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Review Article

Fluidized Bed Contactors: A Review on Studies and Research

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ABSTRACT

Chemical engineering involves contacting of two phases or reactants for mass transfer or chemical reaction. Various cocurrent, countercurrent contacting patterns can be used according to requirements. For gas, liquid and solids and mass transfer among any two of these states, proper contact is important. Packed beds, tray towers, spray towers are usually used as contacting devices. Fluidized bed offers advantage of uniform temperature distribution and excellent contact between particles. It has been tried for adsorption and chemical reactions. Current review summarizes studies and research on fluidized bed contactors.

Key words: fluid, particles, contact, phase, yield.

INTRODUCTION

Chemical reactions involve two major substreams namely Mass transfer and Reaction Engineering. Research on various contacting equipments has been carried out to study affecting parameters, isotherms and kinetics. [1,2] Batch and packed bed experiments are used to study the removal efficiency and affecting parameters in adsorption. [3-5] In catalysis also various packed bed and fluidized bed contactors are used. [6-8] Fluidized beds can be used for efficient contact between fluid and solid. [9] Current review summarizes research on fluidized beds.

Research and Studies on Fluidized Beds

Sathiyamoorth provided an account of the use and exploitation of plasma coupled with spouted/ fluidized bed (PFBR) for material processing. [10] According to him, use of PFBR still stands mainly on the extensive hydrodynamic studies. Subbaiah et.al carried out an investigation on gasification of biomass using fluidized bed. [11] They analyzed the potential of groundnut shell to produce combustible gas in a fluidized bed gasifier. They observed that gasification temperature was the most influential factor on the gasification performance. The higher temperature leads to improve the gas yield. Suleiman et.al designed and constructed fluidized-bed reactor for practical demonstration of the fluidization of solid particles at different fluid flow rates. [12] The bed included sand particles of average size 1800 μm, weighed 0.6 N and the fluidizing fluid was air. Their design was found suitable for undergraduates of chemical engineering and related studies for improved knowledge and practical skill required for effective and optimal performance in meeting industrial needs towards improved service delivery.

Hassimi et.al carried out unsteady-state modeling of the fluidized bed polyethylene reactor. [13] They developed a mathematical model for describing the dynamic behavior of the gas phase ethylene polymerization reactor. They observed that a significant amount of polymer production (roughly 12%) takes place in the bubbles. Tisa et.al carried out an investigation on basic design of a fluidized bed reactor for wastewater treatment using fenton oxidation. [14] Detailed design parameter studies which included different correlations for calculating the required design parameters were carried out. They evaluated the performance of the FBR for treatment of phenolic water (<200ppm).

Mixed plastic wastes pyrolysis was carried out by Aida et.al in a fluidized bed reactor for potential diesel production. [15] They carried out feasible study on converting mixed plastic wastes by applying catalytic pyrolysis into valuable products. Also they analyzed the properties of liquid products and compared them using Fourier Transform Infrared Spectroscopy (FTIR) and High-Pressure Liquid Chromatography (HPLC). They observed that those functional groups detected are similar with commercial diesel together with HPLC results, indicating diesel concentration. Farag et.al presented the developments in modeling gas-phase catalyzed olefin polymerization fluidized bed reactors (FBR) using chromium catalyst technique. [16] They used model based on the two-phase theory of gas-solid fluidization: bubble phase and emulsion phase. They observed a good agreement between the model predictions and the actual plant data. Souzaet.al. carried out studies on the performance of a three-phase fluidized bed reactor in treatment of wastewater with high organic load. [17] Their experimental study was aimed at evaluating the performance of a three-phase fluidized bed bioreactor (FBBR) used to treat milk wastewater. They observed that that the average efficiency of COD removal decreased as the concentration of organic load in the substrate was increased. According to them; the higher concentration of active biomass was responsible for achieving a relatively high absolute degradation of the wastewater containing the high organic load. Arumugam and Sabarethinam performed aerobic treatment experimentally in a three phase fluidized-bed bioreactor (FBBR) using culture of living cells immobilized on support particles. [18] They also studied characteristics of dairy waste. They found that percentage reduction in COD for ceramic, Teflon and glass particles are 91%, 85% and 78%, respectively.

Uraz and Atalay carried out studies on a fluidized-bed reactor and a fixed-bed reactor for the oxidation of benzene to maleic anhydride. [19] They studied the selective oxidation of benzene to maleic anhydride (MAN) and compared the performances of fluidized-bed and fixed-bed reactors. They investigated the influences of parameters such as temperature, space time, and air-to-benzene molar ratio on the reaction selectivity. They observed that the conversion of benzene to MAN increased with increasing temperature in both reactors. Lam et.al carried out studies on the influence of various process parameters such as particle size, pyrolysis temperature and activation time on the quality of the activated carbon. [20] They observed that sawdust was considerably efficient in removal of methylene blue from aqueous solution. Barros et. al. carried studies on biohydrogen production in anaerobic fluidized bed reactors. [21] Their studies were concentrated on effect of support material and hydraulic retention time. They evaluated two different support materials (polystyrene and expanded clay) for biohydrogen production in an anaerobic fluidized bed reactor (AFBR) treating synthetic wastewater containing glucose. They observed that the values of hydrogen yield HY, hydrogen production rate HPR, H_2 content, and gram of attached biomass per gram support material were all higher for AFBRs containing expanded clay than for reactors containing polystyrene.

CONCLUSION

Fluidized bed reactors were used by various investigators for catalytic reactions, adsorption and biological reactions. Fluidized bed provides better contact, uniform temperature distribution and lesser pressure drop. It can be concluded that fluidized bed operated under proper operating conditions is very efficient and effective equipments for solid fluid reaction and mass transfer.

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