Do problems 3.8 and 3.9 in Froment & Bischoff, 2nd Ed:

3.8 A series of experiments were performed using various sizes of crushed catalyst to determine the importance of pore diffusion. The reaction may be assumed to be first order and irreversible. The surface concentration of reactant was \( C_a = 2 \times 10^{-4} \text{ mol/cm}^3 \).

**DATA:**

<table>
<thead>
<tr>
<th>Diameter of sphere (cm)</th>
<th>0.25</th>
<th>0.075</th>
<th>0.025</th>
<th>0.0075</th>
</tr>
</thead>
<tbody>
<tr>
<td>( r_{\text{obs}} ) (mol/hr cm(^3))</td>
<td>0.22</td>
<td>0.70</td>
<td>1.60</td>
<td>2.40</td>
</tr>
</tbody>
</table>

1. Determine the “true” rate constant \( k_v \) and the effective diffusivity \( D_e \) from the above data.
2. Predict the effectiveness factor and the expected rate of reaction \( r_{\text{obs}} \) for a commercial cylindrical catalyst pellet of dimensions 0.5 cm x 0.5 cm.

3.9 The following rates were observed for a first-order irreversible reaction, carried out on a spherical catalyst:

- for \( d_p = 0.6 \text{ cm} \); \( r_{\text{obs}} = 0.09 \text{ mol/g cat. hr} \)
- For \( d_p = 0.3 \text{ cm} \); \( r_{\text{obs}} = 0.162 \text{ mol/g cat. hr} \)

Strong diffusional limitations were observed in both cases. Determine the true rate of reaction. Is diffusional resistance still important with \( d_p = 0.1 \text{ cm} \)?