**Distillation Column (Benzene recovery column) Summary:**

Customer ID: IIT Kharagpur, India Designer: PED GROUP – 8

Date: March, 03, 2023

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| **D, Tray/Tower diameter (m)** | **1.6** |  |
| **A, tower area (m²)** | **2.01** |  |
| **A, active area (m ²)** | **1.201085** |  |
| **Adc, downcomer area (m²)** | **0.2412** |  |
| **NP, number of passes** | **1** |  |
| **W\_dc(m)** | **0.280061542** |  |
| **lw, weir length (m)** | **1.216** |  |
| **hw, weir height (mm)** | **73** |  |
| **Downcomer type** | **Segmental** |  |
| **A\_dc(% of A)** | **12** |  |
| **Loadings @ Tray** | **8** |  |
| **TS, mm** | **600** |  |
| **Vapour** | **kg/s** | **6.93497614** |
| **m3/s** | **2.031055519** |
| **P\_v, kg/m3** | **3.414469017** |
| **Liquid** | **kg/s** | **5.397816464** |
| **m3/s** | **22.2139215** |
| **P\_l kg/m³** | **874.7730234** |
| **Pressure Drop** | **QL/lw, m3/s per m** | **0.004382481** |
| **hw, mm** | **73** |
| **h\_tray, mm liq.** | **109.0528855** |
| **A\_dc,clearance (m²)** | **0.0304** |  |
| **h\_dc,pr\_drop, mm liq.** | **6.807904943** |  |
| **hL,dc, mm liq.** | **228.008086** |  |
| **Residence time, sec** | **8.912608306** |  |

**Steps of the Calculation:**

**I. Calculation of Alpha**

1. Obtain data from the available resources.
2. Calculate the pressure drop across the top and bottom of the column, P\_top and P\_bot.
3. Evaluate the temperatures and calculate P\_pure at the given temperature.
4. Calculate the alpha value from the pressure.

**II. Using McCabe Method**

1. Implement McCabe method in MATLAB code to obtain the ideal and actual stages and the feed tray location.
2. Perform the calculations for different values of R/R\_min.

**III. Rough Estimation of the Cost to Obtain the R/R\_min Optimum**

1. Calculate the diameter of the column.
2. Determine the height and thickness of the material required.
3. Estimate the cost of the trays based on the diameter.
4. Add the above values to obtain the total column cost.
5. Estimate the heat load of the reboiler and condenser to calculate their respective costs.
6. Add all the above costs and multiply the sum by a factor of 1.2\*2 to adjust for manufacturing and piping costs.
7. Use depreciation to calculate the annual cost for the column.
8. Calculate the annual operating cost and add it to the column cost to obtain the total cost.
9. Repeat the above steps for all values of R/R\_min to obtain the R/R\_min optimum with the lowest total cost.

**IV. Tray Hydraulics and Bubble Cap Design**

1. Calculate the number of passes and the area distribution over the tray.
2. Determine the weir height and the height over the weir.
3. Decide on the tray layout.
4. Calculate the downcomer dynamics.
5. Determine the liquid gradient and the drop through aerated liquid.
6. Calculate the vapor distribution and the corrected approach to flooding.
7. Calculate the tray pressure drop and the head loss through the wet slot.

**Top of Form**

**Group Member Contribution:**

**Yuvika (20CH30037)** - Written Sample Calculation of Tray Hydraulic and Engineering Drawing of Bubble Cap Design and helped in data collection

**Gopal Gupta (20CH30008**) - Calculation using Excel and Code and helped in sample calculation

**Arsh Singh (20CH10088)** – Written Sample Calculation up to cost Calculation and helped in data collection

**Yash Saraswat (20CH10087)** – Drawn Engineering Drawing of Column, Tray hydraulic side View and Top view of the Tray and helped in data collection.