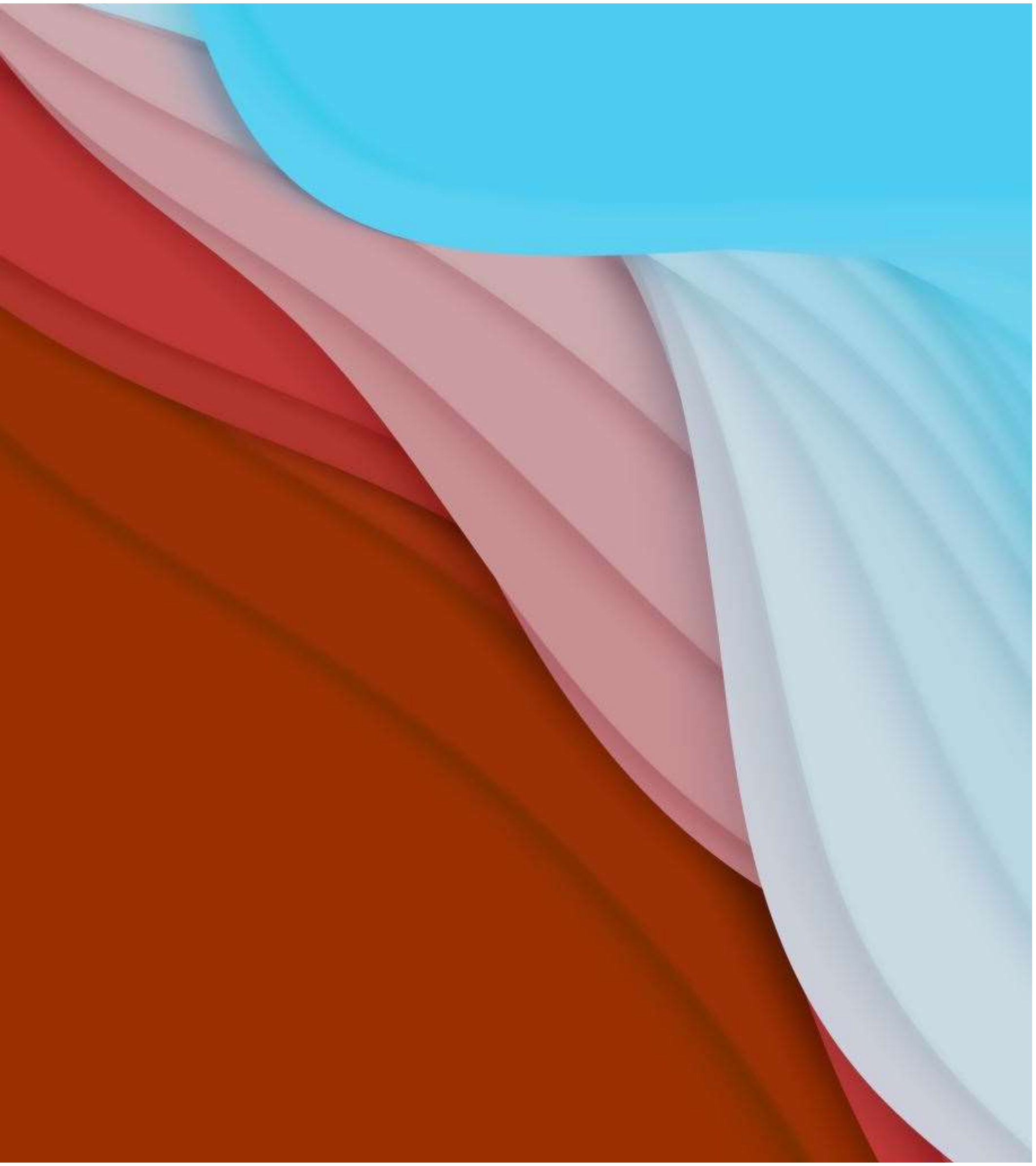
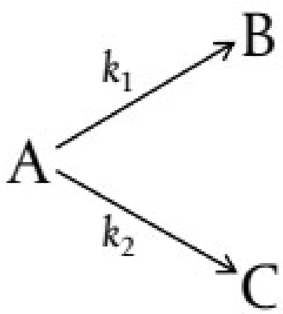


CEN416
PROCESS DESIGN II

Instantanenous Selectivity (S):

It is the ratio of the rate of formation of one product to the rate of formation of another product.



$$r_B = \frac{dC_B}{dt} = k_1 C_A$$

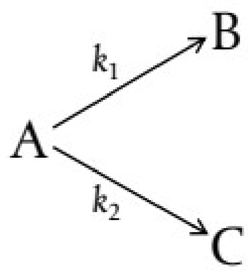
$$r_C = \frac{dC_C}{dt} = k_2 C_A$$

$$-r_A = (k_1 + k_2) C_A$$

$$S_{BC} = \frac{\frac{dC_B}{dt}}{\frac{dC_C}{dt}} = \frac{k_1 C_A}{k_2 C_A} = \frac{k_1}{k_2}$$

Overall Selectivity ($\tilde{S}$):

Ratio of the amount of one product formed to the amount of another product.



$$\tilde{S} = \frac{C_B}{C_C}$$

Qualitative Analysis

$A \xrightarrow{k_1} R$ (desired product) $r_R = \frac{dC_R}{dt} = k_1 C_A^{a_1}$

$A \xrightarrow{k_2} S$ (unwanted product) $r_S = \frac{dC_S}{dt} = k_2 C_A^{a_2}$

$$-r_A = r_R + r_S$$

$$\frac{r_R}{r_S} = \frac{dC_R}{dC_S} = \frac{k_1}{k_2} C_A^{a_1 - a_2}$$

Parallel Reactions with Two Reactants

$$A + B \xrightarrow{k_1} \mathbf{R} \qquad r_R = k_1 C_A^{\alpha_1} C_B^{\beta_1}$$

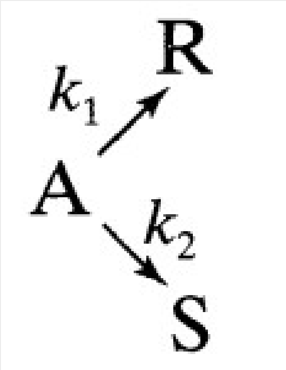
$$A + B \xrightarrow{k_2} \mathbf{S} \qquad r_S = k_2 C_A^{\alpha_2} C_B^{\beta_2}$$

Instantaneous Selectivity:

$$S_{R/S} = \frac{r_R}{r_S} = \frac{k_1}{k_2} C_A^{\alpha_1 - \alpha_2} C_B^{\beta_1 - \beta_2}$$

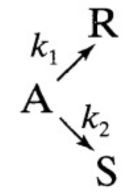
Quantitative Analysis

- $\boldsymbol{Y_R} = \frac{r_R}{r_A} = \frac{R\ formation\ rate}{A\ consumption\ rate} = \frac{\frac{dC_R}{dt}}{\frac{-dC_A}{dt}} = \frac{\boldsymbol{dC_R}}{\boldsymbol{-dC_A}}$



The overall fractional yield is the mean of the instantaneous yields at all points within the reactor; thus we may write

- $\tilde{Y} = \frac{all\ R\ formed}{all\ A\ reacted} = \frac{C_{R_f}}{C_{Ao} - C_{A_f}} = \frac{\boldsymbol{C_{Rf}}}{-\Delta \boldsymbol{C_A}} = \bar{Y}_{in\ reactor}$



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1. Sinnot, R.K. 1999, Coulson's & Richardson's Chemical Engineering, Volume 6, Chemical Engineering Design, ButterWorth Heinemann, Oxford.

2. Turton R., Bailie R.C., Whitin W.C., Shaeiwitz J.A. 1998, Analysis, Synthesis and Design of Chemical Processes, Prentice Hall, New Jersey.