**BY S VISHAL**
**CH18B020**

# ASSIGNMENT-4 PROCESS ENGINEERING

Since 99.8% conversion will need more hydrogen than given in the feed as per given specifications, I raised hydrogen stream flow rate to 340 lbmol/hr, so that more than sufficient hydrogen is available at the reactor.

## 1. Capital Cost

| **Equipment** | **Size** | **Equipment cost ($)** | **Installed cost ($)** | **Total Capital Cost ($)** |
|---|---|---|---|---|
| Heaters (x4) | Tube outside diameter [meter] 0.0254 (for all)<br>Tube length extended [meter] 6.096 (for all)<br>Tube pitch [meter] 0.03175 (for all)<br>Heat transfer area [sqm] 5.7896190206766 9.18395 6.6001 3.1488 | 44600 | 294700 | 339300 |
| Reactor | Liquid volume [l] 1459.507849<br>Vessel diameter [meter] 0.762<br>Vessel tangent to tangent height [meter] 3.2004 | 87500 | 245400 | 332900 |
| Flash | Liquid volume [l] 3269.297609<br>Vessel diameter [meter] 1.0668<br>Vessel tangent to tangent height [meter] 3.6576 | 24800 | 116800 | 141600 |
| Distillation column | Diameter Bottom section [meter] 0.6096<br>Bottom tangent to tangent height [meter] 15.24<br>Number of trays Bottom section 19 | 123200 | 518000 | 641200 |
| **Total Cost** | | $ 3833610 | | |

## 2. Operating Costs

a = 0, b = 2, c = 0.

Heating cost = $ (30 + 0 + 2 + 0) = $ 32 /KBTU

Cooling cost = $ (19 - 0 + 2 - 0) = $ 21 /KBTU

Used 1 cal/sec = 125061.27 BTU/year

| **Item** | **Amount per year (BTU / yr)** | **Cost per year ($ / yr)** |
|---|---|---|
| Heating | $3.3879*10^{10}$ | $1.0841*10^{9}$ |
| Cooling | $9.8436*10^{10}$ | $2.0672*10^{9}$ |
| **Total** | $1.3231*10^{11}$ | $3.1513*10^{9}$ |

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## 3.

To decrease capital costs, one can decrease the number of stages. Maintaining other specs same will result in an increase in operating costs. We also note that, since feed stage is fixed to be 8, we can't reduce number of stages below 8.

| Item | Old design (15 stages) | New design 1 (13 stages) | New design 2 (10 stages) |
|---|---|---|---|
| Capital cost (in $) | $ 3,833,610 | $ 3,804,860 | $ 3,791,000 |
| Operating cost (in $/year) | $ 1,751,780 | $ 1,749,840 | $ 1,748,060 |

We see as number of stages increases, both operating costs and capital costs decrease. But as we can see the reduction in capital costs is minimal (~1.11%). So even if we allow the number of stages to vary, we can't significantly reduce the capital cost.

Summary:

- Yes, capital cost reduces. But not significant enough.
- Operating costs have also decreased by an insignificant amount of 0.21%