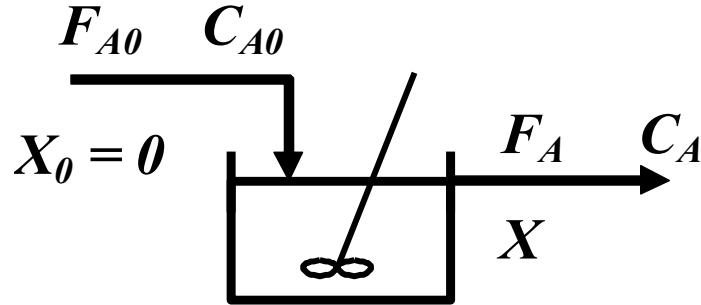


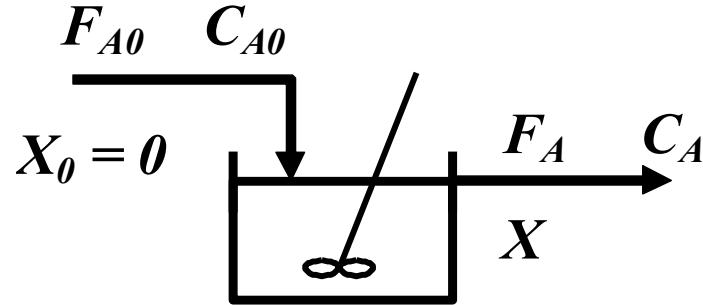
# Dimensionamento gráfico de reactores contínuos

CSTR



# Dimensionamento gráfico de reactores contínuos

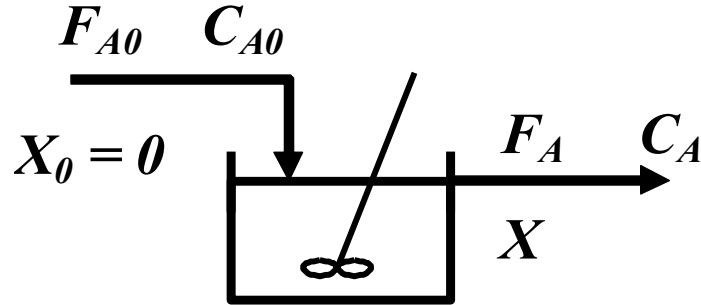
CSTR



$$F_{A0} - F_A + r_A \cdot V = 0$$

# Dimensionamento gráfico de reactores continuos

CSTR

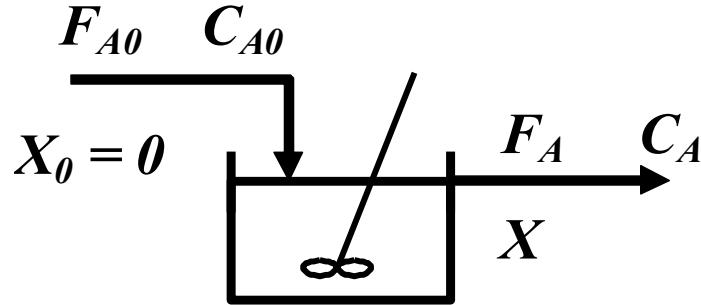


$$F_{A0} - F_A + r_A \cdot V = 0$$

$$X = \frac{F_{A0} - F_A}{F_{A0}}$$

# Dimensionamento gráfico de reactores continuos

CSTR



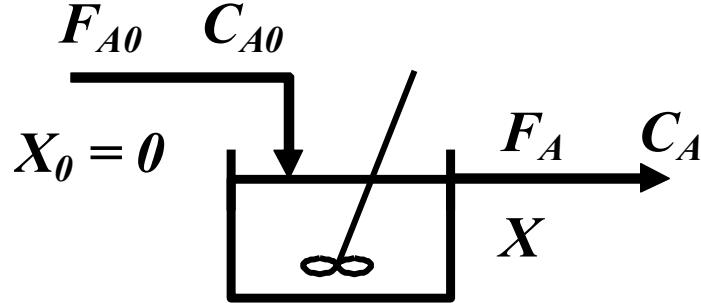
$$F_{A0} - F_A + r_A \cdot V = 0$$

$$X = \frac{F_{A0} - F_A}{F_{A0}}$$

$$F_A = F_{A0} - F_{A0} \cdot X$$

# Dimensionamento gráfico de reactores continuos

CSTR



$$F_{A0} - (F_{A0} - F_{A0} \cdot X) + r_A \cdot V = 0$$

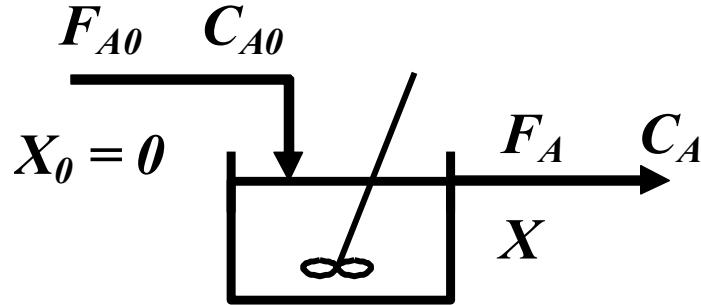
$$F_{A0} - F_A + r_A \cdot V = 0$$

$$X = \frac{F_{A0} - F_A}{F_{A0}}$$

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# Dimensionamento gráfico de reactores continuos

CSTR



$$F_{A0} - (F_{A0} - F_{A0} \cdot X) + r_A \cdot V = 0$$

$$F_{A0} - F_A + r_A \cdot V = 0$$

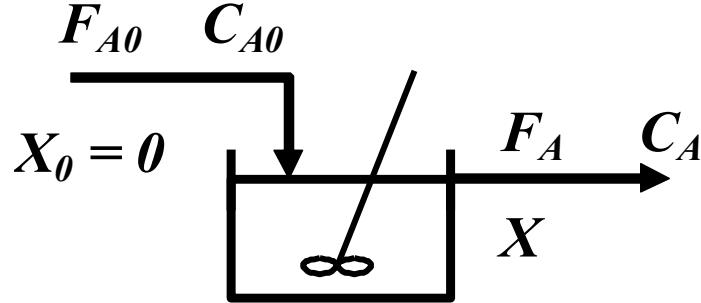
$$X = \frac{F_{A0} - F_A}{F_{A0}}$$

$$F_{A0} - F_{A0} + F_{A0} X + r_A V = 0$$

$$F_A = F_{A0} - F_{A0} \cdot X$$

# Dimensionamento gráfico de reactores continuos

CSTR



$$F_{A0} - (F_{A0} - F_{A0} \cdot X) + r_A \cdot V = 0$$

$$F_{A0} - F_A + r_A \cdot V = 0$$

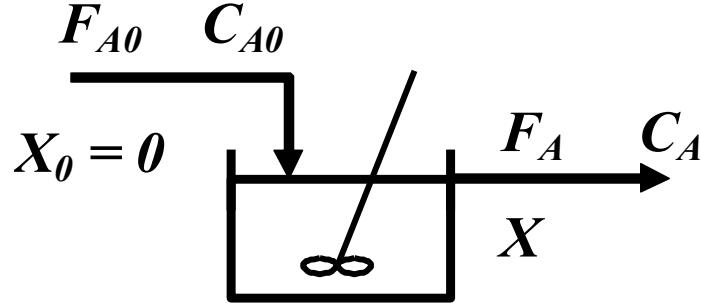
$$X = \frac{F_{A0} - F_A}{F_{A0}}$$

$$F_{A0} X + r_A V = 0$$

$$F_A = F_{A0} - F_{A0} \cdot X$$

# Dimensionamento gráfico de reactores continuos

CSTR



$$F_{A0} - (F_{A0} - F_{A0} \cdot X) + r_A \cdot V = 0$$

$$F_{A0} - F_A + r_A \cdot V = 0$$

$$X = \frac{F_{A0} - F_A}{F_{A0}}$$

$$F_A = F_{A0} - F_{A0} \cdot X$$

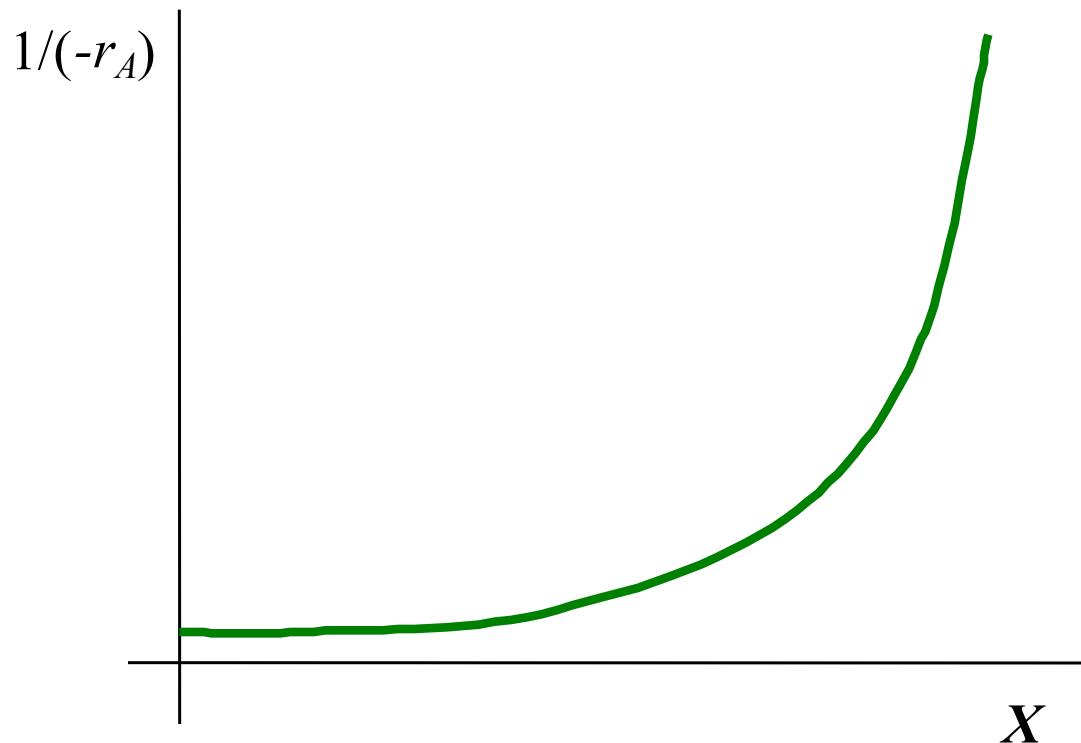
$$F_{A0} X + r_A V = 0$$

$$V = \frac{F_{A0} \cdot X}{(-r_A)}$$

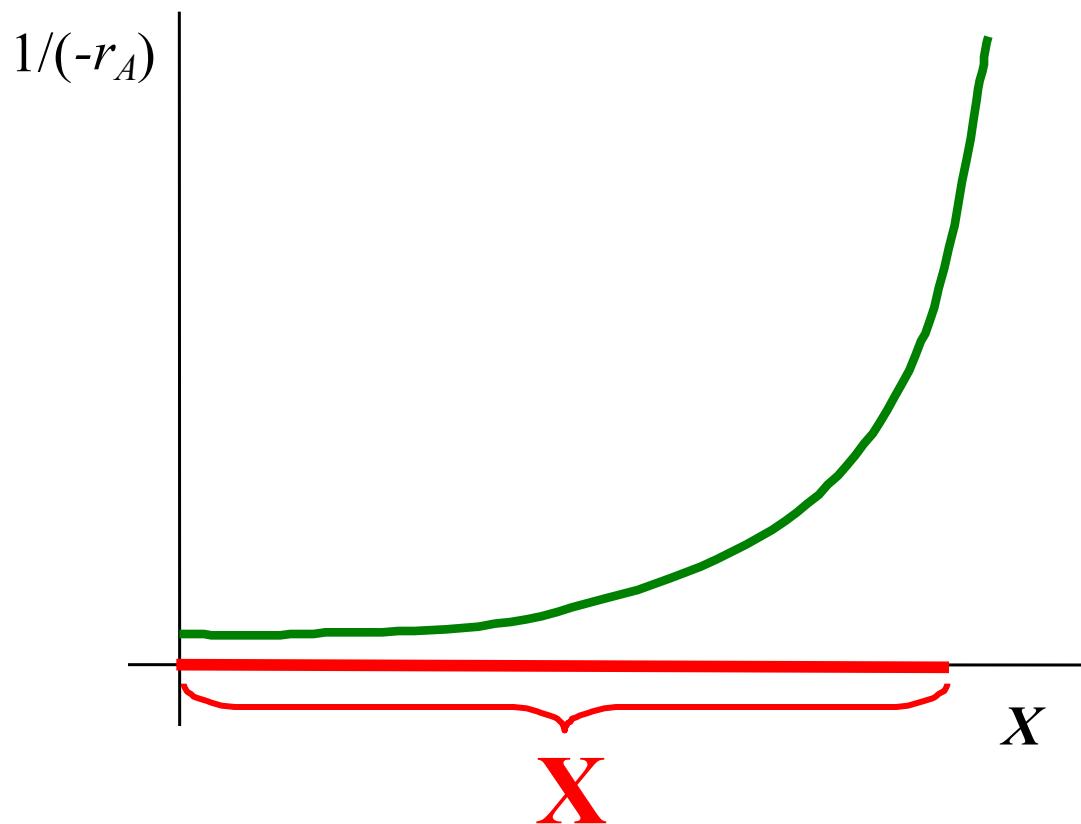
$$\frac{V}{\mathbf{F}_{A0}} = \textcolor{red}{X} \cdot \frac{1}{(-r_A)}$$



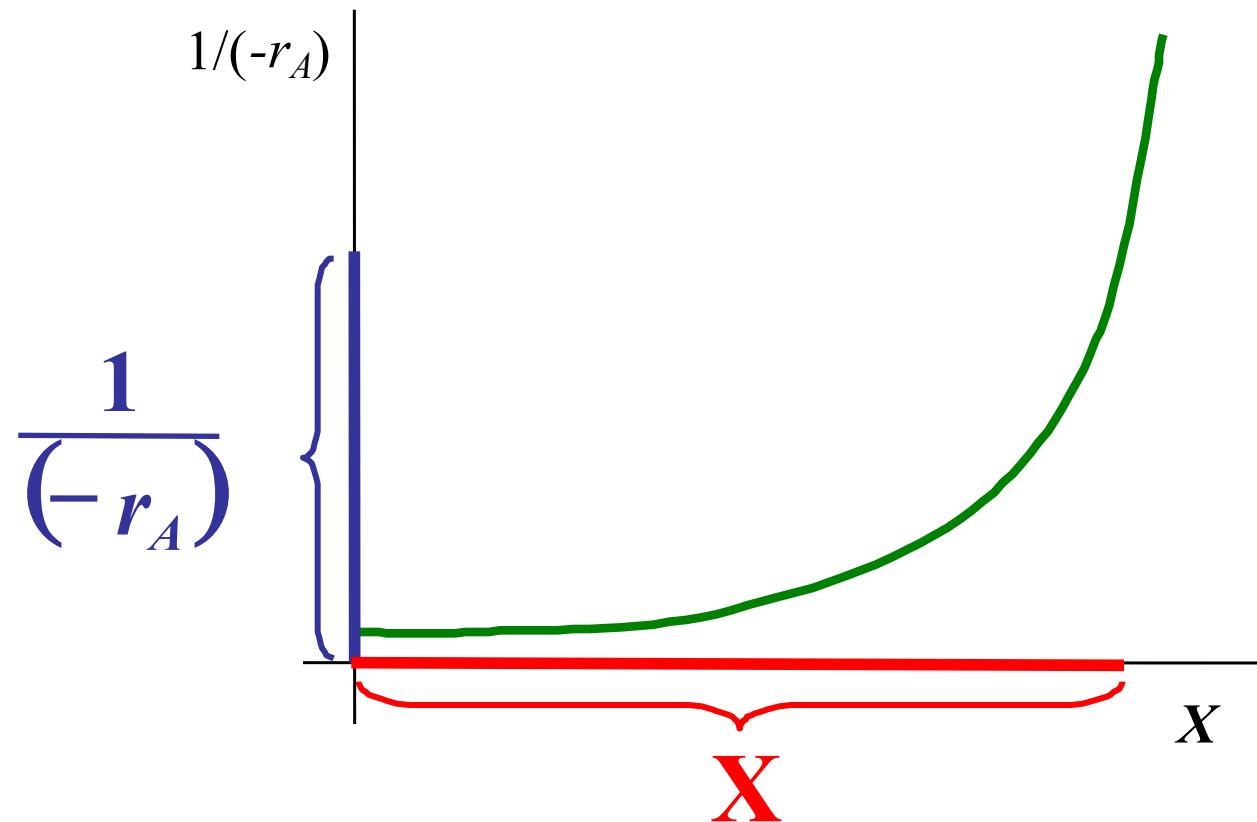
$$\frac{V}{F_{A0}} = \mathbf{X} \cdot \frac{1}{(-r_A)}$$



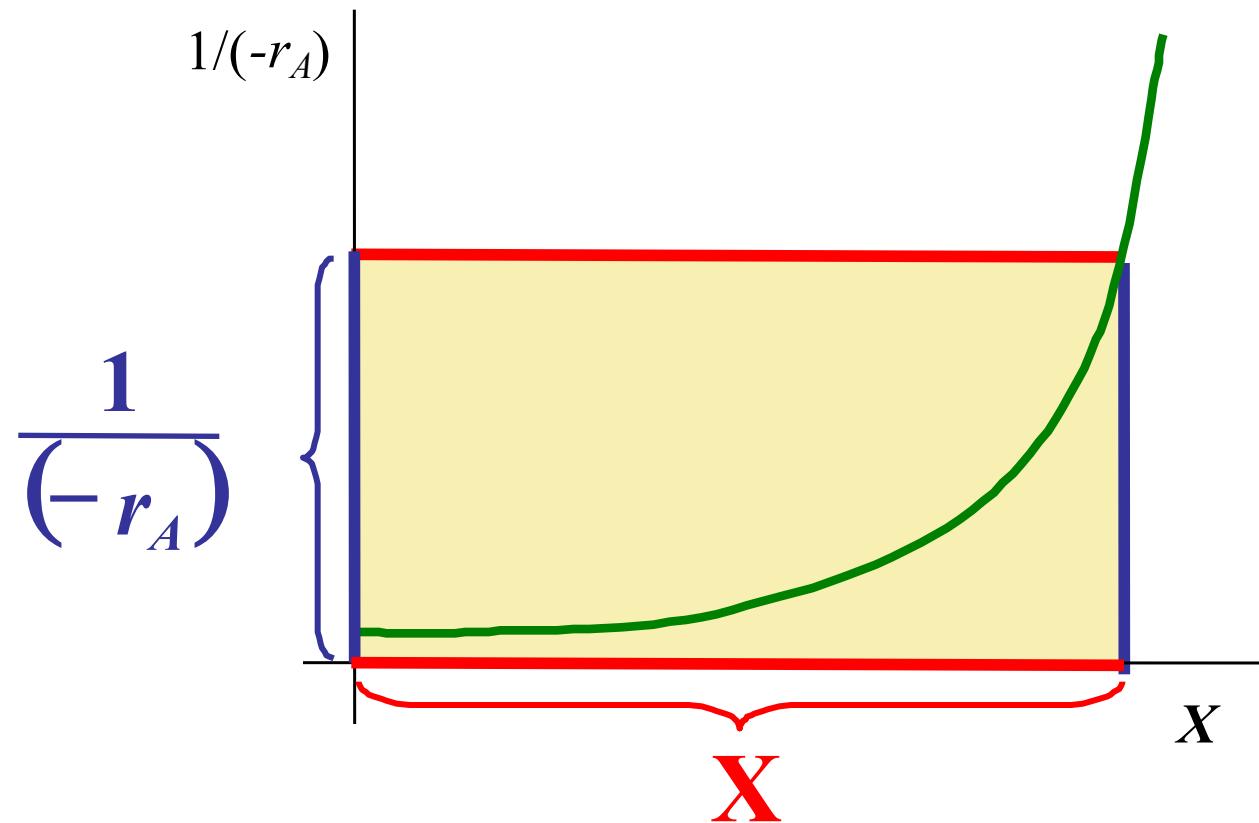
$$\frac{V}{F_{A0}} = \mathbf{X} \cdot \frac{1}{(-r_A)}$$



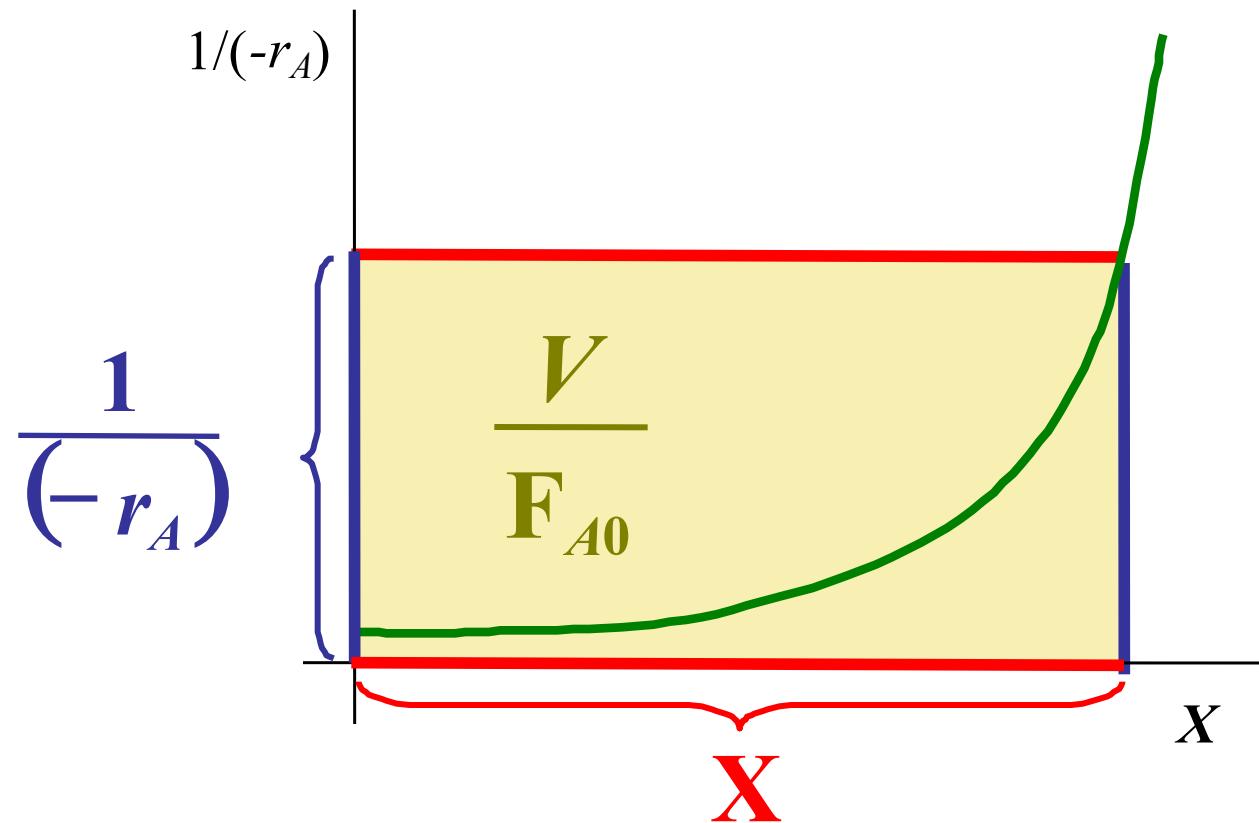
$$\frac{V}{F_{A0}} = \mathbf{X} \cdot \frac{1}{(-r_A)}$$



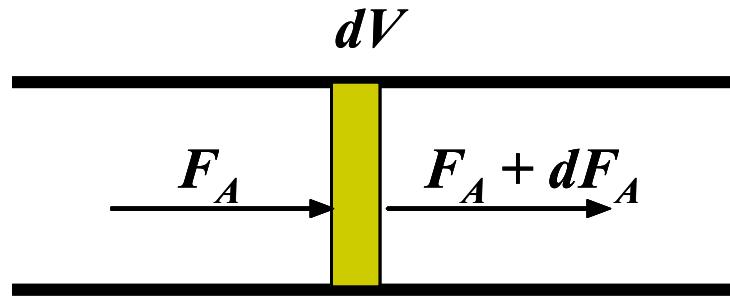
$$\frac{V}{\mathbf{F}_{A0}} = \mathbf{X} \cdot \frac{1}{(-r_A)}$$



$$\frac{V}{F_{A0}} = \mathbf{X} \cdot \frac{1}{(-r_A)}$$



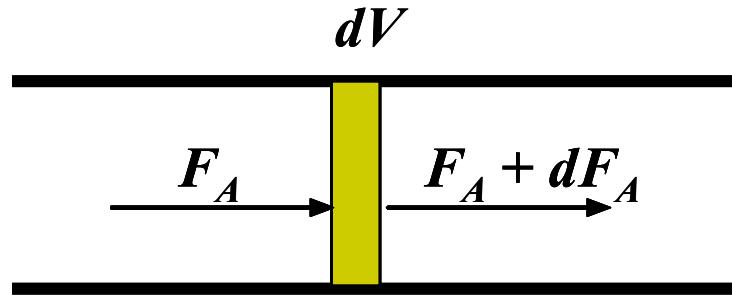
**PFR**



$$dV = F_{A0} \cdot \frac{dX}{(-r_A)}$$

$$V = \int_0^V dV = F_{A0} \cdot \int_0^X \frac{dX}{(-r_A)}$$

**PFR**

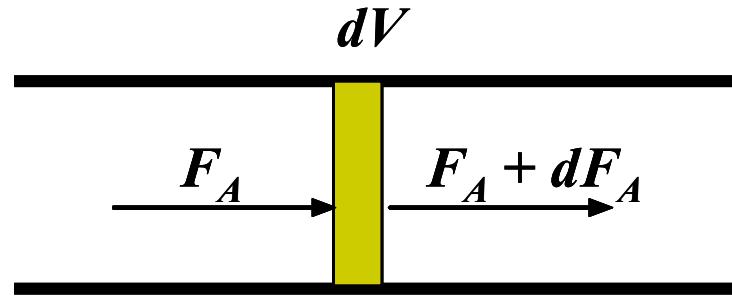


$$F_A - (F_A + dF_A) + r_A dV = 0$$

$$dV = F_{A0} \cdot \frac{dX}{(-r_A)}$$

$$V = \int_0^V dV = F_{A0} \cdot \int_0^X \frac{dX}{(-r_A)}$$

**PFR**



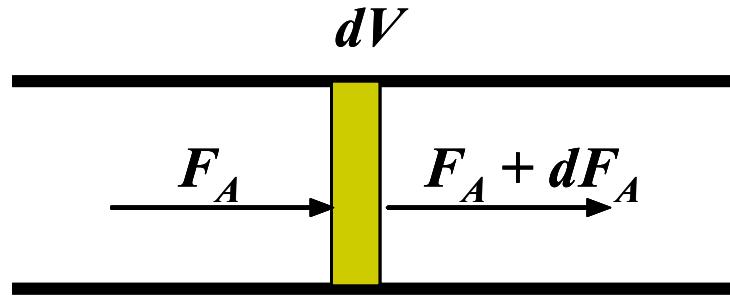
$$F_A - (F_A + dF_A) + r_A dV = 0$$

$$F_A - F_A - dF_A + r_A dV = 0$$

$$dV = F_{A0} \cdot \frac{dX}{(-r_A)}$$

$$V = \int_0^V dV = F_{A0} \cdot \int_0^X \frac{dX}{(-r_A)}$$

# PFR



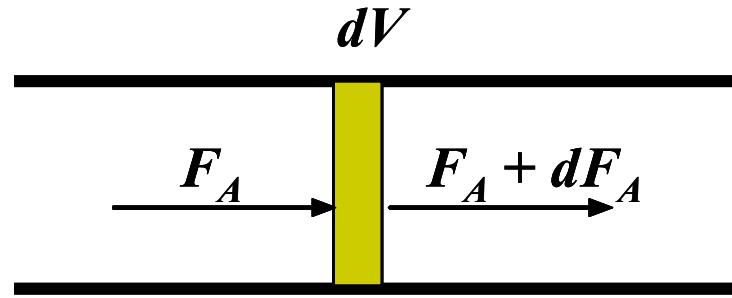
$$F_A - (F_A + dF_A) + r_A dV = 0$$

$$dF_A + r_A dV = 0$$

$$dV = F_{A0} \cdot \frac{dX}{(-r_A)}$$

$$V = \int_0^V dV = F_{A0} \cdot \int_0^X \frac{dX}{(-r_A)}$$

# PFR



$$F_A - (F_A + dF_A) + r_A dV = 0$$

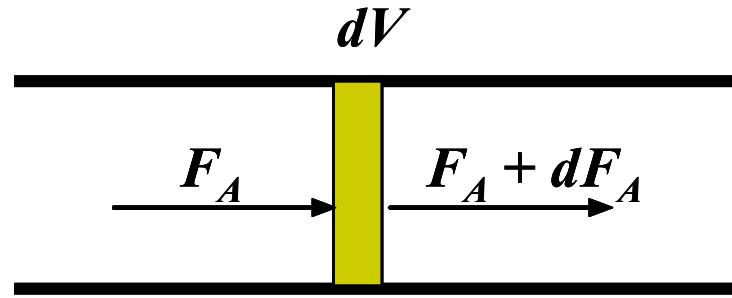
$$F_A = F_{A0} \cdot (1 - X)$$

$$dF_A + r_A dV = 0$$

$$dV = F_{A0} \cdot \frac{dX}{(-r_A)}$$

$$V = \int_0^V dV = F_{A0} \cdot \int_0^X \frac{dX}{(-r_A)}$$

# PFR



$$F_A - (F_A + dF_A) + r_A dV = 0$$

$$F_A = F_{A0} \cdot (1 - X)$$

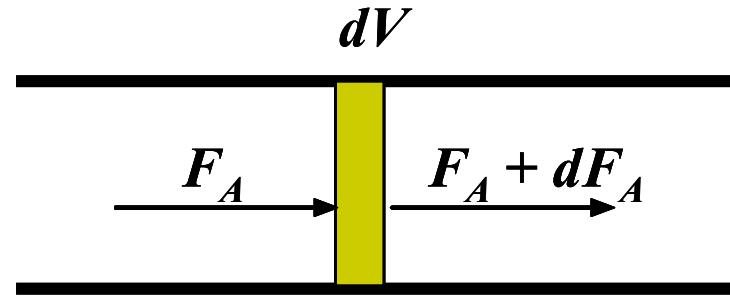
$$dF_A + r_A dV = 0$$

$$dF_A = -F_{A0} dX$$

$$dV = F_{A0} \cdot \frac{dX}{(-r_A)}$$

$$V = \int_0^V dV = F_{A0} \cdot \int_0^X \frac{dX}{(-r_A)}$$

**PFR**



$$F_A - (F_A + dF_A) + r_A dV = 0$$

$$F_A = F_{A0} \cdot (1 - X)$$

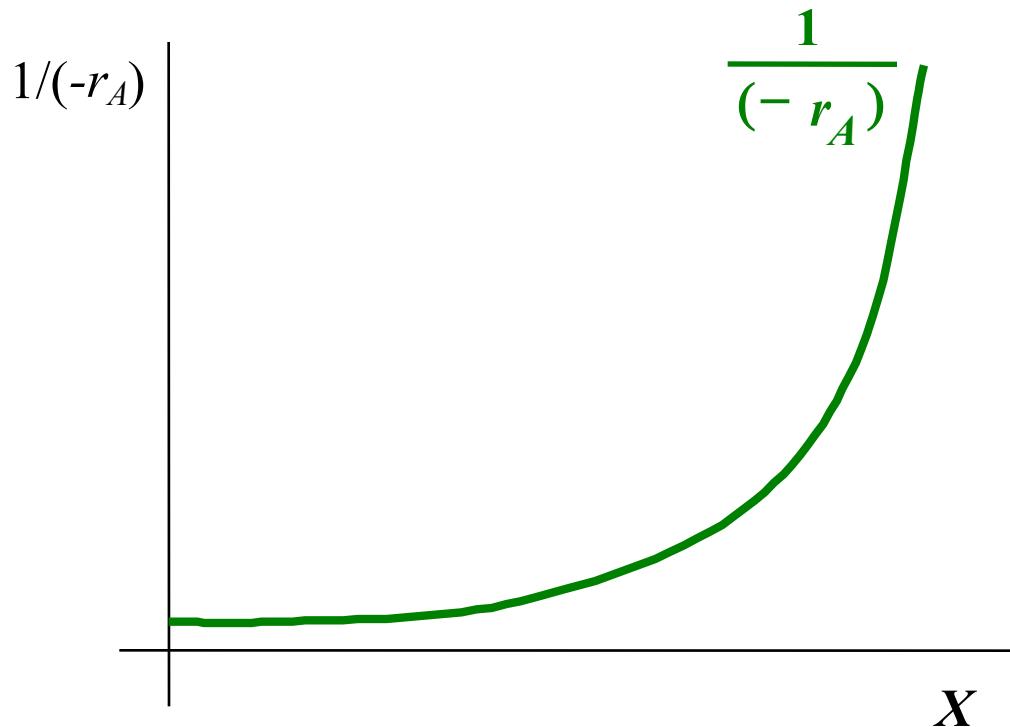
$$F_{A0} dX + r_A dV = 0$$

$$dF_A = -F_{A0} dX$$

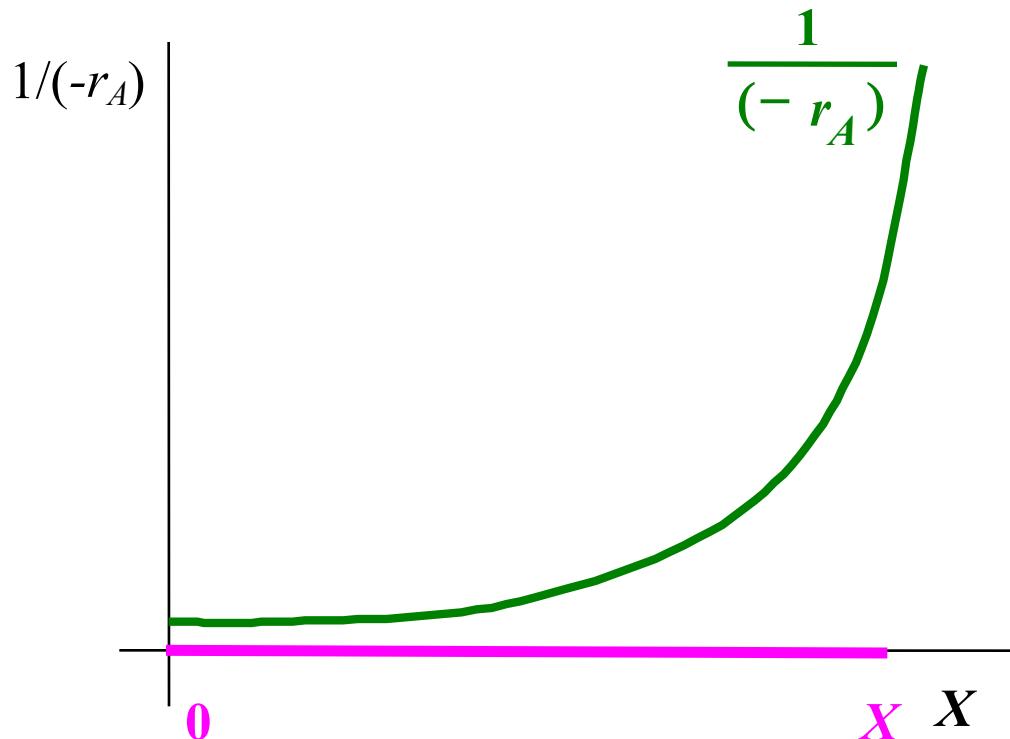
$$dV = F_{A0} \cdot \frac{dX}{(-r_A)}$$

$$V = \int_0^V dV = F_{A0} \cdot \int_0^X \frac{dX}{(-r_A)}$$

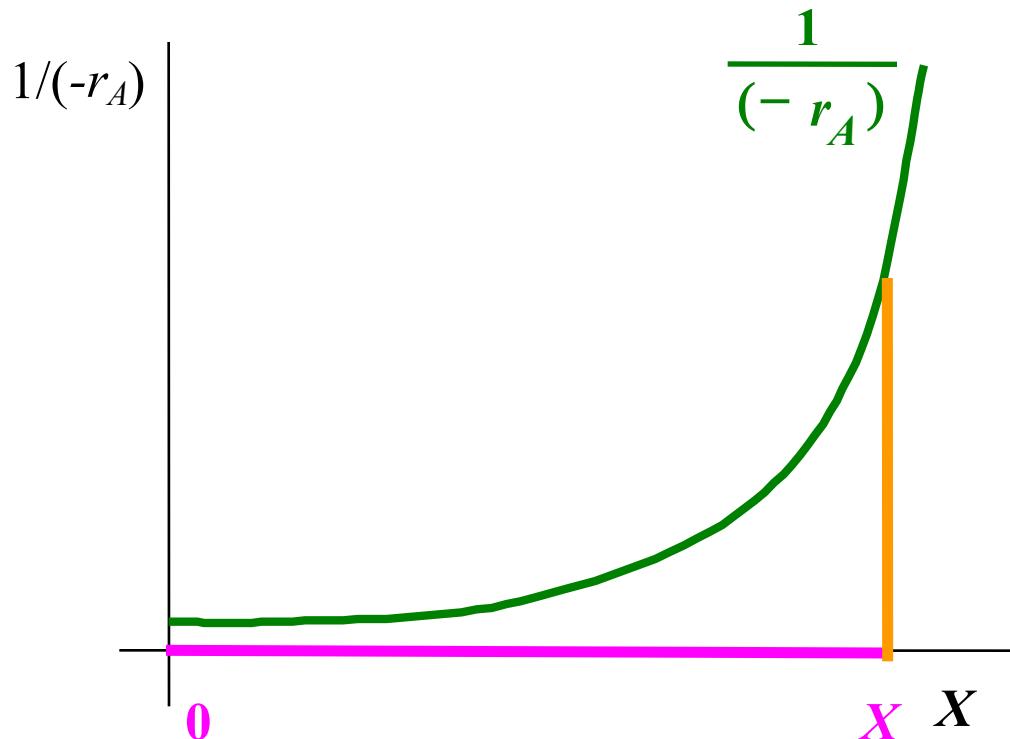
$$\frac{V}{F_{A0}} = \int_0^X \frac{1}{(-r_A)} \cdot dX$$



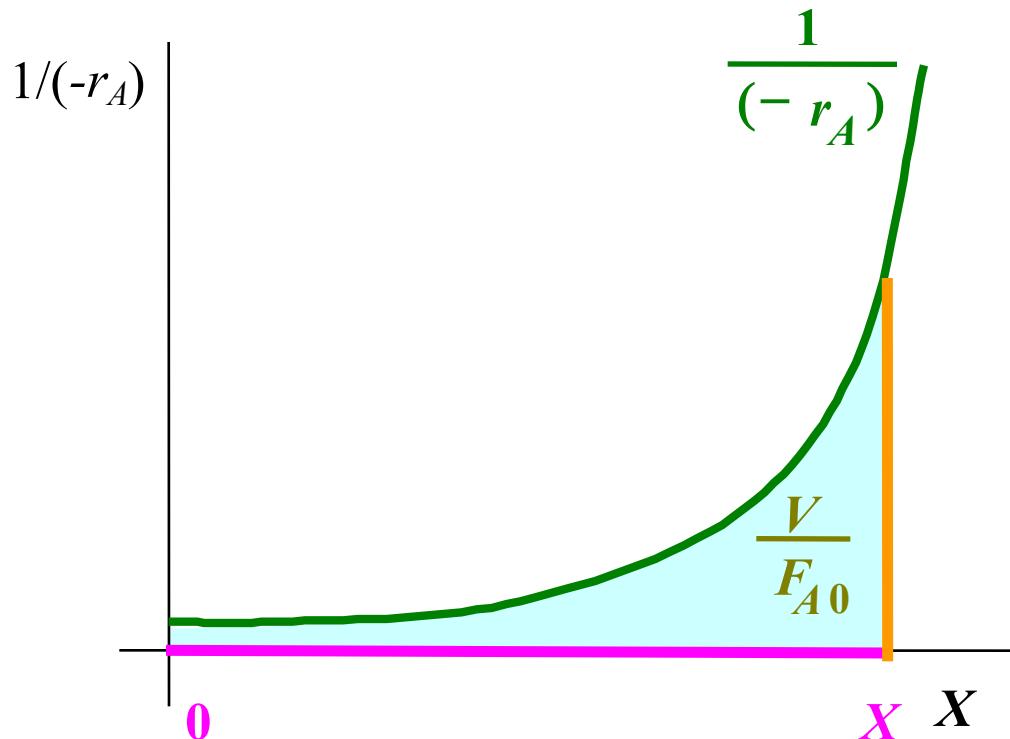
$$\frac{V}{F_{A0}} = \int_0^X \frac{1}{(-r_A)} \cdot dX$$



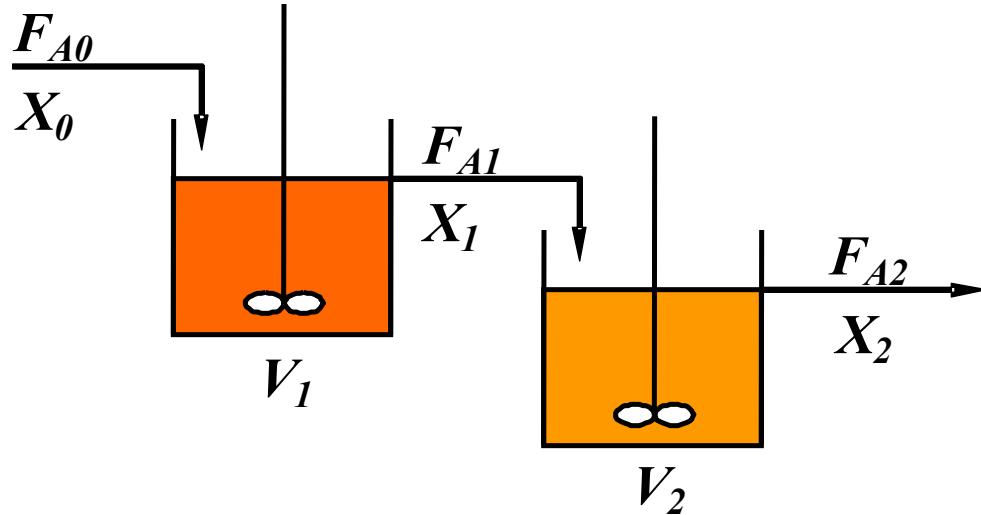
$$\frac{V}{F_{A0}} = \int_0^X \frac{1}{(-r_A)} \cdot dX$$



$$\frac{V}{F_{A0}} = \int_0^X \frac{1}{(-r_A)} \cdot dX$$



# Associação em série de reactores CSTR

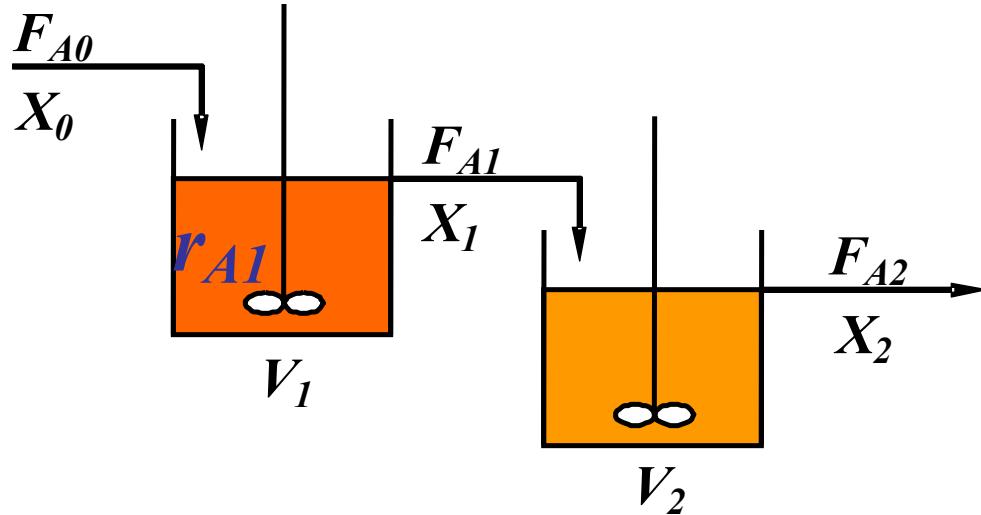


$$X_1 = \frac{F_{A0} - F_{A1}}{F_{A0}}$$

$$X_2 = \frac{F_{A0} - F_{A2}}{F_{A0}}$$

$$\textcolor{red}{C_{A1} > C_{A2}} \quad \Rightarrow \quad \textcolor{blue}{r_{A1} > r_{A2}}$$

# Associação em série de reactores CSTR

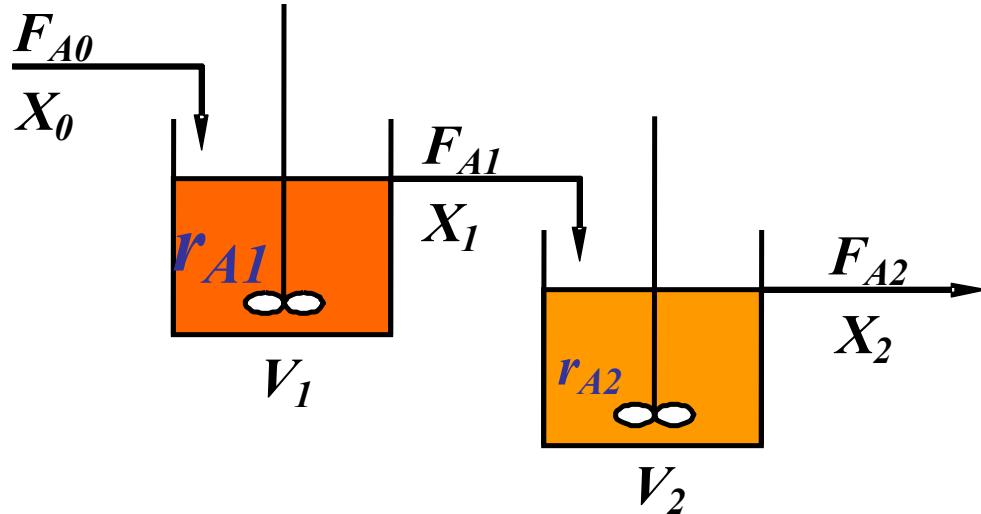


$$X_1 = \frac{F_{A0} - F_{A1}}{F_{A0}}$$

$$X_2 = \frac{F_{A0} - F_{A2}}{F_{A0}}$$

$$C_{A1} > C_{A2} \Rightarrow r_{A1} > r_{A2}$$

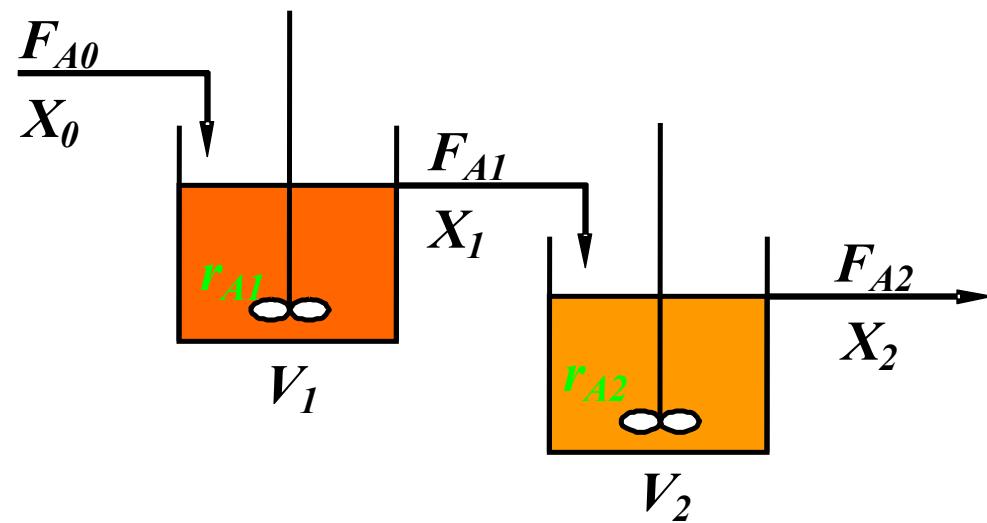
# Associação em série de reactores CSTR

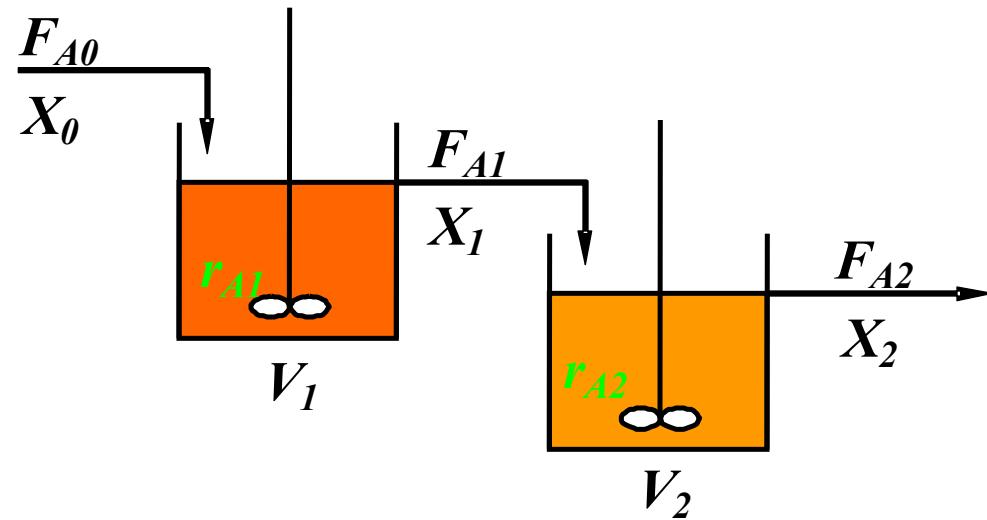


$$X_1 = \frac{F_{A0} - F_{A1}}{F_{A0}}$$

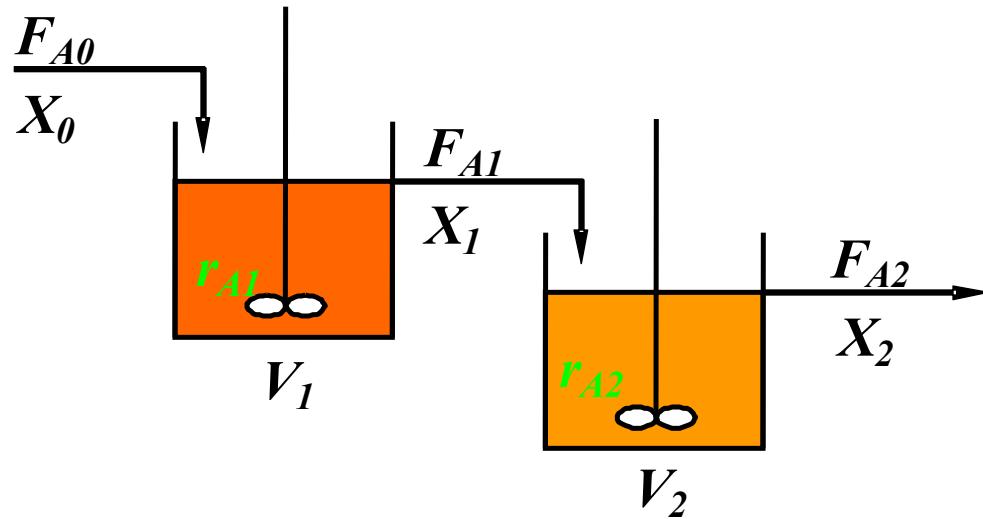
$$X_2 = \frac{F_{A0} - F_{A2}}{F_{A0}}$$

$$C_{A1} > C_{A2} \Rightarrow r_{A1} > r_{A2}$$



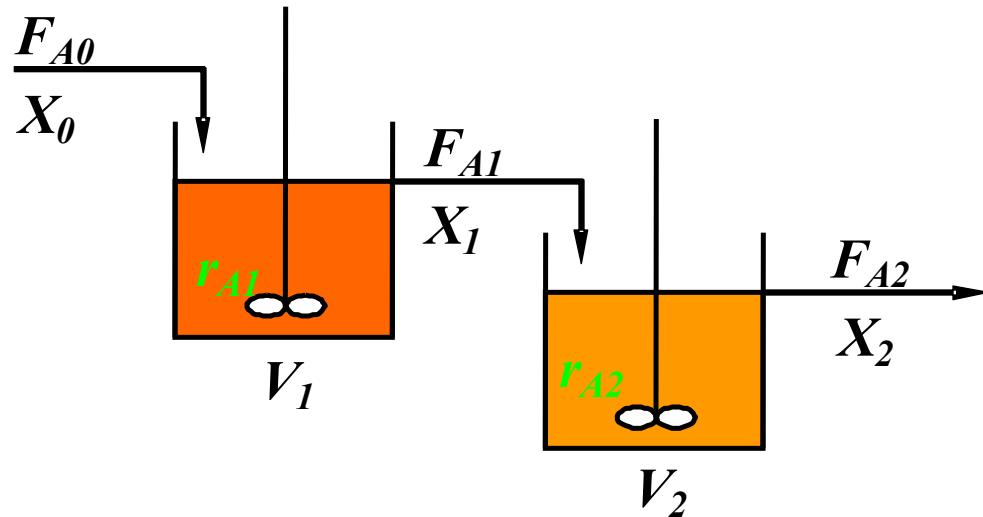


**Reactor 1**



### Reactor 1

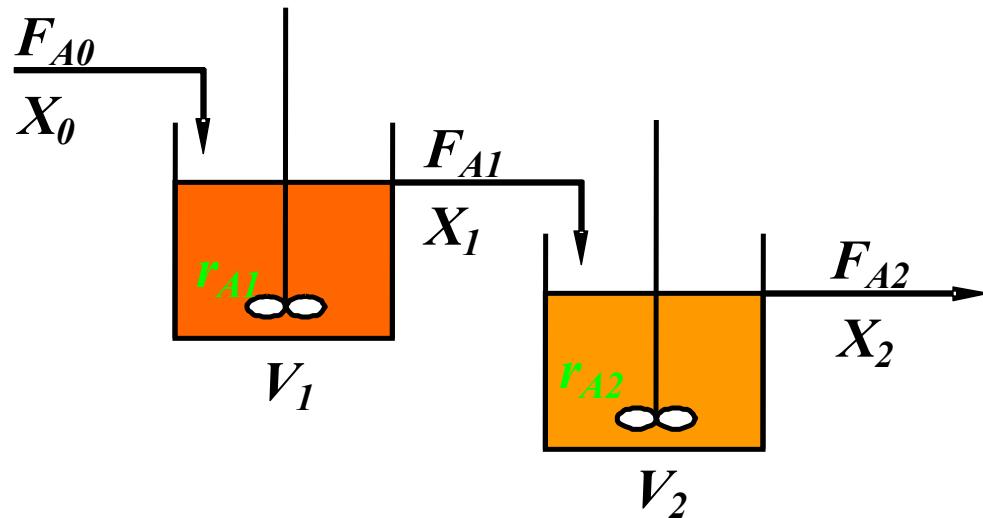
$$F_{A0} - F_{A1} + r_{A1} \cdot V_1 = 0$$



### Reactor 1

$$F_{A0} - F_{A1} + r_{A1} \cdot V_1 = 0$$

$$\therefore F_{A0} - F_{A0} \cdot (1 - X_1) + r_{A1} \cdot V_1 = 0$$

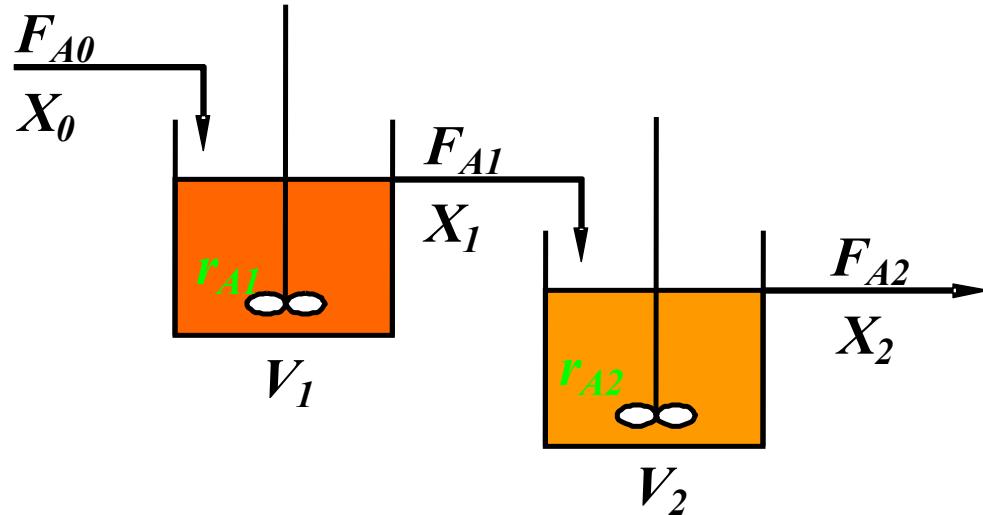


### Reactor 1

$$F_{A0} - F_{A1} + r_{A1} \cdot V_1 = 0$$

$$\therefore F_{A0} - F_{A0} \cdot (1 - X_1) + r_{A1} \cdot V_1 = 0$$

$$\therefore F_{A0} \cdot X_1 + r_{A1} \cdot V_1 = 0$$



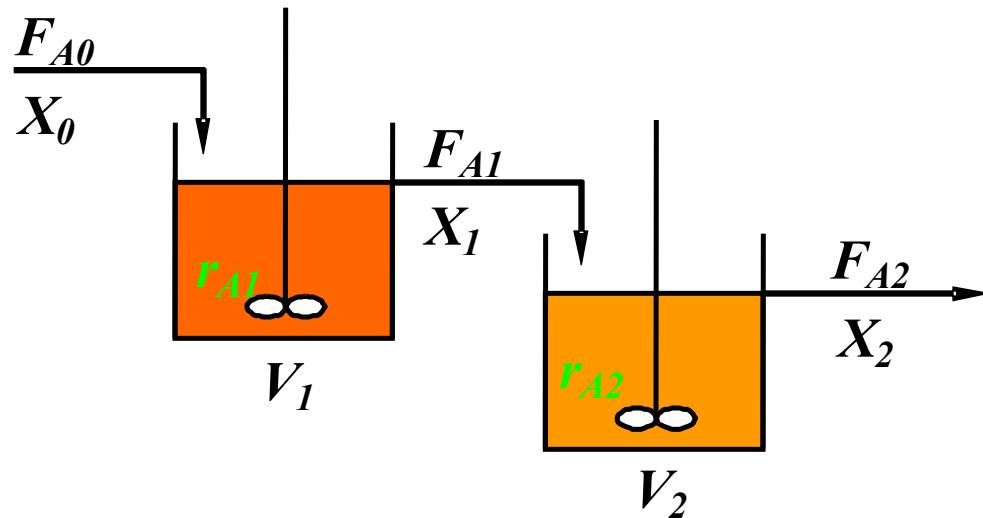
### Reactor 1

$$F_{A0} - F_{A1} + r_{A1} \cdot V_1 = 0$$

$$\therefore F_{A0} - F_{A0} \cdot (1 - X_1) + r_{A1} \cdot V_1 = 0$$

$$\therefore F_{A0} \cdot X_1 + r_{A1} \cdot V_1 = 0$$

$$\therefore \frac{V_1}{F_{A0}} = X_1 \cdot \frac{1}{(-r_{A1})}$$



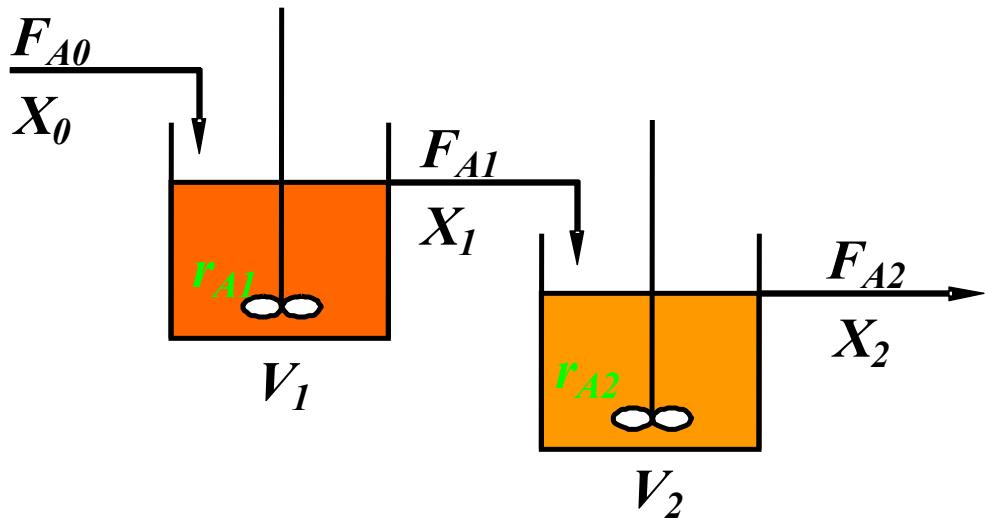
**Reactor 1**

$$F_{A0} - F_{A1} + r_{A1} \cdot V_1 = 0$$

$$\therefore F_{A0} - F_{A0} \cdot (1 - X_1) + r_{A1} \cdot V_1 = 0$$

$$\therefore F_{A0} \cdot X_1 + r_{A1} \cdot V_1 = 0$$

$$\therefore \frac{V_1}{F_{A0}} = X_1 \cdot \frac{1}{(-r_{A1})}$$



**Reactor 1**

$$F_{A0} - F_{A1} + r_{A1} \cdot V_1 = 0$$

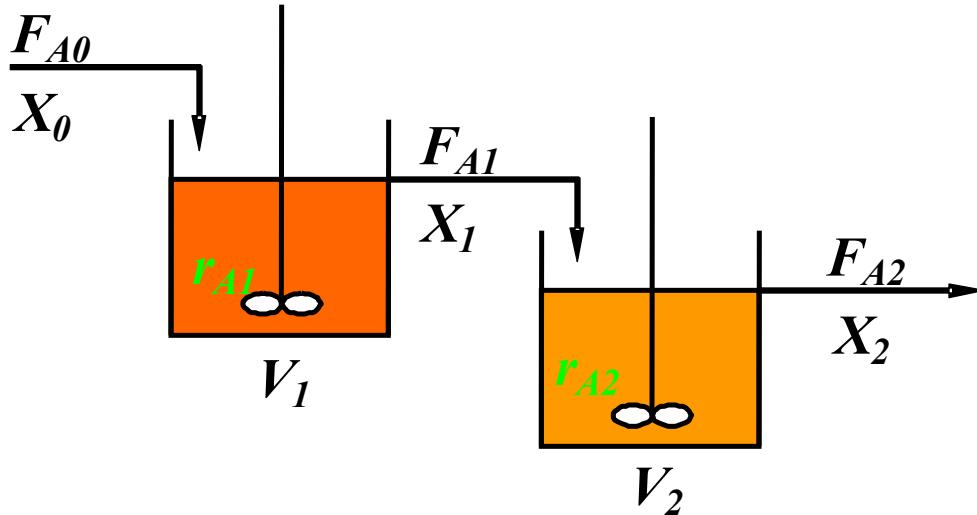
$$\therefore F_{A0} - F_{A0} \cdot (1 - X_1) + r_{A1} \cdot V_1 = 0$$

**Reactor 2**

$$F_{A1} - F_{A2} + r_{A2} \cdot V_2 = 0$$

$$\therefore F_{A0} \cdot X_1 + r_{A1} \cdot V_1 = 0$$

$$\therefore \frac{V_1}{F_{A0}} = X_1 \cdot \frac{1}{(-r_{A1})}$$



**Reactor 1**

$$F_{A0} - F_{A1} + r_{A1} \cdot V_1 = 0$$

$$\therefore F_{A0} - F_{A0} \cdot (1 - X_1) + r_{A1} \cdot V_1 = 0$$

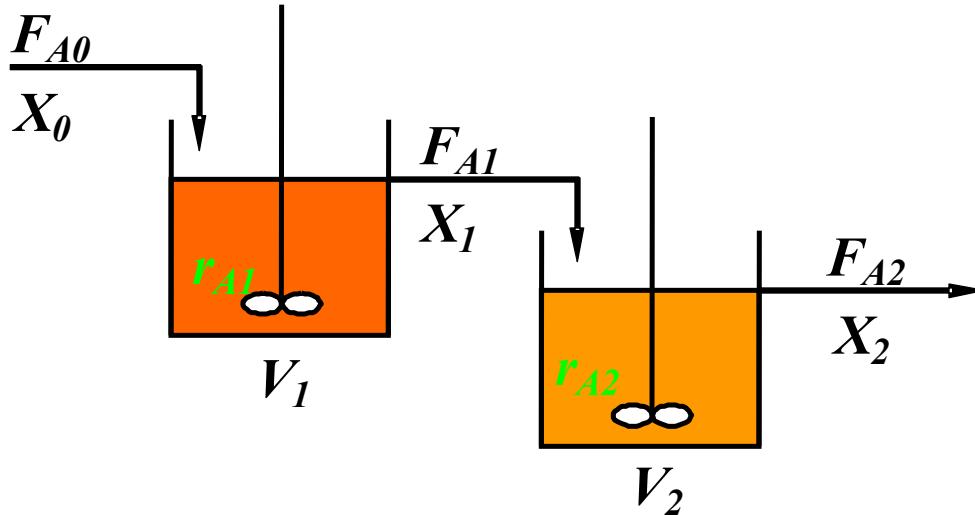
**Reactor 2**

$$F_{A1} - F_{A2} + r_{A2} \cdot V_2 = 0$$

$$\therefore F_{A0} \cdot (1 - X_1) - F_{A0} \cdot (1 - X_2) + r_{A2} \cdot V_2 = 0$$

$$\therefore F_{A0} \cdot X_1 + r_{A1} \cdot V_1 = 0$$

$$\therefore \frac{V_1}{F_{A0}} = X_1 \cdot \frac{1}{(-r_{A1})}$$



### Reactor 1

$$F_{A0} - F_{A1} + r_{A1} \cdot V_1 = 0$$

$$\therefore F_{A0} - F_{A0} \cdot (1 - X_1) + r_{A1} \cdot V_1 = 0$$

$$\therefore F_{A0} \cdot X_1 + r_{A1} \cdot V_1 = 0$$

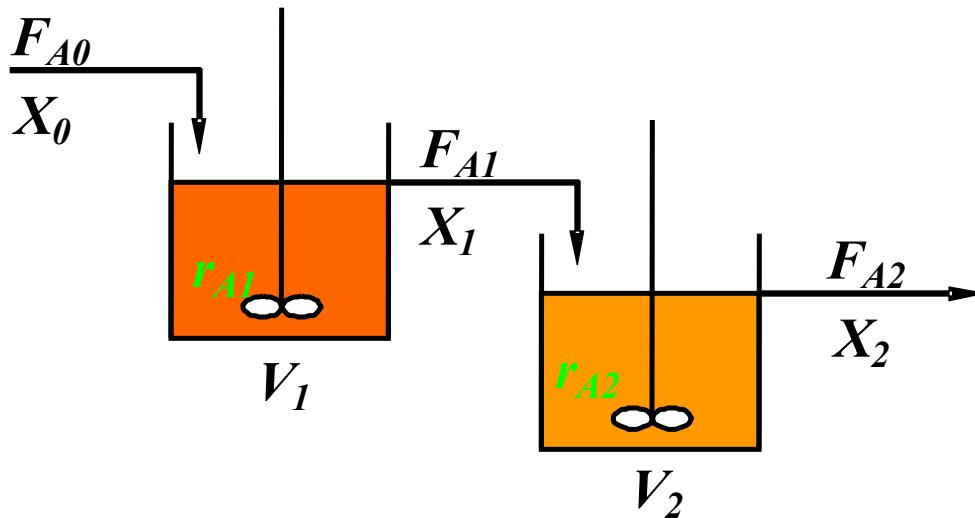
### Reactor 2

$$F_{A1} - F_{A2} + r_{A2} \cdot V_2 = 0$$

$$\therefore F_{A0} \cdot (1 - X_1) - F_{A0} \cdot (1 - X_2) + r_{A2} \cdot V_2 = 0$$

$$\therefore F_{A0} - F_{A0} \cdot X_1 - F_{A0} + F_{A0} \cdot X_2 + r_{A2} \cdot V_2 = 0$$

$$\therefore \frac{V_1}{F_{A0}} = X_1 \cdot \frac{1}{(-r_{A1})}$$



### Reactor 1

$$F_{A0} - F_{A1} + r_{A1} \cdot V_1 = 0$$

$$\therefore F_{A0} - F_{A0} \cdot (1 - X_1) + r_{A1} \cdot V_1 = 0$$

$$\therefore F_{A0} \cdot X_1 + r_{A1} \cdot V_1 = 0$$

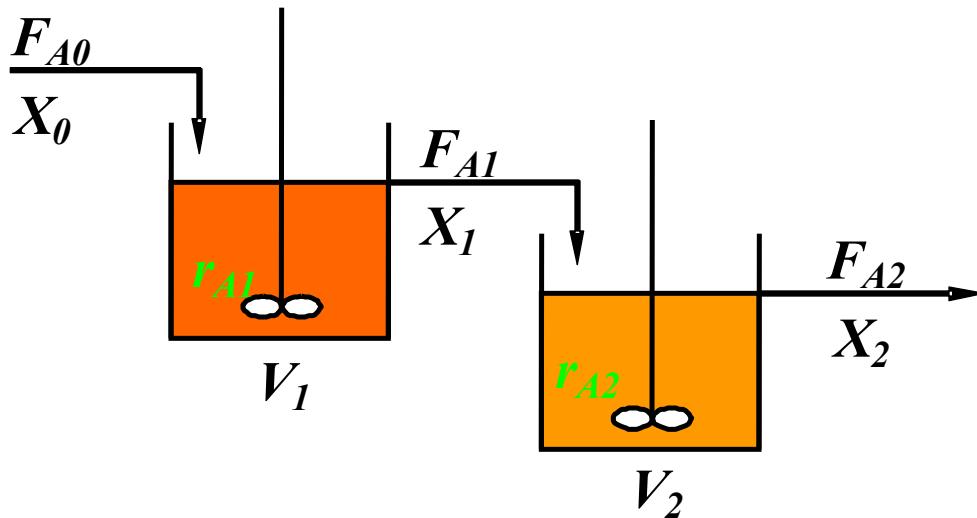
### Reactor 2

$$F_{A1} - F_{A2} + r_{A2} \cdot V_2 = 0$$

$$\therefore F_{A0} \cdot (1 - X_1) - F_{A0} \cdot (1 - X_2) + r_{A2} \cdot V_2 = 0$$

$$\therefore \cancel{F_{A0}} - F_{A0} \cdot X_1 - \cancel{F_{A0}} + F_{A0} \cdot X_2 + r_{A2} \cdot V_2 = 0$$

$$\therefore \frac{V_1}{F_{A0}} = X_1 \cdot \frac{1}{(-r_{A1})}$$



### Reactor 1

$$F_{A0} - F_{A1} + r_{A1} \cdot V_1 = 0$$

$$\therefore F_{A0} - F_{A0} \cdot (1 - X_1) + r_{A1} \cdot V_1 = 0$$

$$\therefore F_{A0} \cdot X_1 + r_{A1} \cdot V_1 = 0$$

$$\therefore \frac{V_1}{F_{A0}} = X_1 \cdot \frac{1}{(-r_{A1})}$$

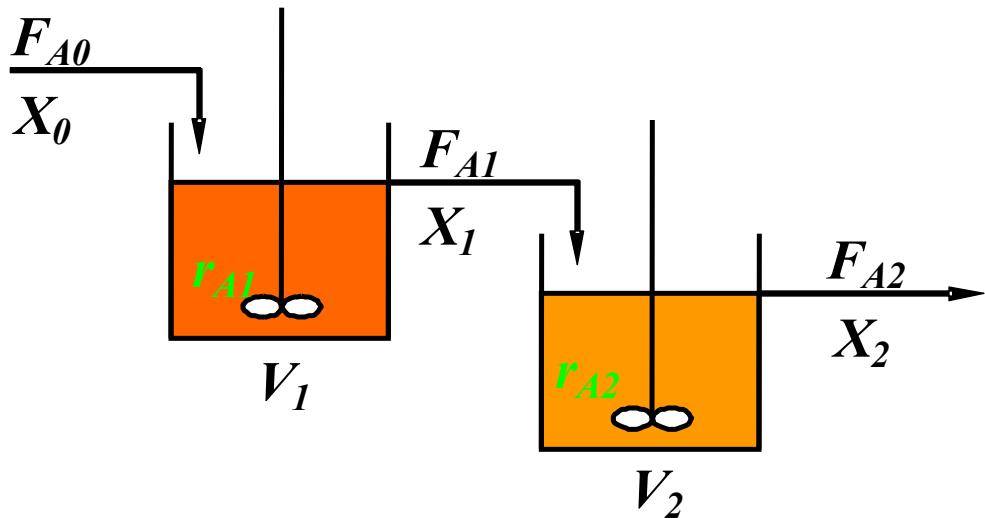
### Reactor 2

$$F_{A1} - F_{A2} + r_{A2} \cdot V_2 = 0$$

$$\therefore F_{A0} \cdot (1 - X_1) - F_{A0} \cdot (1 - X_2) + r_{A2} \cdot V_2 = 0$$

$$\therefore \cancel{F_{A0}} - F_{A0} \cdot X_1 - \cancel{F_{A0}} + F_{A0} \cdot X_2 + r_{A2} \cdot V_2 = 0$$

$$\therefore (X_2 - X_1) \cdot F_{A0} + r_{A2} \cdot V_2 = 0$$



### Reactor 1

$$F_{A0} - F_{A1} + r_{A1} \cdot V_1 = 0$$

$$\therefore F_{A0} - F_{A0} \cdot (1 - X_1) + r_{A1} \cdot V_1 = 0$$

$$\therefore F_{A0} \cdot X_1 + r_{A1} \cdot V_1 = 0$$

$$\therefore \frac{V_1}{F_{A0}} = X_1 \cdot \frac{1}{(-r_{A1})}$$

### Reactor 2

$$F_{A1} - F_{A2} + r_{A2} \cdot V_2 = 0$$

$$\therefore F_{A0} \cdot (1 - X_1) - F_{A0} \cdot (1 - X_2) + r_{A2} \cdot V_2 = 0$$

$$\therefore \cancel{F_{A0}} - F_{A0} \cdot X_1 - \cancel{F_{A0}} + F_{A0} \cdot X_2 + r_{A2} \cdot V_2 = 0$$

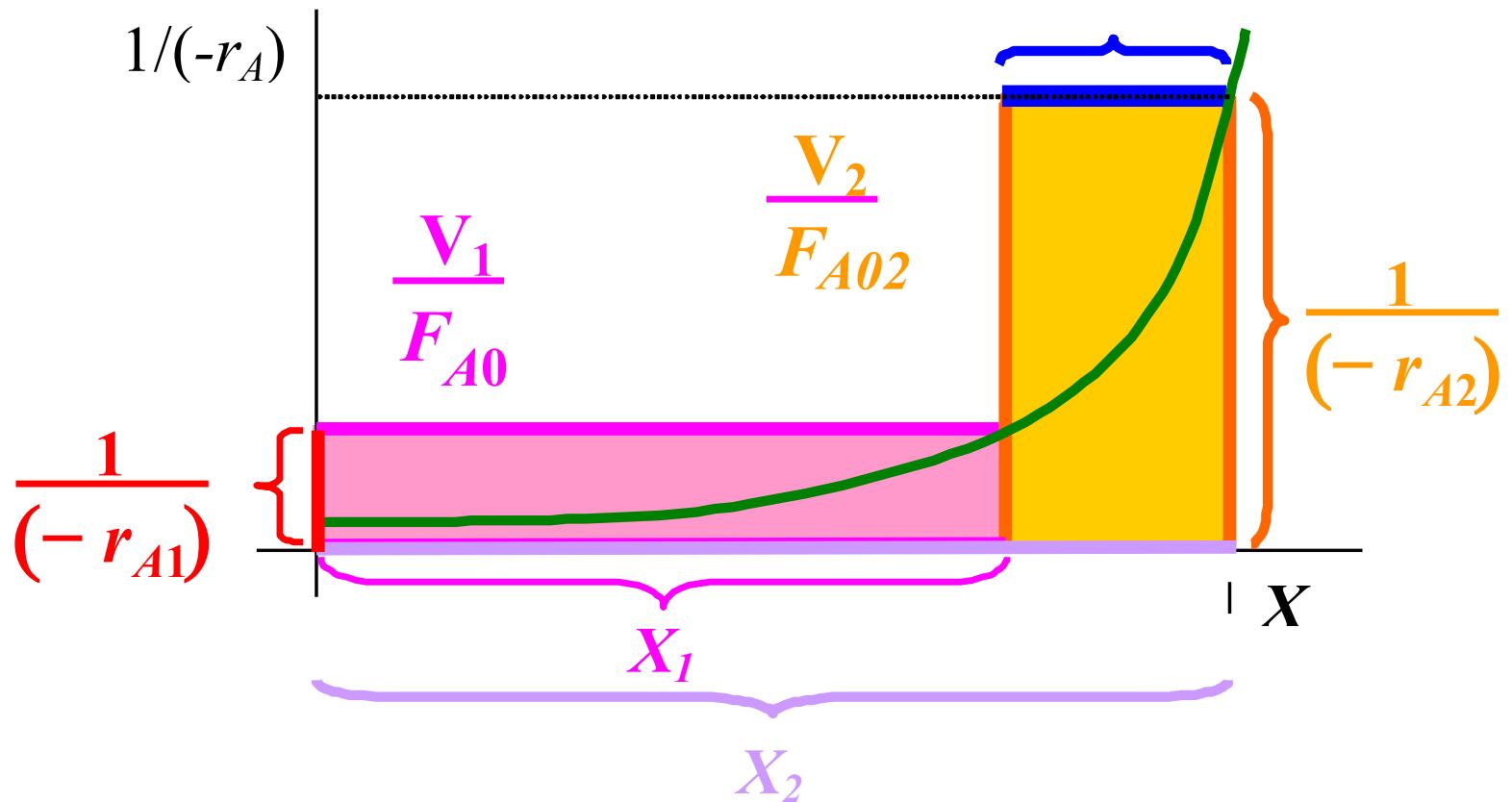
$$\therefore (X_2 - X_1) \cdot F_{A0} + r_{A2} \cdot V_2 = 0$$

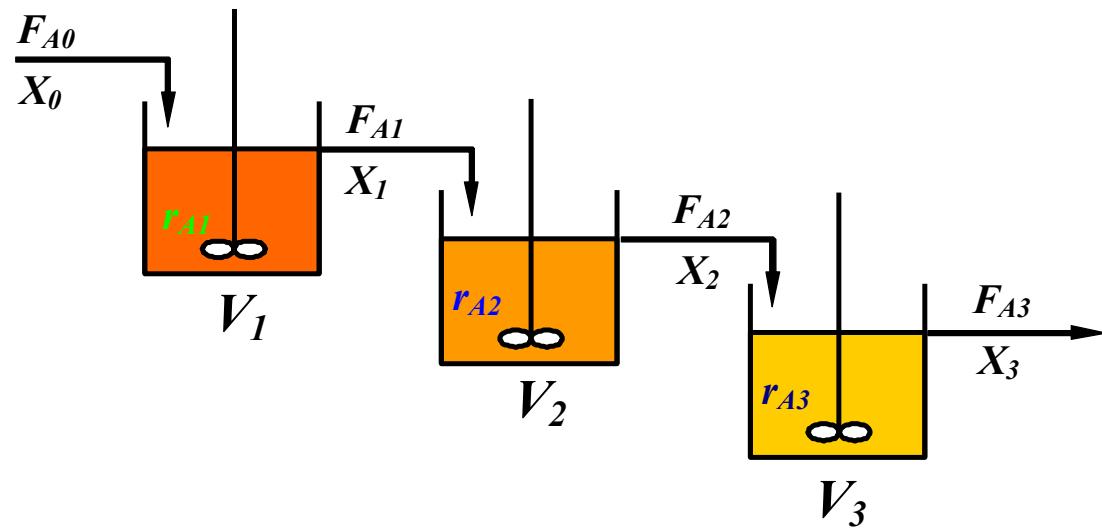
$$\therefore \frac{V_2}{F_{A0}} = (X_2 - X_1) \cdot \frac{1}{(-r_{A2})}$$

$$\therefore \frac{V_1}{F_{A0}} = X_1 \cdot \frac{1}{(-r_{A1})}$$

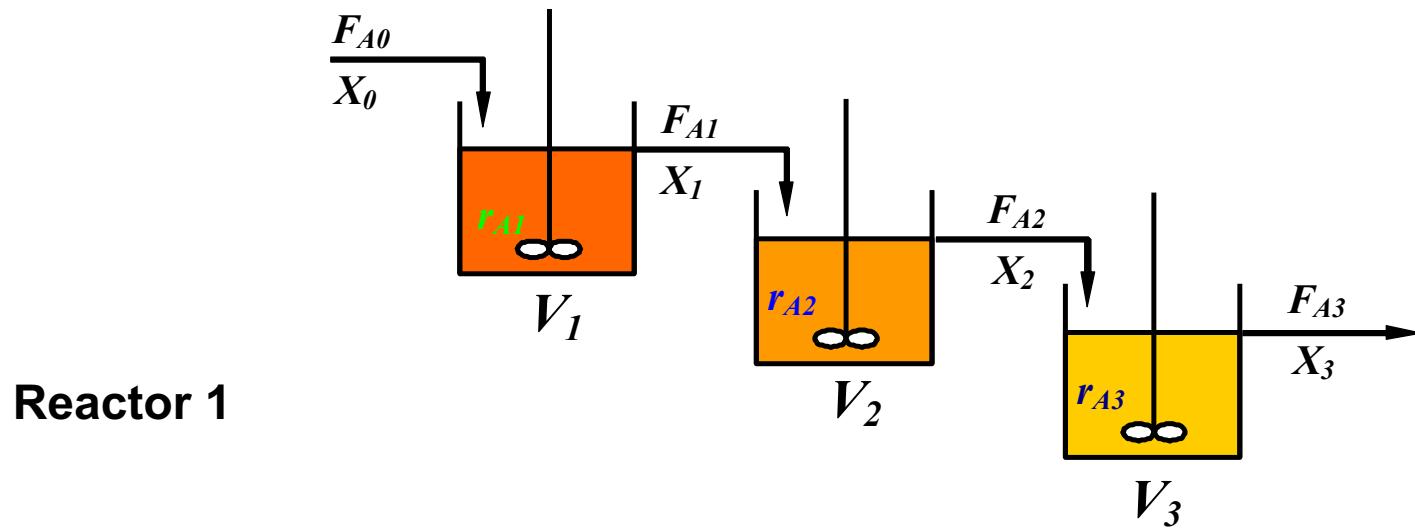
$$\frac{V_2}{F_{A0}} = (X_2 - X_1) \cdot \frac{1}{(-r_{A2})}$$

$$(X_2 - X_1)$$

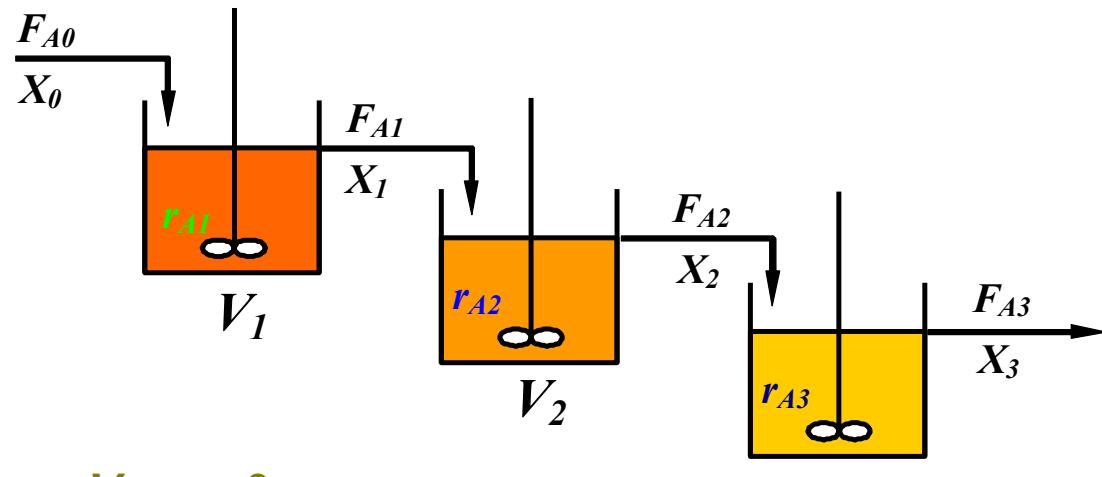




$$V3/F_{A0} = (X_3 - X_2) \cdot 1 / (-r_{A3})$$

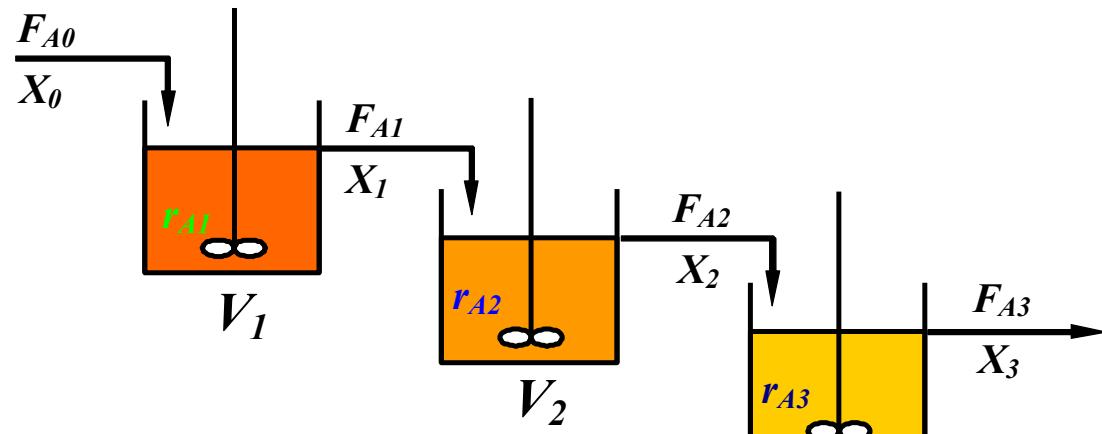


$$V_3/F_{A0} = (X_3 - X_2) \cdot 1 / (-r_{A3})$$



$$F_{A0} - F_{A1} + r_{A1} \cdot V_1 = 0$$

$$V_3/F_{A0} = (X_3 - X_2) \cdot 1 / (-r_{A3})$$

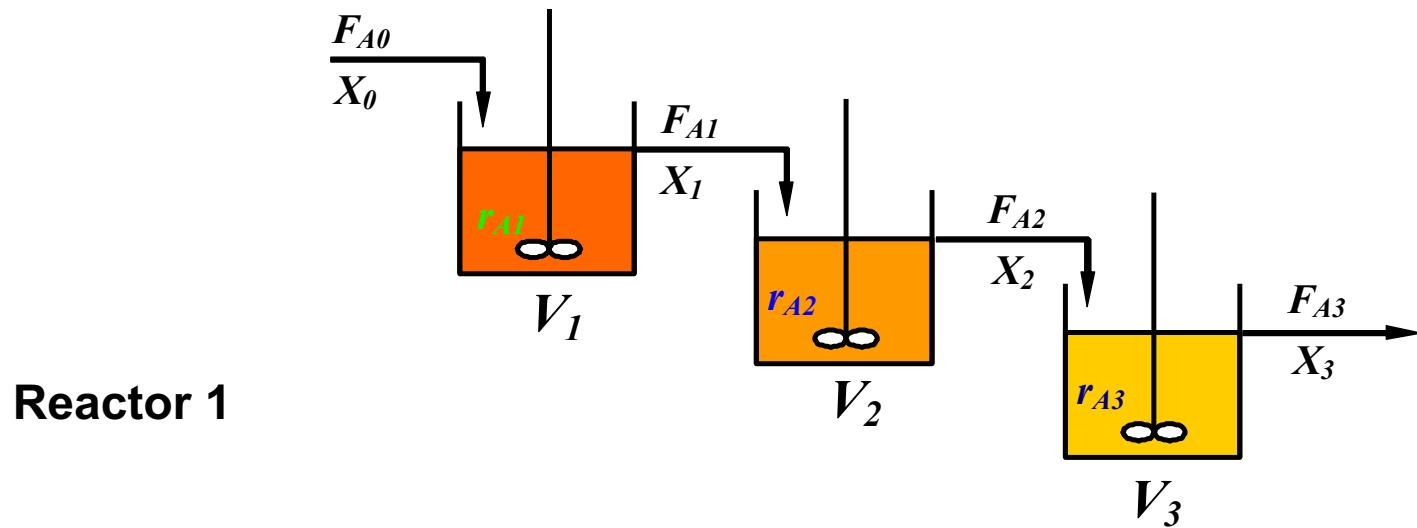


### Reactor 1

$$F_{A0} - F_{A1} + r_{A1} \cdot V_1 = 0$$

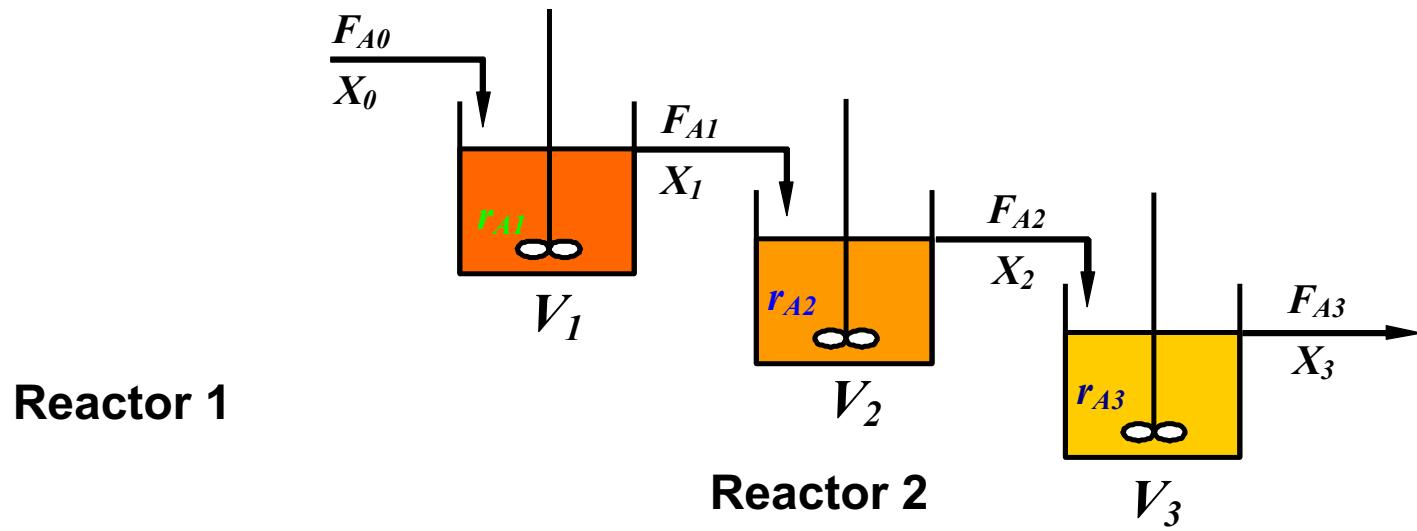
$$F_{A0} - F_{A0} \cdot (1 - X_1) + r_{A1} \cdot V_1 = 0$$

$$V_3/F_{A0} = (X_3 - X_2) \cdot 1 / (-r_{A3})$$



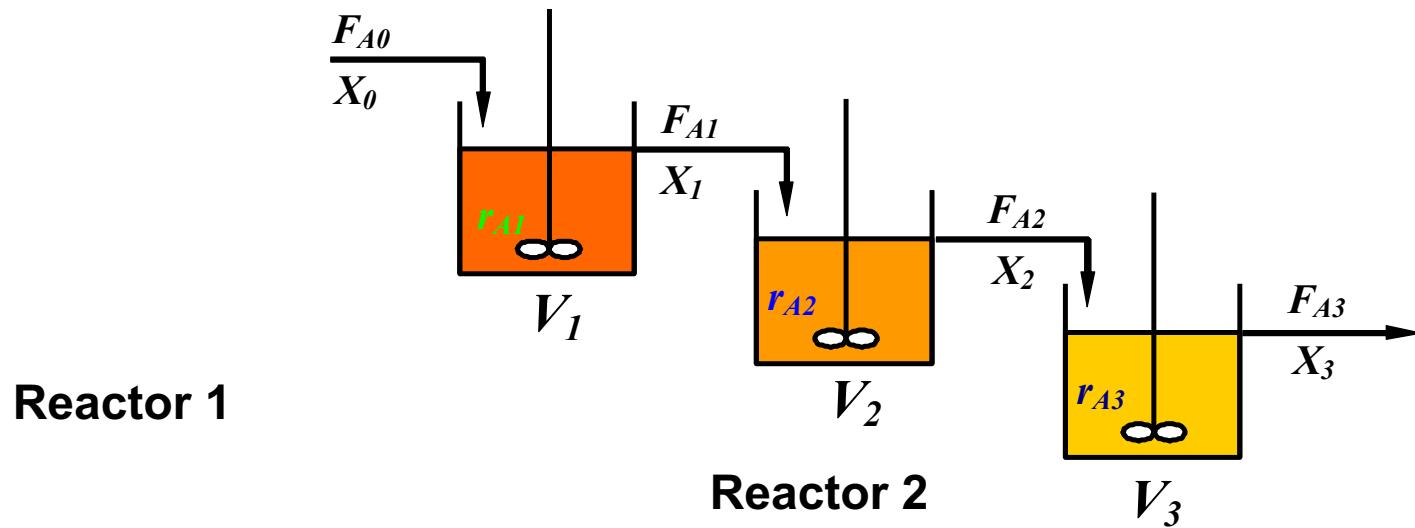
$$\frac{V_1}{F_{A0}} = X_1 \cdot \frac{1}{(-r_{A1})}$$

$$V_3/F_{A0} = (X_3 - X_2) \cdot 1 / (-r_{A3})$$



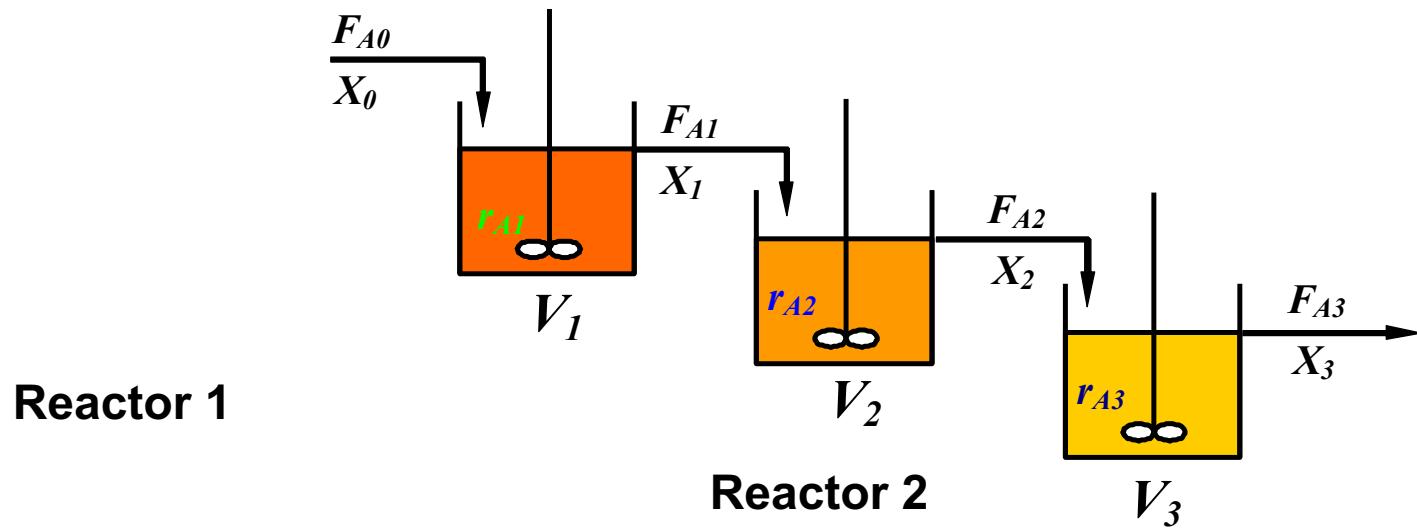
$$\frac{V_1}{F_{A0}} = X_1 \cdot \frac{1}{(-r_{A1})}$$

$$V_3/F_{A0} = (X_3 - X_2) \cdot 1 / (-r_{A3})$$



$$\frac{V_1}{F_{A0}} = X_1 \cdot \frac{1}{(-r_{A1})} \quad F_{A1} - F_{A2} + r_{A2} \cdot V_2 = 0$$

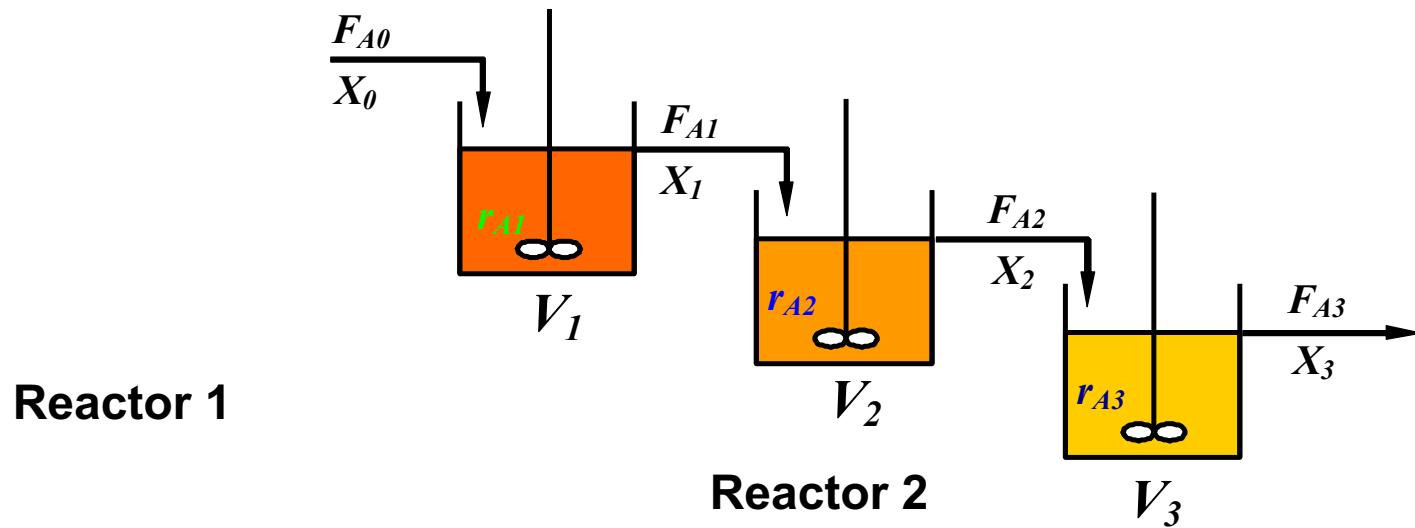
$$V_3/F_{A0} = (X_3 - X_2) \cdot 1 / (-r_{A3})$$



$$\frac{V_1}{F_{A0}} = X_1 \cdot \frac{1}{(-r_{A1})} \quad F_{A1} - F_{A2} + r_{A2} \cdot V_2 = 0$$

$$F_{A0} \cdot (1 - X_1) - F_{A0} \cdot (1 - X_2) + r_{A2} \cdot V_2 = 0$$

$$V_3/F_{A0} = (X_3 - X_2) \cdot 1 / (-r_{A3})$$

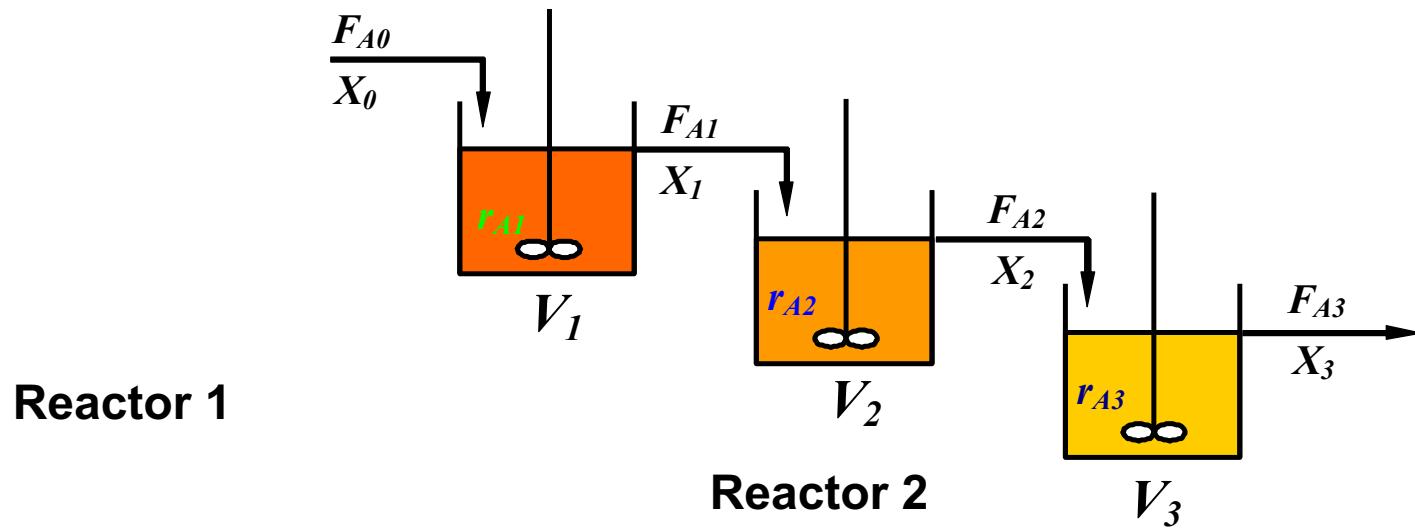


$$\frac{V_1}{F_{A0}} = X_1 \cdot \frac{1}{(-r_{A1})} \quad F_{A1} - F_{A2} + r_{A2} \cdot V_2 = 0$$

$$F_{A0} \cdot (1 - X_1) - F_{A0} \cdot (1 - X_2) + r_{A2} \cdot V_2 = 0$$

$$F_{A0} - F_{A0} \cdot X_1 - F_{A0} + F_{A0} \cdot X_2 + r_{A2} \cdot V_2 = 0$$

$$V_3/F_{A0} = (X_3 - X_2) \cdot 1 / (-r_{A3})$$

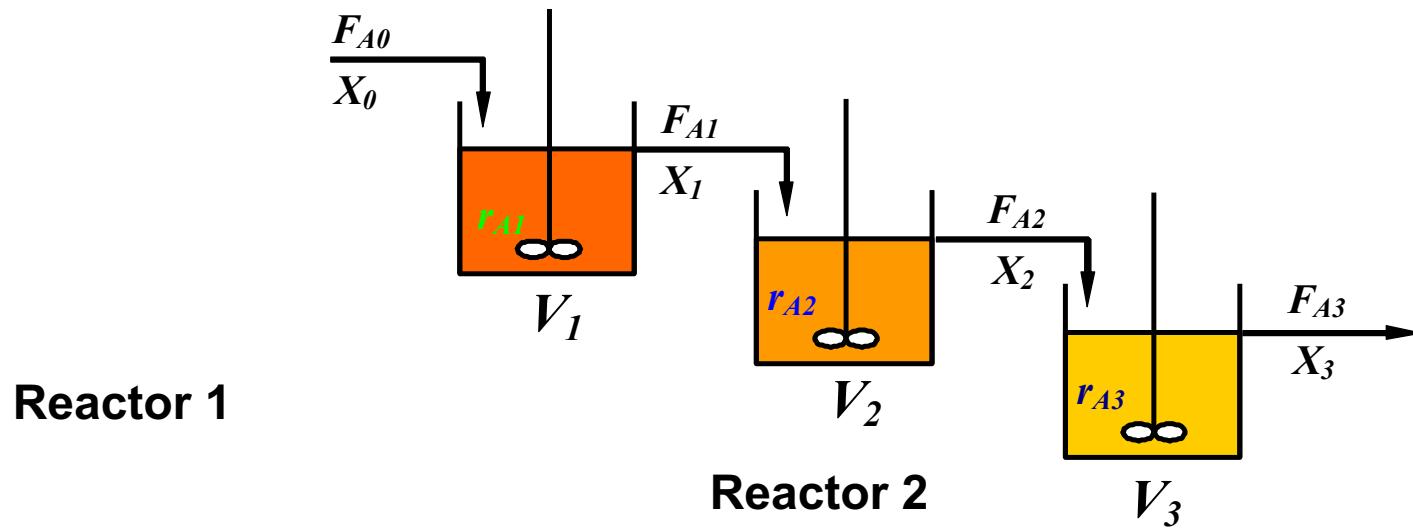


$$\frac{V_1}{F_{A0}} = X_1 \cdot \frac{1}{(-r_{A1})} \quad F_{A1} - F_{A2} + r_{A2} \cdot V_2 = 0$$

$$F_{A0} \cdot (1 - X_1) - F_{A0} \cdot (1 - X_2) + r_{A2} \cdot V_2 = 0$$

~~$$F_{A0} - F_{A0} \cdot X_1 - F_{A0} + F_{A0} \cdot X_2 + r_{A2} \cdot V_2 = 0$$~~

$$V_3/F_{A0} = (X_3 - X_2) \cdot 1 / (-r_{A3})$$



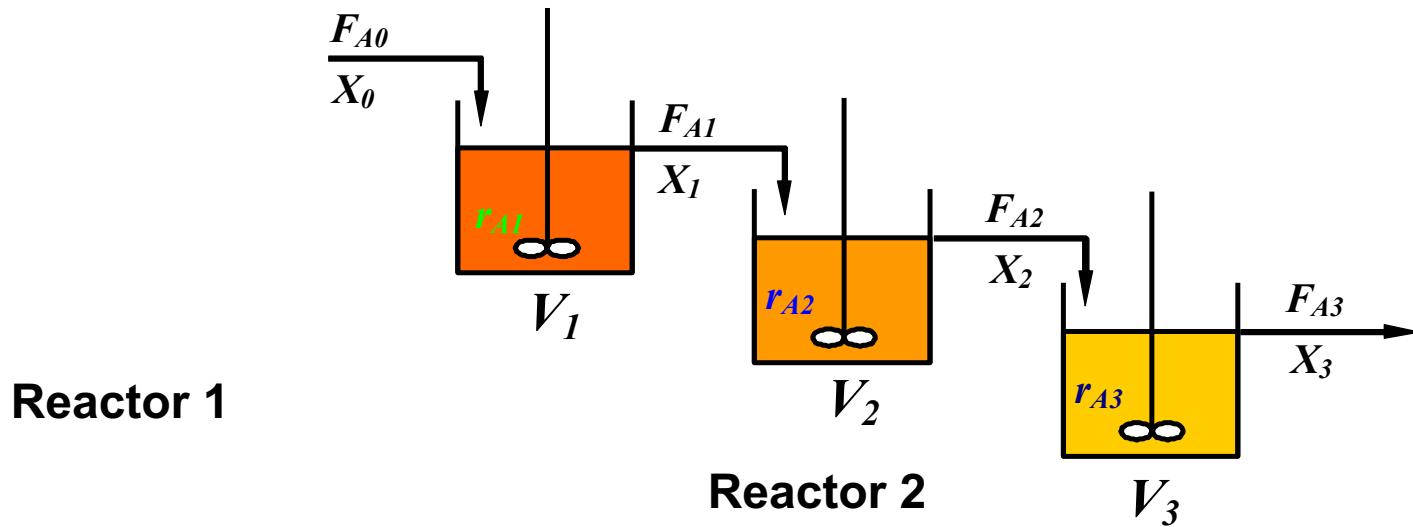
$$\frac{V_1}{F_{A0}} = X_1 \cdot \frac{1}{(-r_{A1})} \quad F_{A1} - F_{A2} + r_{A2} \cdot V_2 = 0$$

$$F_{A0} \cdot (1 - X_1) - F_{A0} \cdot (1 - X_2) + r_{A2} \cdot V_2 = 0$$

~~$$F_{A0} - F_{A0} \cdot X_1 - F_{A0} + F_{A0} \cdot X_2 + r_{A2} \cdot V_2 = 0$$~~

$$(X_2 - X_1) \cdot F_{A0} + r_{A2} \cdot V_2 = 0$$

$$V_3/F_{A0} = (X_3 - X_2) \cdot 1 / (-r_{A3})$$



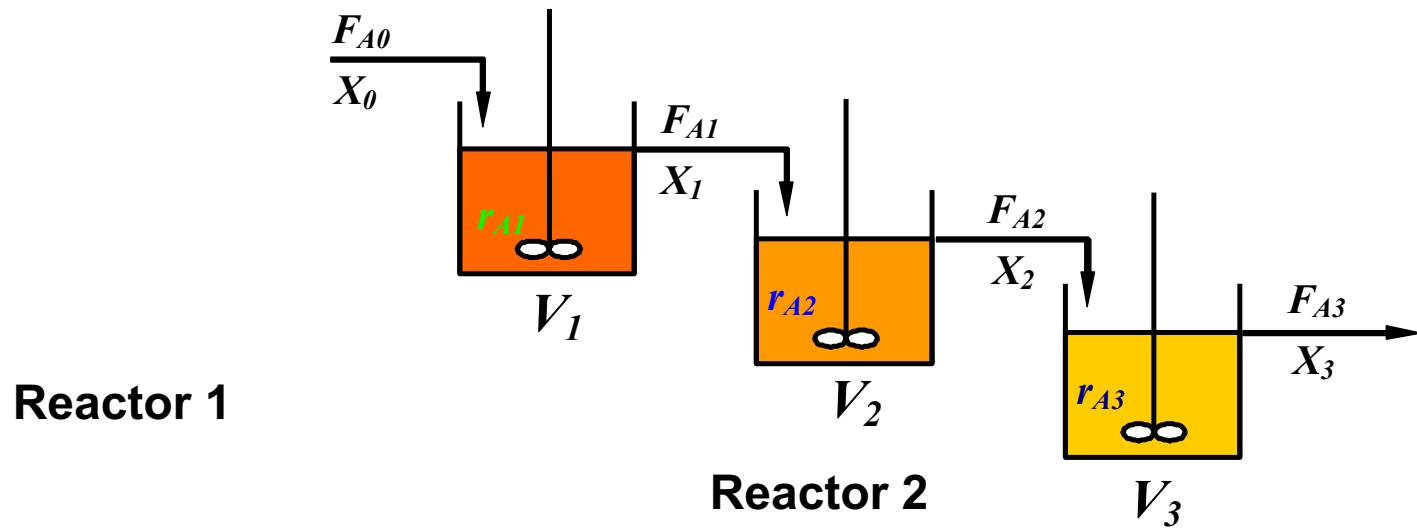
$$\frac{V_1}{F_{A0}} = X_1 \cdot \frac{1}{(-r_{A1})} \quad F_{A1} - F_{A2} + r_{A2} \cdot V_2 = 0$$

$$F_{A0} \cdot (1 - X_1) - F_{A0} \cdot (1 - X_2) + r_{A2} \cdot V_2 = 0$$

~~$$F_{A0} - F_{A0} \cdot X_1 - F_{A0} + F_{A0} \cdot X_2 + r_{A2} \cdot V_2 = 0$$~~

$$(X_2 - X_1) \cdot F_{A0} + r_{A2} \cdot V_2 = 0$$

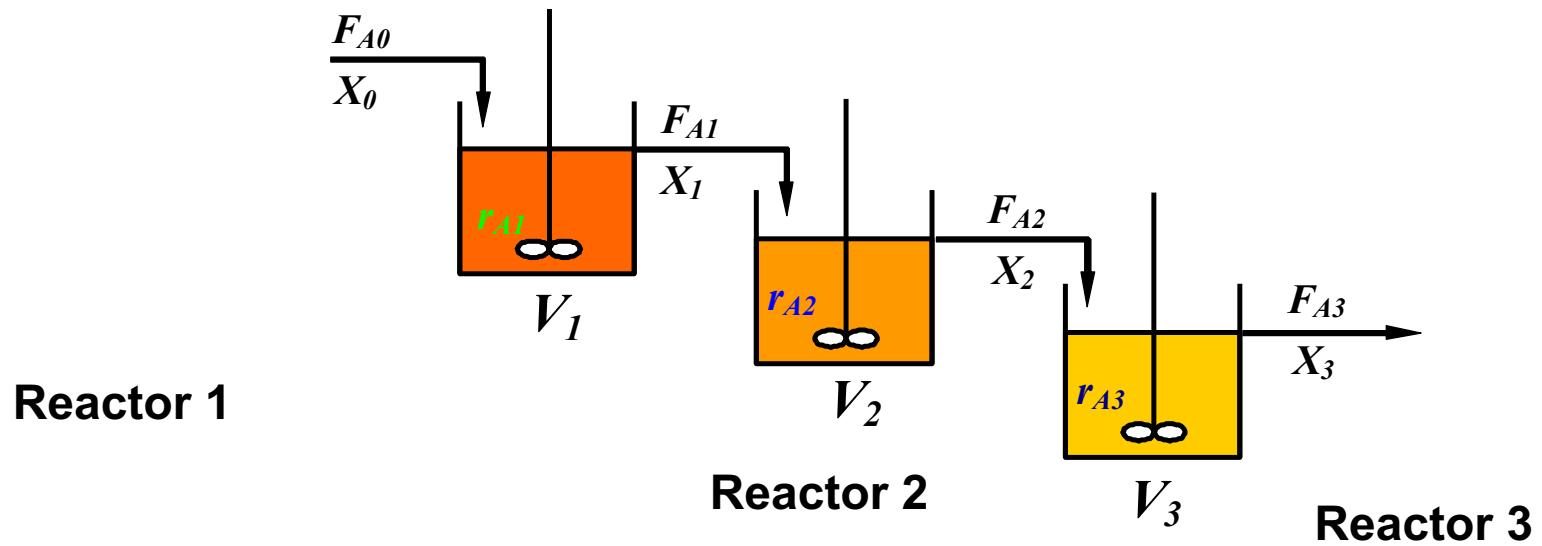
$$\frac{V_2}{F_{A0}} = (X_2 - X_1) \cdot \frac{1}{(-r_{A2})} \quad V3/F_{A0} = (X_3 - X_2) \cdot 1 / (-r_{A3})$$



$$\frac{V_1}{F_{A0}} = X_1 \cdot \frac{1}{(-r_{A1})}$$

$$\frac{V_2}{F_{A0}} = (X_2 - X_1) \cdot \frac{1}{(-r_{A2})}$$

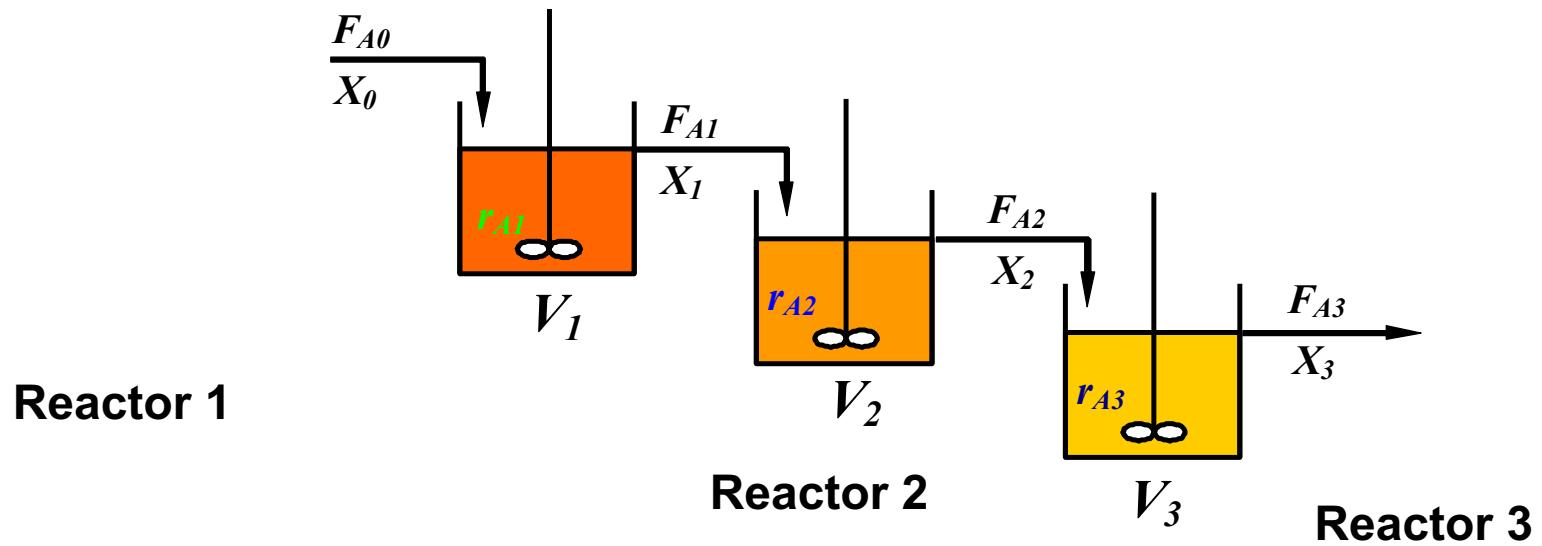
$$V_3/F_{A0} = (X_3 - X_2) \cdot 1 / (-r_{A3})$$



$$\frac{V_1}{F_{A0}} = X_1 \cdot \frac{1}{(-r_{A1})}$$

$$\frac{V_2}{F_{A0}} = (X_2 - X_1) \cdot \frac{1}{(-r_{A2})}$$

$$V_3/F_{A0} = (X_3 - X_2) \cdot 1/(-r_{A3})$$

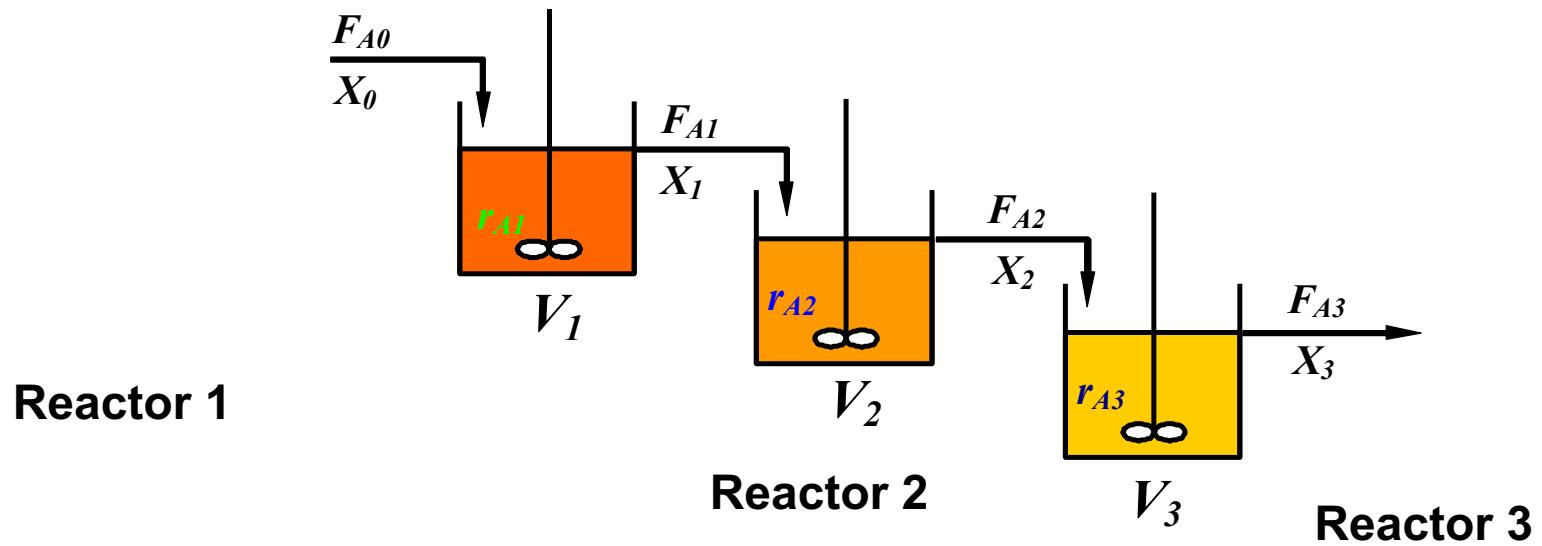


$$F_{A2} - F_{A3} + r_{A3} \cdot V_3 = 0$$

$$\frac{V_1}{F_{A0}} = X_1 \cdot \frac{1}{(-r_{A1})}$$

$$\frac{V_2}{F_{A0}} = (X_2 - X_1) \cdot \frac{1}{(-r_{A2})}$$

$$V_3/F_{A0} = (X_3 - X_2) \cdot 1/(-r_{A3})$$



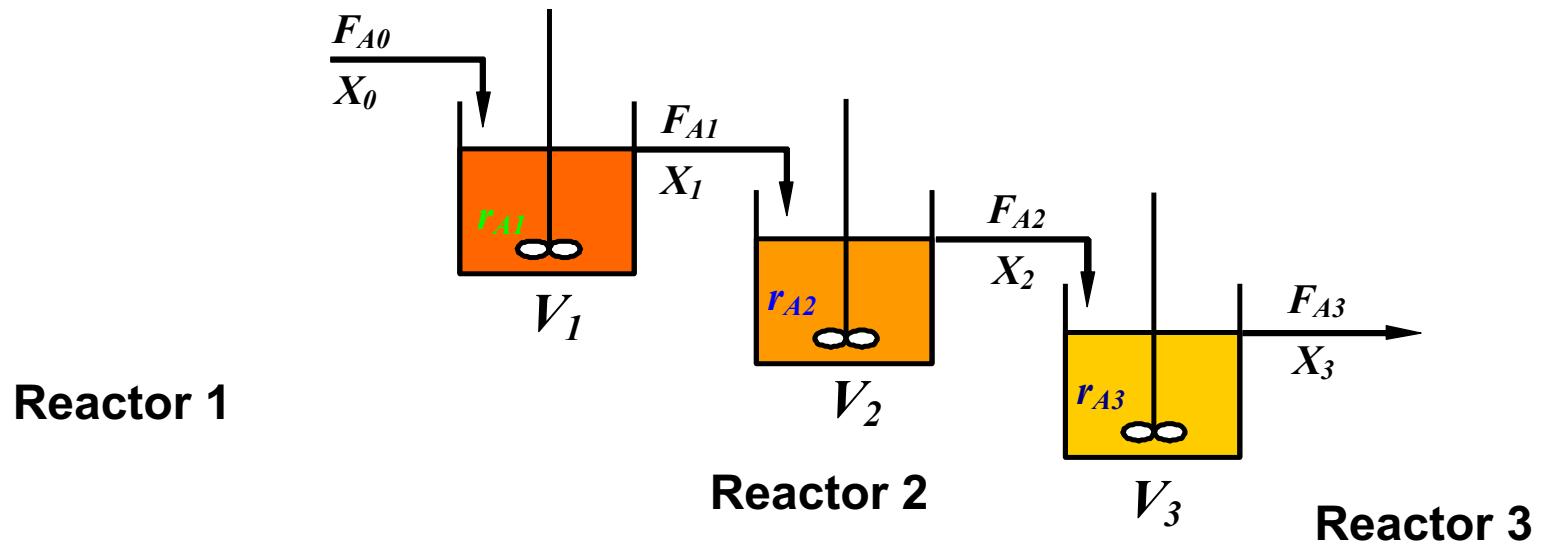
$$F_{A2} - F_{A3} + r_{A3} \cdot V_3 = 0$$

$$F_{A0} \cdot (1 - X_2) - F_{A0} \cdot (1 - X_3) + r_{A3} \cdot V_3 = 0$$

$$\frac{V_1}{F_{A0}} = X_1 \cdot \frac{1}{(-r_{A1})}$$

$$\frac{V_2}{F_{A0}} = (X_2 - X_1) \cdot \frac{1}{(-r_{A2})}$$

$$V_3/F_{A0} = (X_3 - X_2) \cdot 1/(-r_{A3})$$



$$F_{A2} - F_{A3} + r_{A3} \cdot V_3 = 0$$

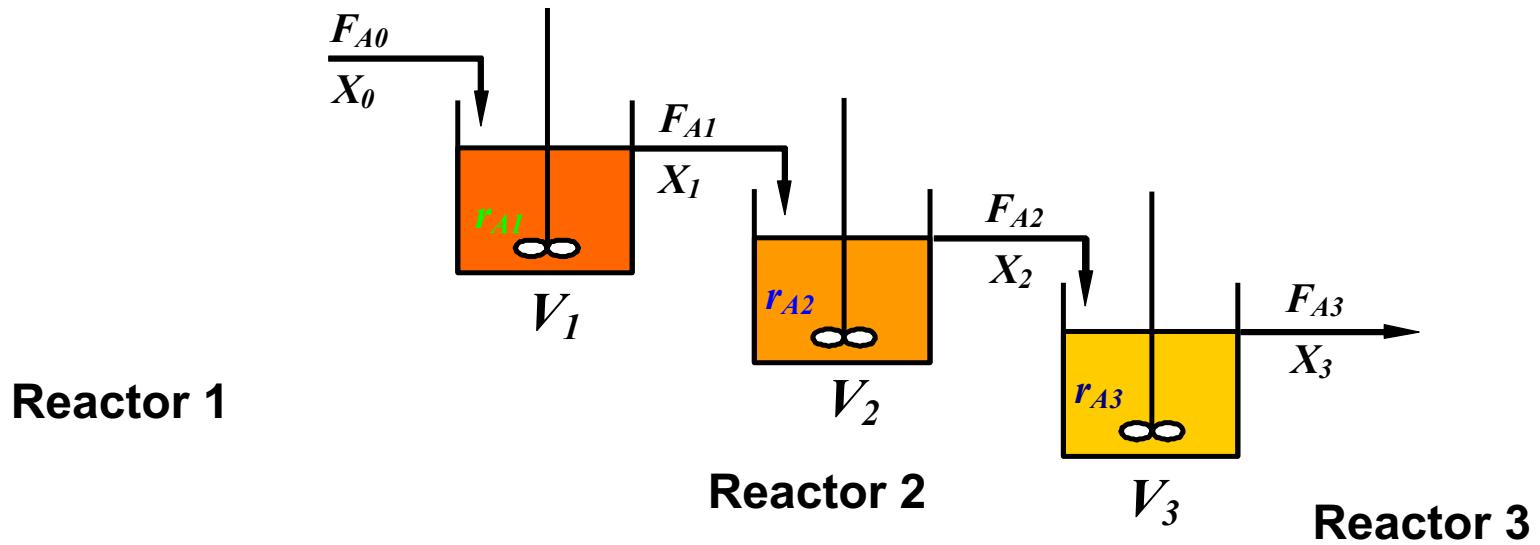
$$F_{A0} \cdot (1 - X_2) - F_{A0} \cdot (1 - X_3) + r_{A3} \cdot V_3 = 0$$

$$F_{A0} - F_{A0} \cdot X_2 - F_{A0} + F_{A0} \cdot X_3 + r_{A3} \cdot V_3 = 0$$

$$\frac{V_1}{F_{A0}} = X_1 \cdot \frac{1}{(-r_{A1})}$$

$$\frac{V_2}{F_{A0}} = (X_2 - X_1) \cdot \frac{1}{(-r_{A2})}$$

$$V_3/F_{A0} = (X_3 - X_2) \cdot 1 / (-r_{A3})$$



$$F_{A2} - F_{A3} + r_{A3} \cdot V_3 = 0$$

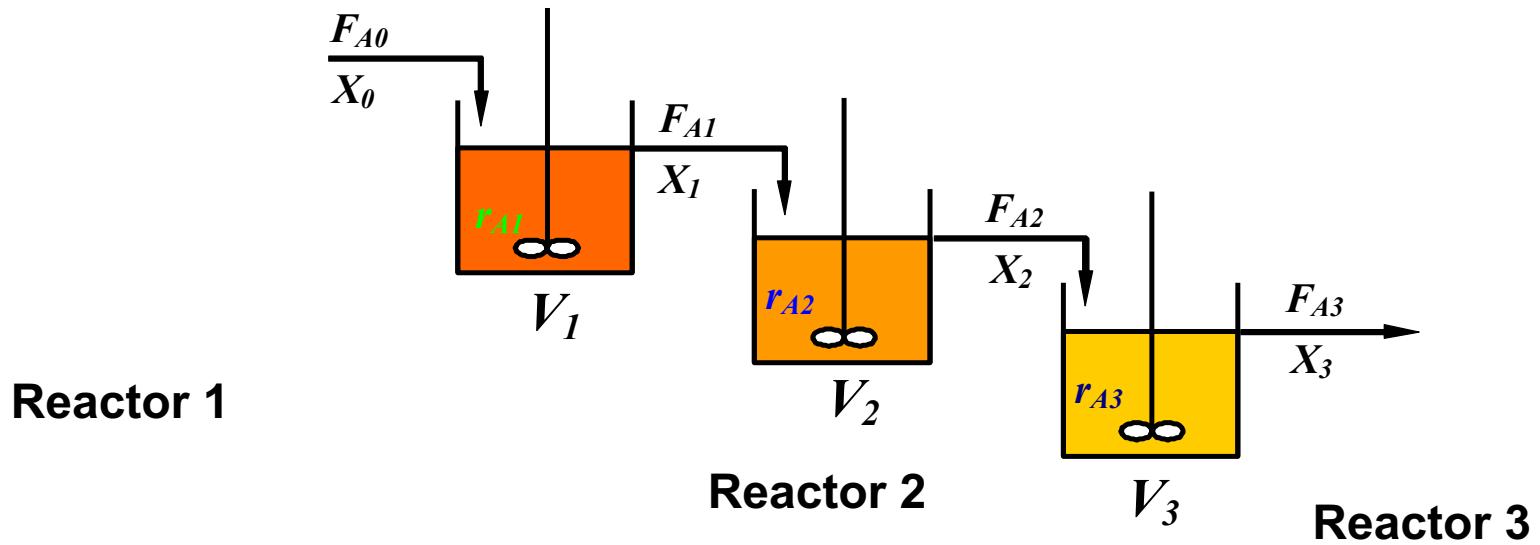
$$F_{A0} \cdot (1 - X_2) - F_{A0} \cdot (1 - X_3) + r_{A3} \cdot V_3 = 0$$

~~$$F_{A0} - F_{A0} \cdot X_2 - F_{A0} + F_{A0} \cdot X_3 + r_{A3} \cdot V_3 = 0$$~~

$$\frac{V_1}{F_{A0}} = X_1 \cdot \frac{1}{(-r_{A1})}$$

$$\frac{V_2}{F_{A0}} = (X_2 - X_1) \cdot \frac{1}{(-r_{A2})}$$

$$V_3/F_{A0} = (X_3 - X_2) \cdot 1 / (-r_{A3})$$



$$F_{A2} - F_{A3} + r_{A3} \cdot V_3 = 0$$

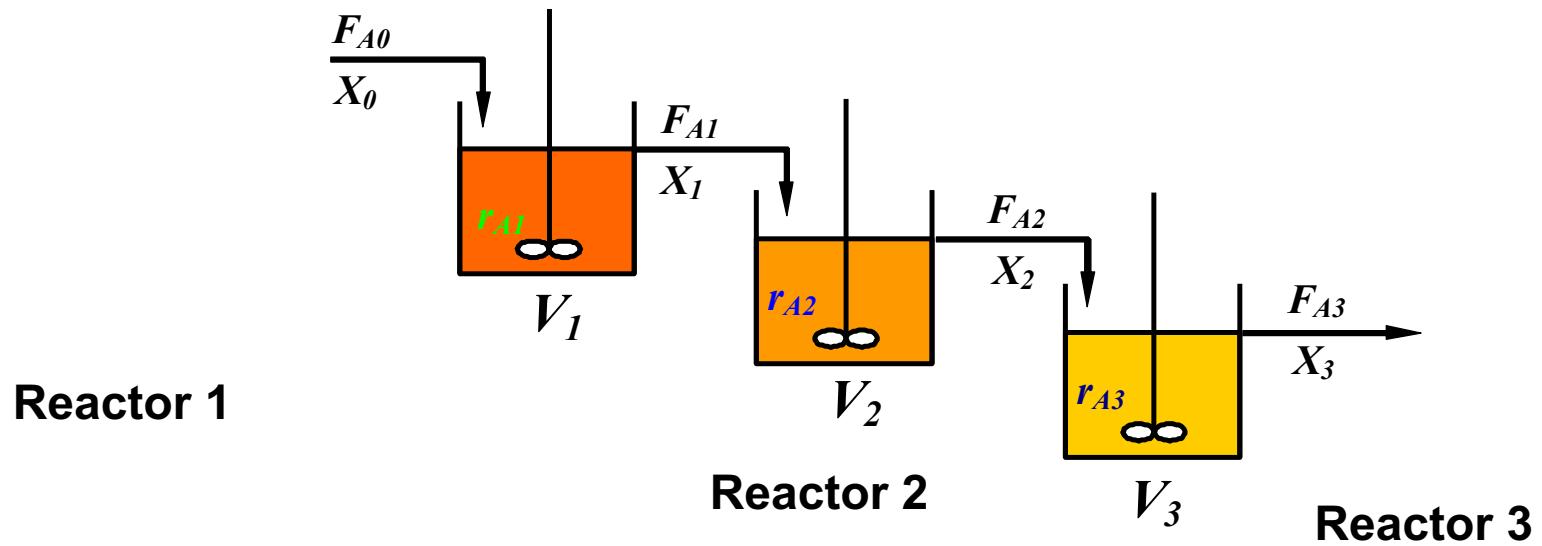
$$F_{A0} \cdot (1 - X_2) - F_{A0} \cdot (1 - X_3) + r_{A3} \cdot V_3 = 0$$

~~$$F_{A0} - F_{A0} \cdot X_2 - F_{A0} + F_{A0} \cdot X_3 + r_{A3} \cdot V_3 = 0$$~~

$$(X_3 - X_2) \cdot F_{A0} + r_{A3} \cdot V_3 = 0$$

$$\frac{V_2}{F_{A0}} = (X_2 - X_1) \cdot \frac{1}{(-r_{A2})}$$

$$V3/F_{A0} = (X_3 - X_2) \cdot 1 / (-r_{A3})$$



$$\frac{V_1}{F_{A0}} = X_1 \cdot \frac{1}{(-r_{A1})}$$

$$\frac{V_2}{F_{A0}} = (X_2 - X_1) \cdot \frac{1}{(-r_{A2})}$$

$$V_3/F_{A0} = (X_3 - X_2) \cdot 1/(-r_{A3})$$

