

FLUID DYNAMICS

19. Laminar Film Flow Around Bubbles

Film flows are an important part of fluidics studies but unfortunately it is not one of the commonly experimentally illustrated examples such as laminar flow in a tube or viscous fluid flow around a sphere. In this study, laminar film flow around air bubbles in fluids will be investigated.

HEAT TRANSFER

20. Cooking Potatoes

In food processing, understanding the properties of the food that is dealt with is an important subject to minimize the cost and food-storage requirement while maintaining effectiveness. In this experiment, heat transfer through potato, which is a representative of a starchy food, will be studied experimentally and the results will be compared with the analytical model.

21. Boiling Heat Transfer

The aim of the experiment is to study heat transfer during different boiling types and to determine the effects of various parameters on heat transfer in a boiling unit calculating heat transfer coefficients. The experimental results will be compared with the correlations for the heat transfer coefficients.

MASS TRANSFER

22. An Introduction to Drug Delivery

Drug delivery is one of the major research areas in the pharmaceutical industry. To design a new drug delivery system, it is important to understand the material properties of the drug and also the factors affecting its delivery. This experiment introduces some basic concepts of drug delivery by studying the dissolution of a lozenge into water, which is a type of experiment performed by a drug company to determine the rate of drug release.

23. Effect of Extraction Parameters on the Yield and Quality of Pectin

The aim of the proposed experiment is to determine the effect of process variables, extraction temperature, duration and acidity of the extraction medium on the yield and quality of pectin extracted from apple.

24. Determination of Liquid Diffusion Coefficient of an Inorganic Solution in Water

Diffusion is an important phenomenon in mass transfer and molecular diffusion is a net transport of molecules from a region of higher concentration to one of lower concentration by random molecular motion. In this experiment, it is objected to investigate the diffusion of KMnO_4 in water at different temperatures. The color of KMnO_4 solution will provide a simple visualization of molecular diffusion. A procedure for obtaining time and position dependent concentration data at different temperatures will be developed and at the end, the diffusivity of KMnO_4 in water will be determined by making use of the Fick's law of diffusion.

25. The Effects of Temperature and Diffusion Tube Length on the Diffusion Coefficient and Finding the Mutual Diffusion Coefficient for a Binary Liquid-Liquid Solution

The first part of the experiment is the investigation of the rate of diffusion of a liquid vapor into stagnant air for different diffusion tube lengths in various temperatures. Thus, the effect of the tube length and the temperature on the diffusion coefficient will be found and compared with the Chapman-Enskog equation. The second part of the experiment is to find the mutual diffusion coefficient for a binary liquid-liquid solution into the stagnant air for various solution concentrations. Wilson equation for binary solutions will be applied to the solution to find the vapor mole fractions.

26. The Removal of Dye from Aqueous Solutions by Adsorption

The removal of color from aquatic systems caused by presence of synthetic dyes is extremely important from environmental point of view. In this experiment, a basic dye (methylene blue) will be adsorbed on activated carbon. Dye concentration will be analyzed using a UV-spectrophotometer. The adsorption data will be analyzed within the context of two common adsorption models; the Langmuir and Freundlich adsorption isotherms.

REACTION KINETICS

27. Batch Reactive Distillation

Batch Reactive Distillation (BRD) is defined as a batch distillation system wherein reaction takes place in either reboiler or condenser or in the column or at more than one of these locations. It has a potential to lower the capital and energy cost of the process. The aim of this experiment is to examine the potential of batch reactive distillation in enhancing the reaction conversion.

28. Study of Reaction Kinetics: Iodination of Acetone

Reaction kinetics plays a key role in chemical engineering education. In this manner, it is objected to investigate the kinetics of a chemical reaction in this experiment. The reaction under consideration will be the iodination of acetone. Acetone and iodine react in the presence of an acid to form a mono-substituted product plus HI. The reaction may be followed by measuring the absorbance of the I_2 using a UV/Vis spectrometer, or by measuring the amount of I_2 by making use of titration. At the end of the experiment, the rate equation (order of the reaction with respect to reactants) and the rate constant will be determined.

29. Kinetic Study of an Acid/Carbonate Reaction

The kinetics of the reaction between magnesium carbonate and hydrochloric acid will be investigated. The dissolution rate of $MgCO_3$ in HCl will be determined both by measuring the volume of the carbon dioxide gas evolved and the weight lost of the system over time. The effect of temperature and HCl concentration will be investigated.

30. Kinetics of Clock Reaction

There are many ways to find the kinetic parameters of a rate expression. For iodine clock reaction, time measurement and hydrogen peroxide analysis can be counted among the methods to find these parameters. The aim of this experiment is to study these methods to determine rate expression of an iodine clock reaction. In addition effects of changing parameters, such as reactant concentration, pH, etc., on reaction will be investigated.

31. Determination of Ethanol in Alcoholic Beverages

Ethanol content can be determined via enzymatic analysis which makes use of the UV method. In the analysis, ethanol is first oxidized to acetaldehyde and then to acetic acid and NADH. The difference between light absorbance before and after the reactions gives the NADH content which is directly proportional with ethanol content. In this experiment ethanol content of different brands and also different type of alcoholic beverages will be determined. The overall reaction order will also be found out.

BIOTECHNOLOGY

32. Do Generic Drugs Have the Same Effect as Brand Name Drugs

Generic drugs are a great way to reduce your out-of-pocket costs without sacrificing quality. Or does it so? In this study the effectiveness of a generic drug will be compared with respect to its brand name drug by observing the bacterial growth on plates.

33. Application of Keildahl's Method for Protein Determination

The Kjeldahl is a method for estimating the protein content in foods. The percent nitrogen measured is converted into the equivalent protein content. The Kjeldahl Method consists of three main steps: digestion, distillation, and titration. The procedure is based on transforming all nitrogen into ammonium sulfate by digestion with sulfuric acid, NH_3 recovery in the distillation step, and the amount of ammonia is quantified by titration. Protein content of different type of meats will be determined by this method.

34. Optimization of recombinant protein expression in E.Coli

E. coli is one of the most commonly used organism for the production of heterologous proteins . The strategies to express recombinant protein in *E. coli* involve cloning your gene of interests into a variety of *E. coli* expression vectors and express them in an *E.coli* strain. Inducible expression vectors keep a cloned gene repressed until we are ready to express it. In this experiment, *E. coli* BL21 (DE3) strain harboring plasmid pET-28a(+) vector will be used. pET-28a(+) vector was used for the large scale production of recombinant protein. Time, temperature of induction and IPTG concentration are the factors that contribute the level of expression of recombinant protein. Recombinant protein expression is under the control of IPTG (isopropyl- β -D-thiogalactopyranoside) induction. In this experiment *E. coli* BL21(DE3) cells harboring recombinant pET-28a(+) plasmid will be grown in LB medium at 37°C at 180rpm to an OD₆₀₀ of 0.5 with various concentrations of IPTG. The growth properties of recombinant *E. coli* BL21 (DE3) will be monitored to investigate the effect of the different expression levels of recombinant protein.

35. Determination of the Effectiveness of Sunscreens

UV radiation harms cells by causing changes in their DNA. While most cells repair this damage, occasionally one does not. This “glitch” can cause a mutation, in the DNA of a gene. When this gene is transcribed and translated into a protein, the protein may contain an error that causes it to function improperly and lead to cancer. Skin cancer is one of the major diseases linked to overexposure to UV radiation. Commercial preparations are available that block UV light, known as sunscreens or sunblocks. They have a Sunburn Protection Factor (SPF) rating, based on the sunblock's ability to suppress sunburn. Ordinary baker's yeast (*Saccharomyces cerevisiae*) contains genes for DNA repair that are very similar to human genes with the same function; therefore it can be used as a model system. This project aims to explore the effects of UV radiation on yeast cells and determine the effectiveness and differences between different sunscreen brands and different SPFs.

CONTROL THEORY

36. Ideal Tuning of a PID Controller to Control a Heat Exchanger and Determination of the Effect of Operating Conditions on Its Efficiency

The experiment focuses on a plate type heat exchanger to demonstrate the ideal tuning strategies to control a process more efficiently by using Internal Model Control, Ziegler-Nichols and Cohen Coon tuning methods and through simulations on Matlab/Simulink. In the second part of the experiment, the tuned PID controller is used. In this part, the basic concepts of experiment design and statistical analysis of the outcoming data are demonstrated. Effect of the factors such as mass flow rates of the fluids, temperature of the heating stream and the type of the heat exchanger on the efficiency of the process are analyzed through randomized factorial experiments and data is analyzed using F-test. Shell and tube and Plate Type Heat exchangers will be used in the second part.