *three* intermediate sections of height 40inch each.

**Various sections of column are connected by bell and spigot joint (as shown in schematic)**

#### Vapor distribution plate:

- It is holding 6 risers of 5inch ID and 7inch height. Raisers have vertical slots of 2inch high 0.25 inch wide on their sides with spacing of 0.5 inch.
- Vapor distribution plates also have large number of holes of 0.25 inch diameter on 0.5 inch triangular pitch
- The inside rim near the top of the inlet section is holding the vapor distribution plate.

#### Liquid distribution plate:

- The inside rim near the top of the top-intermediate section is holding the liquid distribution plate.

#### Liquid re-distribution plate:

- There is a liquid redistribution plate at the middle intermediate section

$\Delta P$  allowed in the column = 42 mm water per meter of packing height.

Packing factor ( $F_p$ ) for stacked cross-partition ring of size  $\frac{3}{4}$ " is = 1500  $m^{-1}$

**(a) Check whether the above absorber is suitable for the following duty, in terms of height and diameter.**

The carbon dioxide issuing out of a fermenter at a flow rate of 750 kg/h contains 0.0025 mole fraction of ethanol, which has to be reduced to 0.0001 mole fraction by scrubbing with water in a countercurrent packed tower.

Equilibrium relationship: (in mole fraction units)

$$y = 1.07 x$$

Absorption factor is to be maintained at 1.5

Density of liquid = 1000 kg/m<sup>3</sup>

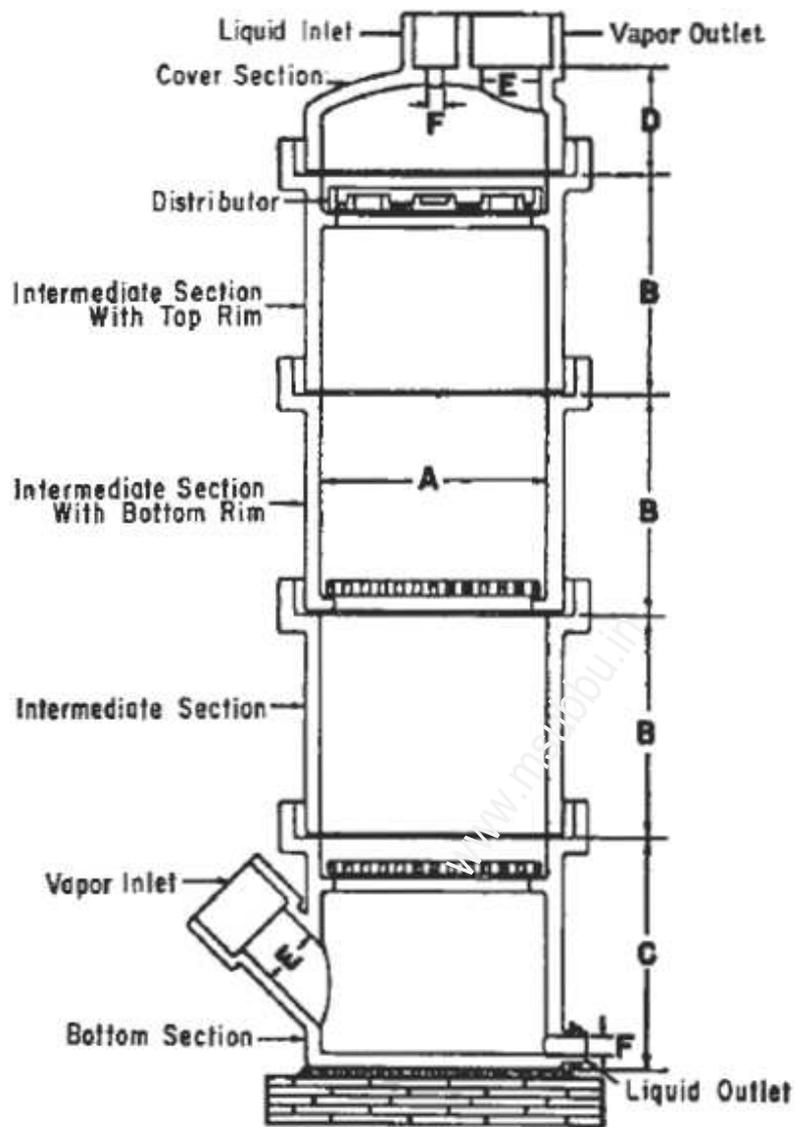
Viscosity of liquid = 0.001 kg/m.s

Density of gas = 1.84 kg/m<sup>3</sup>

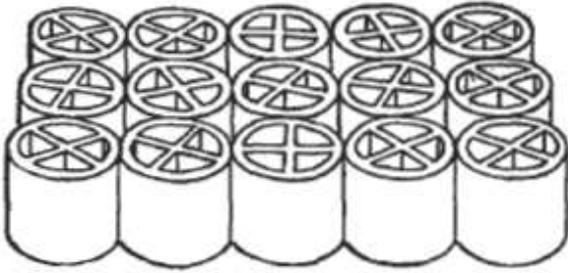
For cross-partition rings of size ¾", for the gas-liquid system,  $H_{IG} = 0.27$  m; and  $H_{IL} = 0.23$  m.

**(b) And draw:**

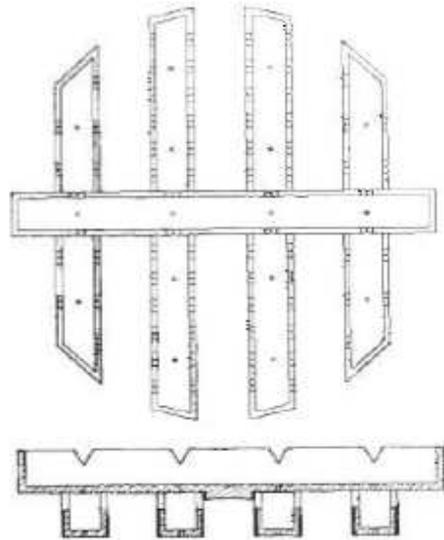
- (i) Sectional elevation of packed bed absorber assembly
- (ii) Detailed drawing of liquid distributor (plan and elevation)
- (iii) Detailed drawing of gas injection support plate (plan and elevation)



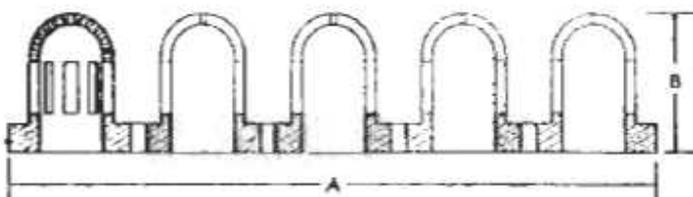
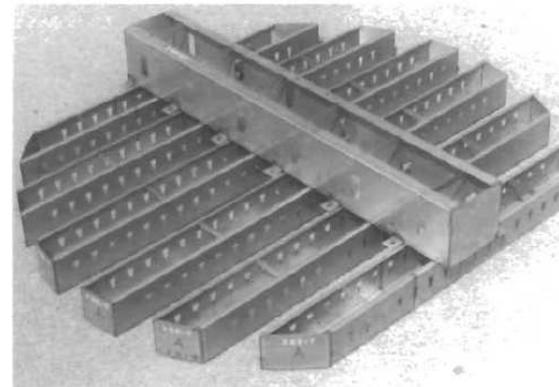
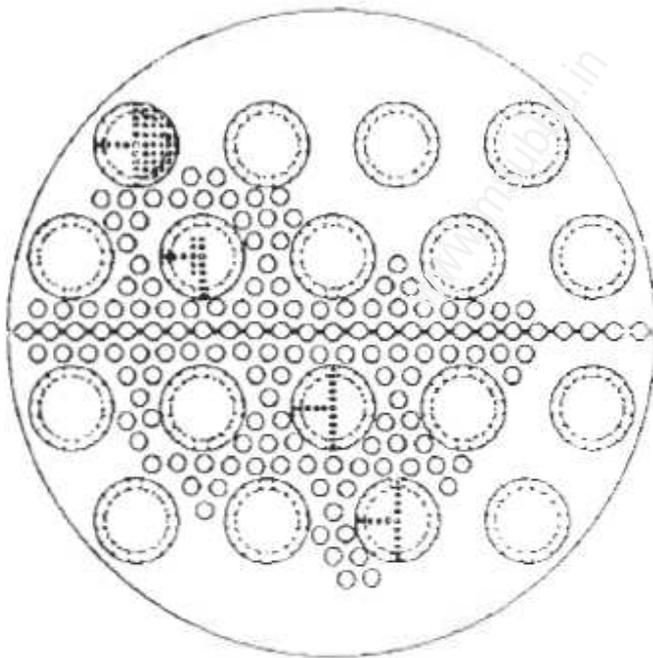
Bell and spigot ceramic tower (A = 24"; B = 40"; C = 30"; D = 7"; E = 6"; F = 2")



**Stacked packing:** cross-partition rings, packing size:  $\frac{3}{4}$ "



**Trough Liquid distributor**



**Gas-injection support plate (porcelaine) / redistributor :**  
 Number of risers = 6; diameter of riser = 5"; A = 23"; B =  $7 \frac{11}{16}$ "