Investigating the Operational Parameters Affecting the Acid-Base Reaction Inside the Stirred Tank by PIV/PLIF Technique

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Abstract

In this study, the acid-base neutralization reaction of acetic acid and ammonium hydroxide reaction inside a mixing tank to study the mixing interaction and chemical reaction by using simultaneous planar laser-induced fluorescence (PLIF)[1] and particle image velocimetry (PIV)[2] methods has been examined. The blade rotation speed, the blade distance from the bottom of the tank, the presence of buffers and the rheological properties of the fluid inside the tank are all the parameters that can be changed and optimized to improve the conditions of performance of mixed tanks which they are investigated to test them effects. The results showed that the progress of the acid-base neutralization reaction in the studied conditions was under the control of the mixing conditions of the reactants. To investigate the effect of blade distance from the tank floor, the ratios C/T = 0.25, C/T = 0.5 and C/T = 0.75 were selected which C is the distance of the blade from the tank floor and T is the diameter of the tank. Also the experiments were repeated at three speeds of 100 rpm, 150rpm and 200rpm. The results showed that by increasing the distance of the blade from the bottom of the tank, which is equivalent to increasing the C/T ratio, the reaction time was significantly reduced. In addition, at constant C/T ratios, the reaction time decreases sharply by increasing blade rotation speed. Also, in order to investigate the effect of the number of buffles in the tank, a buffleless, 2 buffles and 4 buffles blades were used at speeds of 100 rpm, 150rpm and 200rpm. Based on the results, it was found that as the number of buffles in the tank increased, the reaction time decreased. Also, a comparison of experiments performed in each tanks with three different speeds showed that the time-reduction ratios in tanks with fixed number of buffles at different speeds have a similar downward trend. Another parameter studied in this study was fluid viscosity, which was tested in μ= 35 mPa.s, μ=55 mPa.s, μ=75 mPa.s. The results of these experiments showed that with increasing fluid viscosity from μ=35 mPa.s to μ=55 mPa.s, the reaction time increased significantly, However, increasing the fluid viscosity by μ=75 mPa.s has less effect on the reaction time.

Keywords: Stirred Tank, Acid-Base Reaction, Planar Laser-Induced Fluorescence, Particle Image Velocimetry, Curved-Blade Turbine.

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Adsorption of Valeric Acid from Aqueous Solution Onto the Activated Carbon

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Abstract

In this research, adsorption of valeric acid from aqueous solution was investigated at different temperatures (25, 35 and 45°C) by using activated carbon in a batch system. In order to determine the functional groups in structure of adsorbent and surface characteristics of adsorbent, FTIR and SEM analysis were used, respectively. In the adsorption experiments, the effect of important parameters such as effect of contact time, the amount of adsorbent, temperature and initial acid concentration were investigated. Equilibrium time was determined 120 min. The optimum amount of adsorbent was determined 1.0g (for 40ml of solution). Investigation of the temperature effect demonstrated that the percentage of removed valeric acid increased by increasing the temperature. Different types of adsorption isotherms models such as Langmuir, Freundlich, and Temkin models were applied to analyze the equilibrium data at different temperatures and Langmuir isotherm had the most agreement with experimental data at different temperatures (with maximum R^2 values). The maximum adsorption capacity by using Langmuir isotherm model was determined 196.078 mg/g. Different kinetic models such as pseudo- first order, pseudo-second order, Elovich and intraparticle diffusion model were chosen to describe the kinetic of adsorption, and pseudo-second order model had the best agreement with experimental data for each adsorbents. Thermodynamic parameters like standard Gibbs free energy changes of adsorption (ΔG°_{ads}), standard enthalpy changes of adsorption (ΔG°_{ads}) and standard entropy changes of adsorption (ΔG°_{ads}) were calculated by using equilibrium constant values at different temperatures. Negative value of (ΔG°_{ads}) demonstrated that adsorption of valeric acid was spontaneity and positive values of (ΔG°_{ads}) showed that adsorption of valeric acid on adsorbent was endothermic.

Keywords: Adsorption, Valeric Acid, Activated Carbon, Isotherm, Kinetic, Thermodynamics.

1. Planar Laser-Induced Fluorescence
2. Particle Image Velocimetry

Experimental Study Extraction Oil from Francoeuria Undulata Using Supercritical Carbon Dioxide

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Abstract

Supercritical fluid extraction method is a replacement of conventional methods such as organic solvent extraction with hexane and mechanical pressing. Because in this method the operation temperature is low and the solvent does not remain in the final product. In this study, the effect of changing three parameters of temperature (35, 45, 55 °C), pressure (150, 175, 200 bar) and particle size (0.074, 0.149, 0.210 mm) on the extracted oil yield of the medicinal plant of Francoeuria undula using supercritical carbon dioxide was investigated. The results of the experiments showed that the extraction yield was increased by particle size reduction and increased pressure. Temperature up to 45 ºC has a positive impact on the extraction efficiency. However, increased efficiency was observed with increasing temperature more than of 45 °C. The best extraction yield in conditions of pressure was 200 bar, temperature 45 °C and particle size of 0.074 mm.

Keywords: **Extraction, Essential Oil, Supercritical Carbon Dioxide, Francoeuria Undula, Taguchi Method.**

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Effectiveness of Soluble Oxygen in Preparation of Thyme Oil Nanoemulsion- Simulation and Characterization

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Abstract

Due to the sensitivity of plant essential oils to molecular oxygen which, that causes oxidation and destruction of oils and changes its properties, it can be removed from the aqueous phase, during preparation of oil in water nanoemulsions. In the present study, dissolved oxygen was removed by nitrogen purging, and the thyme essential oil nanoemulsions, under subcritical water conditions (temperature 120 oC for 2 h) and using Tween 80, were prepared by two types of aqueous phases having dissolved oxygen and without that. Obtained results indicated that by removal dissolved oxygen from the aqueous phase, characteristics of the prepared nanoemulsions were improved and their mean particle size and polydispersity index decreased from 170 to 83 nm and from 0.562 to 0.2012, respectively, and zeta potential changed from -1.27 to -3.25 mV. Evaluation of the antioxidant and antibacterial activities of the prepared nanoemulsions against Streptococcus mutans, bacteria strain that causes tooth decay, also indicated that antioxidant activity of the formed nanoemulsions increased from 31.3% to 45% and their bactericidal activity, as manifested in diameter of the created clear zone, increased from 11 to 18 mm. Finally, based on obtained results and simulation of the operation conditions for the nanoemulsion preparation process, indicated that pressure of 1.7 bar was necessary and by removal dissolved oxygen from the aqueous phase consumed energy decreased from 10.01 and 8.88 kJ/h.

Keywords: **Antibacterial Activity, Antioxidant Activity, Dissolved Oxygen, Nanoemulsion, Subcritical Water, Simulation, Thyme Essential Oil.**

A Review of CFD Modeling of Gravity Multi-Phase Separators

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Abstract
Gravity multiphase separators are one of the most important equipment in different industries. Due to the limitations related to semi-empirical models and the high-performance cost of experimental tests in finding the optimized design, computational fluid dynamics (CFD) has been widely used recently. In this research, after a total review on gravity separators, a review of CFD studies on these apparatuses, to find the appropriate model for simulation and optimization, are considered. Results show that, although CFD is a powerful technique for modeling and improving the separator design, some disadvantages like using incorrect models, simplified assumptions and inappropriate optimization methods lead to inaccurate simulation and optimization results, which should be considered in future works.

Keywords: **Gravity Separator, Simulation, Computational Fluid Dynamics, Multi-Phase Flow.**

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The Optimal Design of the Dividing Wall Distillation Columns - Case Study of Benzene, Toluene and Xylene Separation

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Abstract
The design of a dividing wall distillation column for the separation of the mixture of benzene, toluene and xylene has been studied to produce 99 mol% pure products. The effect of changes in the feed composition on three structures including direct sequence, indirect sequence and dividing wall column and also selection of the optimal structure on the basis of the optimization results have been studied to minimize the total annual cost. For the single column structure and equimolar feed, it has been shown that it is possible to reduce the energy consumption cost in the reboiler by about 30% and the initial investment cost by about 27% compared to the direct sequence structure. However, this is not true for all feed conditions. The dividing wall column structure always reduces energy costs, however, the indirect structure is more appropriate considering the total annual cost as the decision-making criterion when the xylene is the dominant feed component.

Keywords: **Dividing Wall Distillation Column, Optimization, Thermal Coupling, Benzene, Toluene, Xylene.**