A Mathematical Model for Determination of Effect of Temperature, Diameter and Moisture Content of Droplet on Efficiency of an Industrial Spray Dryer

A. A. Hamidi[1], M. Semnani Rahbar[2*], F. Darabi[3]

1- Chemical Engineering Department, Tehran University, Tehran, Iran

2- Chemical Engineering Department, Imam Hossein University, Tehran, Iran

3- Chemical Engineering Department, Iran University of Science & Technology, Tehran, Iran

E-mail: msrahbar@yahoo.com

Abstract

Spray dryers are one the most applicable dryer in chemical industries. In spite of different theoretical researchs on spray drying, industrial dryer performance is still a considerable subject for scientists. In this investigation, at first, a mathematical model of a spray dryer was persented and then, the model was applied on an industrial case (Paxan Co.) with presentation of basic relations and equations. Thus, variation of feed temperature, droplet diameter and humidity versus time and also, effects of feed temperature and nozzel orifice diameter on droplet distance in vertical and horizental axes in the spray dryer tower were investigated. The obtained results from mathematical model and practical data show that effect of droplet humidity on outlet gas depends on contact time between droplet and gas. In contact time more than five seconds, higher temperature of feed causes more decrease of outlet gas temperature. In enough contact time, diameter of droplets with high temperature can be less than droplet with low temperature. Also, the nozzle with 3.5mm diameter produces low diameter droplet and decreases vaporization load of tower. According to the results, nozzle feed temperature doesn`t affect on gas temperature at the beginning of gas entry. The comparison between model results and pactical data shows that this model satifies the data very well.

Keywords: **Spray Dryer, Mathematical Model, feed Temperature, Orifice, Droplet**

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Review of Various Kinds of Airlift Bioreactors and its Effective Hydrodynamic Parameters

M. K. Moraveji[1*], M. Morovati[1], E. Ghaderi[1], M. Vossoughi[2]

1- Department of Chemical Engineering ,Arak University, Arak, Iran

2- Department of Chemical and Petroleum Engineering, Sharif University of Technology, Tehran, Iran

E-mail: m-moraveji@araku.ac.ir

Abstract

Airlift bioreactors form one of the most important classes of gas-liquid contactors that are extensively used in chemical and biochemical processes especially in oil and gas industries. These bioreactors have some advantages respect to CSTR and BCR's especially in bioprocesses. In this article, various kinds of airlift bioreactors have been investigated. Design or scaling of the bioreactors is depend on the hydrodynamics turnover, that inclusive using parameters such as gas velocity, void fraction, liquid velocity and mixing. Because of the rigorous interaction, behavior study of these bioreactors are complicated. In this research, effective hydrodynamics parameters in the airlift bioreactors are investigated.

In the recent years, computational fluid dynamic (CFD) as tools for study the airlift bioreactors were used. CFD methods and their application in simulation of airlift bioreactors have been introduced and investigated.

Keywords: **Two-Phase Gas-Liquid Flow, Airlift, Bioreactor, Hydrodynamic, CFD**

Employment of Supercritical CO_2 in Membrane Preparation Process

S. S. Madaeni*, N. Arast
Chemical Engineering Department, Razi University, Kermanshah, Iran
Email: smadaeni@yahoo.com

Abstract

Supercritical CO_2 (SC-CO_2) have been extremely used in membrane formation process due to the appropriate properties. Numerous polymeric membranes have been prepared by the phase separation process using SC-CO_2 as a non-solvent for the polymer solution. This process exhibit several advantages, mainly membrane properties may bemanupulated by changing process condition; i.e., supercritical CO_2 can produce very different non-solvent activities using different pressures and temperatures. However the major drawback of this technique is limited affinity between CO_2 and water at the ordinary process conditions. Consequently, this process cannot be used to produce membranes of water-soluble polymers. In another supplement method, the phase inversion of water-soluble polymers was proposed using liquids expanded by SC-CO_2. With this process, it is possible to take advantage of both capabilities of the organic solvents and SC-CO_2 at very low temperatures. The next methods are synthesis of composite membranes. In a case study for improving the conductivity of Nafion membranes and to inhibit methanol permeation, styrene monomer was radically grafted onto the Nafion 115 membrane using SC-CO_2. In another work; Pd particles were grafted on Nafion 117 by supercritical-impregnation and chemical reduction. Moreover the gas permeation properties of carbon molecular sieve (CMS) membranes dispersed with palladium nano particles via SC-CO_2 impregnation method were investigated in another work. In this review paper we cite other methods which have successfully used for preparation of membranes namely formation of integrally skinned asymmetric gas separation membranes by SC-CO_2 and proton conducting membrane preparation using multi-layer acid–base complex formation on porous polymeric film.

Keywords: **Membrane, SC-CO_2, Phase Inversion, Impregnation**

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Convergence Procedure of Methane Gas Hydrate Equilibrium Calculation in HV and HLW Equilibrium

M. Karamoddin , F. Varaminian*
Chemical, gas and petroleum Engineering School, Semnan University, Semnan, Iran
Email: farshad_varaminian@yahoo.com

Abstract

In some special conditions of hydrate forming, three hydrate-vapor-liquid phases are equilibrated together. In this research, thermodynamic hydrate equilibrium in binary mixture of methane and water with VPT equation of state and Danesh mixing rule and using Van der Waals Plauteeuw model for hydrate solid phase by attending to (HVLW) equilibrium phases is studied. In this purpose equilibrium pressure, once by using HV state and another time with HLW, and by two suggested algorithm is calculated. Comparison between calculation results and available experimental data in 262.4-285.9 K temperature range for methane hydrate pressure, shows that if two phases chosed from three equilibrium phases, HV equilibrium phases must be used and then equilibrium percent in other phases will obtain. Calculated average error percent in HV equilibrium state of two methods is 9.21%, although this percent in HLW state is 23.23%.

Keywords: **Mixing Rules, Equation of State, Gas Hydrate, Phase Equilibrium**

Outlook of Bioenergy in Iran and in the World

M. Pazouki[1*], Kh. Hadipour[1], P. Parvin[2], L. Posht Sheykhani[1]
1- Materials and Energy Research Center, Meshkindasht, Karaj, Iran
2- Alcohol Producing Society of Iran,Tehran,Iran
E-Mail: mpazouki@merc.ac.ir

Abstract
In this article the importance of bioenergy as an alternative fuel source is investigated. Also programs and outlooks of bioenergy in Iran and some other countries which possess both fossil energy sources and renewable energy sources are reported. The present and future of bioethanol consumption in Iran as a supplementary to petrol fuel and the necessity to support and invest on research and development of this strategic product is emphasized. Countries like United States, Australia, Canada and Brazil are very concerned about the development of bioenergy and have plans for using bioenergy resources for production of fuel, electricity, and heat. These plans include using less fossil fuel and also reducing the risk of air pollution. Iran also has programs to reduce dependencies on fossil fuel. Iran in 2008 had biomass gross production of about 25.4 Mtoe which is about 1.1 % of the fuel gross production.

Keywords: **Bioenergy, Bioethanol, Renewable Energies, Biomass**

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A CFD Based Correlation for Effective Vapor Diffusivity of Porous Gelatin in Freeze Drying Process

M. Hassan Ghajar, S.H. Hashemabadi[*]
Computational Fluid Dynamics Research Laboratory, Chemical Engineering Department,
Iran University of Science and Technology, Tehran, Iran
E-mail: Hashemabadi@iust.ac.ir

Abstract
Ascertainment of effective diffusion coefficient in porous solids is difficult and will determine empirically. A model to assess the relationship between the effective vapor diffusivity and porosity has been developed by computational fluid dynamic techniques and experimental data of freeze dryer set up. Continuity, momentum and energy equations with heat and mass transfer models solved for idealized geometry of porous hydro gel and diffusion mechanism duo to pressure gradient in freeze drying porous media was studied for two phase liquid-vapor as mixture model multiphase flow. The effective vapor diffusivity at freeze drying has been determined as a function of porosity and water volume fraction at vapor diffusion and condensation process in freeze dryer. The simulation results are in a quite fair agreement with empirical models to predict effective vapor diffusivity.

Keywords: **Effective Diffusivity, Continuum Diffusion, Freeze Drying, CFD Simulation**

Using Supercritical Fluids for Solid Particle Production with Suitable Size Distribution

H. R. Satvati, M. N. Lotfollahi*
Gas and Petroleum Engineering Department, Semnan University, Semnan, Iran
E-mail: mnlotfollahi@semnan.ac.ir

Abstract

In many of chemical processes, the narrow and suitable size distribution for solid products and raw materials is necessary. Traditional processes such as crushing, milling and drying have problems like high energy consumption, solvent residue in product as well as thermal decomposition of product. Therefore, research about alternate methods instead of traditional procedures is of interest the researchers. One of these alternatives is the use of supercritical fluids. The supercritical fluids are used for solid particle production with small size and narrow size distribution using different processes with different roles. Rapid expansion of supercritical solution (RESS) method can be used to produce particles which have significant solubility in supercritical fluid. In supercritical anti-solvent (SAS) process, pressure term is more dominant; however its problem is solvent residue in the product. The procedures of the gas-saturated solution (PGSS) and the depressurization of expanded liquid organic solution (DELOS) processes are different with the previous mentioned methods. These two processes do not use advantage of supercritical fluid properties as solvent or anti-solvent, but they use the large cooling effect of supercritical fluid when expansion occurs suddenly.

Keywords: **Size Reduction, Size Distribution, Supercritical Fluid, RESS, SAS, PGSS, DELOS**

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A Review on Experimental and Mathematical Modeling Studies of Bioremoval of Gaseous Pollutants in Biofilters

S. Sami[1], A. Rahimi[2*]
1- Chemical Engineering Department, Isfahan University of Technology, Isfahan, Iran
2- Chemical Engineering Department, Engineering Faculty, Isfahan University, Isfahan, Iran
E-mail: Rahimi@eng.ui.ac.ir

Abstract

The present paper is a review paper which explains and analyses the recent mathematical modeling and experimental studies on removal of the gaseous pollutants by biofiltration. Also, the comparison of these studies is carried out on the basis of differences in experimental methods and modeling approaches. This study shows that however the biofiltration systems have been considered through several experimental studies, but the results have been not used for developing of comprehensive empirical correlations which could be used in similar operating conditions and systems. It seems this is due to complicated nature of such systems and abundance of effective operating parameters. Also the analysis of modeling studies shows that any of the proposed models have not adequate universality. Nonetheless, the results of the models with oversimplifying assumptions have enough accuracy, especially when the results of the models are compared with the experimental data presented by the same authors. Results of this analysis also show that still, there is a large scientific deficiency in predicting of main and important parameters in the modeling of biofilters, including the kinetic of reactions, the actual mass and heat transfer area, and the non-uniform distribution of microorganism. Therefor, many of the mathematical models are based on the oversimplifying assumptions for the main parameters.

Keywords: **Modeling, Biofiltration, Biofilter, Bioreaction**

Technical and Economical Aspects of Pipeline and LNG Plant Options for Natural Gas Transmission from the South Pars Field

F. Abdollahi-Demneh[1], M. A. Moosavian[1*], M. R. Omidkhah[2], H. Bahmaniar[1]

1- Chemical Engineering School, Engineering College, Tehran University, Tehran, Iran

2- Chemical Engineering Department, Tarbiat Modares University, Tehran, Iran

E-mail: moosavian@yahoo.com

Abstract

During recent decade it has been repeatedly declared by Iranian top managements that in the case of producing gas more than domestic consumption how it might be converted to more value added. Actually there are following five possible options in front of them for this additional natural gas:

- *Transmission via natural gas trunk-lines up to the border of Turkey in order to inject to the Nabucco pipeline for consumption in Europe.*
- *LNG production in Assaluyeh (Tombak) and selling in the LNG market all around the world.*
- *Gasoline and petrol production via Gas to liquid (GTL) process.*
- *Methanol production*
- *Ethylene production via Oxidative Coupling of Methane (OCM).*

Up to now, amongst the abovementioned options only the methanol production projects have been executed in industrial scale inside Iran while regarding the OCM and GTL processes some pilot plant projects in the Research Institute of Petroleum Industry (RIPI) are on stream. It is noteworthy that the OCM and GTL processes are economically feasible provided that oil prices are high. About the first and second abovementioned options, namely pipeline and LNG, it is remarkable that for a long period of time Iranian top managements in the filed of energy were doubtful to select one of them in a manner that one must be selected and the other ought to be forgotten. During recent years both two options were pursued by Iranian top managements hence some projects were defined and now are on stream. The objective of this study was to investigate the technical and economical aspects of these two options in order to make the issue more clear.

Spray dryers are one of the most important dryers and have many applications in the food, drug and chemical industries. In this investigation, a model Is suggested to predict the product temperature, drying time and the dryer height In order to evaluate the dryer performance in different operational conditions. To achieve this, knowledge of the drying kinetics and the transfer phenomenon are necessary. The main aim in this project is, modeling of the spray drying of Alumina Slurry in a co current dryer.

In this modeling Mass, heat and momentum transfer equations on droplets and hot air have been written. By writing a computer program for the simultaneous solution of mass, energy and momentum balances, a mathematical model is introduced. In order to evaluate the accuracy of the model, the experimental data were used and results showed good agreement between the theory and the experiments. By using the results of the model, the change in the dryer input parameters and their effect on final product characterizations have been studied.

Keywords: Natural Gas, Pipeline, LNG, Economical and Technical Aspects