

will consume less than 1% of the caustic, its concentration will be essentially constant. In this case, the rate expression simplifies to:

$$\text{Rate} = k' C_{\text{CVD}} \quad (4)$$

where $k' = k C_{\text{NaOH}}$.

Equipment

The available equipment includes a UV/Vis spectrophotometer, a CSTR test rig, an electronic balance, feed solutions of 0.1 M NaOH and 2×10^{-5} M CVD, and typical laboratory glassware. Read the CSTR manual to familiarize yourself with the equipment. Note that the CSTR vessel has 2 lines drawn on it to indicate 1L and 2L the vessel contains 3L when full. Additionally, note that the CSTR unit has been modified to pump in *and* out of the vessel rather than depend on siphon flow for the discharge. To run the reactor full, you must vent it to remove the air.

Objectives

- Determine the batch kinetics of the reaction using a cuvette as the reaction vessel. The outside of the cuvette must be clean and the solution inside well mixed before placing it in the spectrophotometer to measure absorbance (concentration) as the reaction progresses. Confirm that the reaction is first order, and determine the value of the rate constant. What would happen if the initial concentration of the reactants changed? What are the initial concentrations of each species? How can this be determined accurately in the reactor? Remember the reaction begins the instant the two reagents contact one another.
- Perform several CSTR runs at different residence times. How do the batch reaction results compare to the CSTR performance quantitatively? Discuss. Remember that the residence time is a function of flow rate and total reaction volume. Thus, one can vary residence time by changing either flow or volume. You should try to minimize the amount of reagents consumed during these runs. After changing feed flows to the CSTR, you should allow approximately three (3) residence times for the vessel to reestablish steady state before taking readings. Why?
- If you have time, determine the activation energy for the reaction in units of kcal/mol. This may have an impact on our desired reaction conditions and our final reactor size.

Final Report

In addition to the normally required items, your report should include a section titled *Preliminary Design* that describes the design of a process for a 2000 gpd decolorizing plant. This section should include: (1) a block process diagram, (2) a stream table indicating flows, temperatures and pressures of all streams, (3) the size and type (CSTR, PFR, or batch) of reactor, (4) a list of other required equipment such as pumps (you do not have to size these items), and (5) a written description of the process in which you justify the type of reactor used.

Literature Cited

Fogler, H. S., *Elements of Chemical Reaction Engineering*, 3rd edition, Prentice Hall, New Jersey (1999).