Introduction to Process Design

The buck stops here

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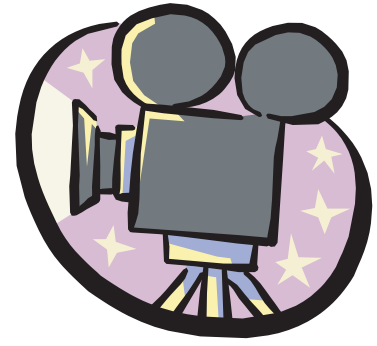

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- Planning and Organizational Design
  - Development of design team
  - Budget and time line

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- Utilize engineering judgment to analyze the solution.

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It is desired to produce 150,000 cubic meters of 190 proof ethanol per year from a feed of 75 million kg/year of ethylene. The ethylene feed is 96 mole % ethylene, 3 mole % propylene and 1 mole % methane. The feed costs $0.18 per pound and it is estimated that ethanol can be sold for $2.55 per gallon.

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Fundamental Rule of Economics:SELLING PRICE SHOULD BE GREATER THAN COST PRICE

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(because mol. wt. of ethanol is 46.07 and mol. wt. of water is 18.02)

Weight fraction of ethanol is: $\frac{(0.8544)(46.07)}{41.99} = 0.937$

Density of 190 proof ethanol is 810 kg/m^3.

Thus, moles of ethanol in 150,000 m^3/yr of 190 proof ethanol is:

$$\frac{(0.937)(150,000)(810)}{46.07} = 2,471,000\ kmol/yr$$

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Assuming 100% conversion of ethylene to ethanol, to produce 1 mole of ethanol requires 1 mole of ethylene.

Thus, to produce 2,471,000 $kmol/yr$ of ethanol, we need: $(2,471,000)(28.05) = 69,310,000\ kg/yr$ of ethylene

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$$\frac{3}{96}(2,471,000)(42.08) = 3,249,000\ kg/yr \text{ propylene}$$

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Total feed = $72,980,000\ kg/yr$
Cost of feed = $\$0.18/lb$ (given)

$$\text{Thus total feed cost} = (72,980,000)(2.2046)(0.18)$$
$$\approx \$29 \text{ million}$$

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Thus, we need a process where equipment cost plus operating cost are less than $72 million.

Effect of Price Fluctuation

Ethylene	Ethanol	Max. Profit
$\$0.18/lb$	$\$2.55/gal$	$\$72$ million
$\$0.16/lb$	$\$2.04/gal$	million
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