$$A + \frac{1}{2} B \rightarrow C$$

Gas-phase reaction

$$-r_A' = k\, p_A^{1/3}\, p_B^{2/3} = kRT \cdot C_A^{1/3} C_B^{2/3}$$

Stoichiometric Feed

$$C_A = \frac{C_{A0}(1-X)}{(1+\varepsilon X)} \frac{P}{P_0}$$

$$C_B = \frac{C_{A0}(\Theta_B - X/2)}{(1+\varepsilon X)} \frac{P}{P_0}$$

$$\Theta_B = \frac{1}{2}$$

$$-r_A' = kRT \left(\frac{1}{2} \right)^{2/3} \frac{C_{A0}(1-X)}{(1+\varepsilon X)} \frac{P}{P_0}$$

$$F_{A0} \frac{dX}{dW} = -r_A' = kRT \left(\frac{1}{2} \right)^{2/3} \frac{C_{A0}(1-X)}{(1+\varepsilon X)} \frac{P}{P_0} = k' \frac{(1-X)}{(1+\varepsilon X)} \frac{P}{P_0}$$

If, $1+\varepsilon X \approx 1$, then $\frac{P}{P_0} = (1-\alpha W)^{1/2}$

$$F_{A0} \frac{dX}{dW} = k' \frac{(1-X)}{(1+\varepsilon X)} (1-\alpha W)^{1/2}$$

Separate variables and integrate

$$\int_0^X \frac{F_{A0}(1+\varepsilon X)}{k'(1-X)} dX = \int_0^W (1-\alpha W)^{1/2}\, dW$$

$$\frac{F_{A0}}{k'} \left[(1+\varepsilon) \ln \frac{1}{1-X} - \varepsilon X \right] = \frac{2}{3\alpha} \left[1 - (1-\alpha W)^{3/2} \right]$$