416a Hands on Experiments in an Introduction to Chemical Engineering Course

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Establishing contact with freshman chemical engineering majors in their first semester can be beneficial for retention of students [1,2]. At Mississippi State University, our Introduction to Chemical Engineering seminar course objectives include having the students: • Gain an appreciation and knowledge of chemical engineering as a career, • Perform laboratory activities that illustrate key chemical engineering concepts, • Gain experience in oral and written communication skills, • Gain an appreciation for chemical manufacturing processes, • Be introduced to MSU chemical engineering faculty and the curriculum. Hands-on experiments are an engaging way to introduce young students to the many facets of chemical engineering while introducing fundamental engineering concepts. This contribution will discuss two such experiments, Charged Up on Electrophoresis and Brewing with Bioreactors [3].

The fundamentals of electrophoretic separations are colorfully demonstrated in the Charged Up on Electrophoresis experiment, which spans four contact sessions (only two need to be dedicated solely to this topic). The first contact session is an introductory lecture that reviews basic knowledge, industrial applications, and discusses with the students important equations and procedures. At this first contact meeting, a pre-assignment and experimental procedure is handed out; the pre-assignment is due the following week, just prior to the experiment. The experiment is conducted in teams of two during the second contact session. Each team is assigned to one of four salt solution concentrations. The procedure can be completed within about 30 minutes leaving plenty of time for explanations, corrections, and clean up. The students leave the lab with the data they have collected and are asked to work with their lab mate to calculate mobility of the ions in solution. They turn these results in at the beginning of the third contact session. The instructor compiles the ion mobility results, organizes it by the four salt concentrations, and distributes this to the entire class. The teams then write a two-page report complete with tables and graphs discussing their results and how they compared to the class mobility trend as a function of salt concentration. These reports are turned in during the fourth contact session.

The second experiment that will be discussed is a desktop yeast bioreactor. Activities associated with the Brewing with Bioreactors experiment span four contact sessions, but only one needs to be dedicated solely to this topic. The first contact session need only be 10 to 15 minutes at the end of another class and serves as a brief introduction to bioremediation / bioreactors. This discussion integrates well with lab tours of our bioremediation research facilities in the department). Also during this introduction, a pre-assignment and experimental procedure is handed out; the pre-assignment is due the following week, just prior to the experiment.

The experiment is conducted in teams of two with each team assigned to one of four sugar concentrations. The procedure can be completed within about 40 minutes leaving time for questions, discussions, and clean up. The students leave the lab with the data they have collected and are asked to work with their lab mate to calculate lag time, maximum and minimum bubble rates, temperature cooling curves, and biomass height in the bioreactor. They turn in their results on lag time and maximum bubble rate in at the beginning of the third contact session. The instructor compiles the data, organizes it by the four sugar concentrations, and posts the summary online. The lab mates once again work in teams to write a two-page report complete with tables and graphs discussing their results and how they compared to the trend in the class. These reports are turned in during the fourth contact session.

In these activities, electrophoresis and bioreactor processes are brought to life via an introductory lecture, assignments, and simple desktop experiments that utilize inexpensive supplies to demonstrate

electrophoretic separations and bioprocessing. Advantages of these hands-on experiences include that they are not dependent on the availability of lab space and students have a unique experience to link into their evolving understanding of chemical engineering concepts. Complete supply lists, pre-assignment exercises, experimental procedures, and lab mats are discussed for both experiments and available for instructor use.

[1] Bowman, F.M., R.R. Balcarcel, G.K. Jennings, and B.R. Rogers. "Frontiers of Chemical Engineering: A Chemical Engineering Freshman Seminar," Chemical Engineering Education. 36(1), 24-29, 2002.

[2] Shallcross, D.C. "Factors Influencing the Selection of Chemical Engineering as a Career," Chemical Engineering Education. 37(4), 268-273,281, 2003.

[3] Minerick, A.R. and K.H. Schulz, "Freshman Chemical Engineering Experiments: Charged up on Electrophoresis & Brewing with Bioreactors." Chemical Engineering Division - American Society of Engineering Education Proceeding, Portland, OR June 2005.