Solutions Assignment 7

Problem 1.

\[ \frac{dC_A}{dt} = k C_A^n \]

From a non-linear fit, we get:

\[ k = 0.033 \]
\[ n = 1.54 \]

Problem 2
(a) **Mole Balance: constant \( V \)**

\[
\frac{dC_A}{dt} = -k \cdot C_A
\]

\[
\ln \left( -\frac{dC_A}{dt} \right) = \ln k + \ln C_A
\]

**Differentiation**

<table>
<thead>
<tr>
<th>( t ) (min)</th>
<th>10</th>
<th>20</th>
<th>30</th>
<th>40</th>
<th>50</th>
<th>60</th>
</tr>
</thead>
<tbody>
<tr>
<td>( \Delta t ) (min)</td>
<td>10</td>
<td>10</td>
<td>10</td>
<td>10</td>
<td>10</td>
<td>10</td>
</tr>
<tr>
<td>( C_A ) (ppm)</td>
<td>2.45</td>
<td>1.74</td>
<td>1.23</td>
<td>0.88</td>
<td>0.62</td>
<td>0.44</td>
</tr>
<tr>
<td>( \Delta C_A ) (ppm)</td>
<td>-0.71</td>
<td>-0.51</td>
<td>-0.35</td>
<td>-0.26</td>
<td>-0.18</td>
<td></td>
</tr>
<tr>
<td>( \frac{\Delta C_A}{\Delta t} ) (ppm/min)</td>
<td>-0.071</td>
<td>-0.051</td>
<td>-0.035</td>
<td>-0.026</td>
<td>-0.018</td>
<td></td>
</tr>
</tbody>
</table>
After plotting and differentiating by equal area

<table>
<thead>
<tr>
<th>(-\frac{dC_A}{dt})</th>
<th>0.082</th>
<th>0.061</th>
<th>0.042</th>
<th>0.030</th>
<th>0.0215</th>
<th>0.014</th>
</tr>
</thead>
<tbody>
<tr>
<td>(\ln(-\frac{dC_A}{dt}))</td>
<td>-2.501</td>
<td>-2.797</td>
<td>-3.170</td>
<td>-3.507</td>
<td>-3.840</td>
<td>-4.269</td>
</tr>
<tr>
<td>(\ln C_A)</td>
<td>0.896</td>
<td>0.554</td>
<td>0.207</td>
<td>-0.128</td>
<td>-0.478</td>
<td>-0.821</td>
</tr>
</tbody>
</table>

Using linear regression: \(\alpha = 1.0\)

\[ \ln k = -3.3864 \Rightarrow k = 0.0344 \text{ min}^{-1} \]

\[ \frac{d\chi_A}{dt} = V \frac{r_A}{V} = F_B \]

\[ r_A = -0.0344 \text{ ppm min}^{-1} = -0.0344 \text{ l min}^{-1} \text{ at } C_A = 1 \text{ ppm} \]

\[ F_B = (25000 \text{ gal}) (0.0344 \frac{mg}{1 \text{ min}} \frac{60 \text{ min}}{1 \text{ hr}} \frac{1 \text{ g}}{1000 \text{ mg}} \frac{3.7851}{453.6} \frac{1 \text{ gal}}{1 \text{ lbm}} = 0.429 \frac{\text{ lbm}}{\text{ hr}} \]