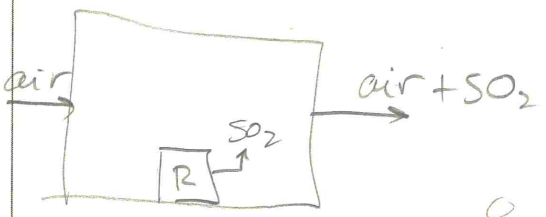
Leaky Reactor



SO_2 balance

$$\text{accum} = \cancel{\text{in}}^{\,0} - \text{out} + \text{gen} - \cancel{\text{cons}}^{\,0}$$

$$\frac{dn_{SO_2}}{dt} = \dot{n}_{SO_2,gen} - \dot{n}_{SO_2,out}$$

$$\frac{d(y_{SO_2} n_{tot})}{dt} = \dot{n}_{SO_2,gen} - y_{SO_2}\dot{n}_{out}$$

$$n_{tot}\frac{dy_{SO_2}}{dt} = \dot{n}_{SO_2,gen} - y_{SO_2}\dot{n}_{out}$$

$$\frac{dy_{SO_2}}{\dot{n}_{SO_2,gen} - y_{SO_2}\dot{n}_{out}} = \frac{dt}{n_{tot}}$$

$$\int_{x_1}^{x_2} \frac{dx}{a+bx} = \frac{1}{b}\ln(a+bx)\Big|_{x_1}^{x_2}$$

$$= \frac{1}{b}\ln\left(\frac{a+bx_2}{a+bx_1}\right)$$

$$\int_0^t \frac{dy_{SO_2}}{\dot{n}_{SO_2,gen} - y_{SO_2}\dot{n}_{out}} = -\frac{1}{\dot{n}_{out}}\ln\left(\frac{\dot{n}_{SO_2,gen} - y_{SO_2}\dot{n}_{out}}{\dot{n}_{SO_2,gen} - (0)(\dot{n}_{out})}\right) = \frac{t}{n_{tot}}$$

$$\ln(\quad) = -\frac{t\dot{n}_{out}}{n_{tot}}$$

$$\dot{n}_{SO_2,gen} - y_{SO_2}\dot{n}_{out} = \dot{n}_{SO_2,gen}\, e^{-\frac{t\dot{n}_{out}}{n_{tot}}}$$

$$y_{SO_2} = \frac{\dot{n}_{SO_2,gen} - \dot{n}_{SO_2,gen}\, e^{-\frac{t\dot{n}_{out}}{n_{tot}}}}{\dot{n}_{out}}$$

$$= \frac{\dot{n}_{SO_2,gen}}{\dot{n}_{out}}\left(1 - e^{-\left(\frac{t\dot{n}_{out}}{n_{tot}}\right)}\right)$$