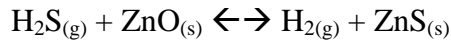


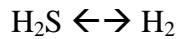
Assignment #6: More Reaction and Diffusion in Catalysts

1. Reaction and Diffusion in Catalytic Membranes

A porous ceramic membrane is to be designed for removing hydrogen sulfide from a hydrogen-rich gas stream. The membrane is comprised of a porous α -alumina tube that has been impregnated with Zinc Oxide adsorbent. Hydrogen sulfide reacts with zinc oxide by the following reaction:



If one assumes an infinite excess of ZnO (during initial operation), then the above reaction can be approximated as:



- Determine the thiele modulus necessary to reduce H_2S concentration to 0.1% of the feed gas concentration. Assume that there are no external mass transfer limitations.
- Repeat the above analysis, only accounting for finite external mass transfer corresponding to $\text{Bi}_m = 0.2$.
- Repeat the analysis in part (b), if the reaction is reversible, with $K_e = 2$.

2. Power-Law Kinetics Reaction and Diffusion

Using the analysis detailed in lecture, plot (i) inner-most catalyst concentration, u_0 as a function of thiele modulus, and (ii) catalyst effectiveness as a function of thiele modulus, for the following reaction orders:

$$r = kC^p, \quad p = -2, -1, -\frac{1}{2}, 0, \frac{1}{2}, 1, 2.$$