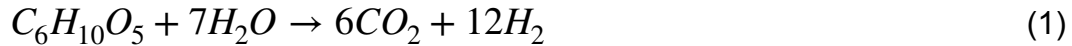


REB, The Course Class 2 Practice Assignment Solution

1. Cellulosic biomass, represented here as $C_6H_{10}O_5$, can be gasified using steam. Reactions (1) through (3) take place. Suppose gasification began with 10 moles of H_2O for every mole of $C_6H_{10}O_5$, and no other reagents present. If 50% of the cellulose is converted and the selectivity for CO_2 over CO is 3, what will the CO to H_2 ratio equal?



To simplify the notation, let “cell” denote $C_6H_{10}O_5$.

Basis: $n_{cell,0} = 1 \text{ mol}$

Given: $n_{H_2O,0} = 10 \text{ mol}$, $f_{cell} = 0.5$, and $S_{CO_2/CO} = 3$

Quantity of interest: R_{CO/H_2}

The basis above could be chosen because no extensive quantities are provided in the assignment narrative.

Use the given information to calculate the apparent extents of reaction.

A complete, independent subset of the reactions is needed. It can be seen that subtracting reaction (2) from reaction (1) gives, after minor rearrangement, reaction (3). Therefore reactions (1) and (2) are a complete, independent subset of the reactions.

$$f_{cell} = \frac{n_{cell,0} - n_{cell}}{n_{cell,0}} = \frac{n_{cell,0} - (n_{cell,0} - \xi_1 - \xi_2)}{n_{cell,0}} = \frac{\xi_1 + \xi_2}{n_{cell,0}} \quad (4)$$

$$S_{CO_2/CO} = \frac{n_{CO_2}}{n_{CO}} = \frac{\cancel{n_{CO_2,0}} + 6\xi_1}{\cancel{n_{CO,0}} + 6\xi_2} = \frac{\xi_1}{\xi_2} \quad (5)$$

After substituting the known values of f_{cell} and $S_{CO_2/CO}$, equations (4) and (5) can be solved to find $\xi_1 = 0.375$ mol and $\xi_2 = 0.125$ mol.

Use the apparent extents of reaction to calculate the quantity of interest.

$$R_{CO/H_2} = \frac{n_{CO}}{n_{H_2}} = \frac{\cancel{n_{CO,0}} + 6\xi_2}{\cancel{n_{H_2,0}} + 12\xi_1 + 6\xi_2} = \frac{\xi_2}{2\xi_1 + \xi_2} = \frac{0.125}{2(0.375) + 0.125} = 0.14$$