

RESEARCH ARTICLE

Impact of Secondary Fluidizing Medium on Hydrodynamics and Reaction Performance in Liquid Phase Semi-fluidized Bed Reactor: A Lab-scale Investigation

Ankita Mazumder¹, Raja Jana¹ and Deepak Kumar Samal^{1,*}

¹Department of Chemical Engineering, Haldia Institute of Technology, ICARE Complex, Haldia, West Bengal, 721657, India

Abstract: Introduction: The present investigation is focused on evaluating the influence of secondary fluidized medium (air) in a lab-scale fabricated liquid phase Semi-Fluidized Bed Reactor (SFBR). With the inclusion of air as a secondary medium, any alterations in hydrodynamic behavior, mixing pattern, bed stability, and conversion efficiency with respect to a liquid-liquid system will be thoroughly studied and analyzed in the current study.

Methods: The hydrodynamic development of a semi-fluidized bed with the help of alumina beads in an indigenously fabricated reactor of 240 mm height and 25.4 mm ID was investigated in two different ways, initially by employing only the liquid phase and secondarily by the liquid-gas phase. Furthermore, the saponification reaction has been carried out with and without a secondary medium, in which reaction performance was enumerated in terms of the sodium hydroxide (NaOH) conversion efficiency.

Results: It has been observed that the conversion of NaOH is enhanced by 10-22% with the incorporation of secondary medium in the present range of investigation.

Discussion: The experimental findings suggest that the secondary fluidizing medium is playing a crucial role in controlling the hydrodynamic behavior and improving reaction performance. The inclusion of air in semi-fluidized operation facilitates overcoming limitations of conventional two-phase fluidization, including improper, non-homogeneous mixing or limited mass transfer, and thus delivers higher bed stability and mass transfer rate.

Conclusion: Thus, the utilization of air as a secondary fluidizing medium in a lab-scale SFBR substantially modifies hydrodynamic behaviour and improves conversion efficiency by approximately 10-20%. These findings establish the promising suitability of secondary-fluidizing-medium-assisted SFBRs for process intensification in biochemical and chemical engineering applications.

Keywords: Conversion, fluidization, hydrodynamics, SFBR, saponification, secondary medium.

1. INTRODUCTION

Reactors play a pivotal role in chemical and biochemical process industries, serving as the

integral units where the transformation of raw materials into desired products takes place through molecular and phase changes. Though the fundamental role of each and every reactor is to promote reactions (chemical or biochemical), their indigenous design, construction, and operational aspects differ substantially based on the specific process requirements. One of the significant

*Address correspondence to this author at the Department of Chemical Engineering, Haldia Institute of Technology, ICARE Complex, Haldia, West Bengal, 721657, India; E-mail: dkssamal@hithaldia.ac.in

ARTICLE HISTORY

Received: January 05, 2026
Revised: March 04, 2026
Accepted: March 16, 2026

DOI:
10.2174/0124055204464062260603044440