

# Hydrodynamics of Adsorption Beds: A Review

Sunil Jayant Kulkarni<sup>1</sup>, Dr. Jayant Prabhakar Rao Kaware<sup>2</sup>

<sup>1</sup>Chemical Engineering Department, Datta Meghe College of Engineering, Airoli, Navi Mumbai, Maharashtra, India.

<sup>2</sup>Bhonsala College of Engineering & Research, Akola, Maharashtra, India.

\*E-mail: [suniljayantkulkarni@gmail.com](mailto:suniljayantkulkarni@gmail.com)

## Abstract:

*Adsorption is used in wastewater treatment for removal of various organic and inorganic pollutants. Low cost of the operations is the main attribute which makes this option very attractive. The use of the contacting system is very important in practical use of the operation. Packed, fluidized and expanded beds are the options available for this. The effect of various packings and their effect on the hydrodynamic behavior is important from the efficiency and effectiveness point of view. This review aims at presenting a summary on research carried out to study hydrodynamics of packed bed.*

**Keywords:** Pressure drop; efficiency; porosity.

## Introduction

Wastewater treatment includes many physical, chemical and biological processes. Adsorption is very important process used for wastewater treatment. It has been used for removal of organic matter by using various low cost adsorbents (1, 2, 3, 4, 5). Also removal of phenol, acetic acid was

carried out successfully by various investigators (6, 7, 8, 9, 10). Removal of dyes was also successful. The studies on various types of contactors were carried out. Fluidized beds were used effectively for removal of phenols (11). The packed beds and batch processes were used for removal of various pollutants by researchers (12, 13, 14, 15). The investigation on packed bed indicates that, the study of hydrodynamics of the packed bed is important aspect which needs to be studied. Pressure drop, the other the problem in the packed bed adsorption can be minimized by various techniques. This review aims at presenting summary of various research papers related to hydrodynamics of adsorption beds.

## Research on Hydrodynamics of Adsorption Beds

Chelating resin was used in a binary solid fluidized bed for heavy metal removal by Yang and Renken [16]. According to them addition of lighter and small diameter particles increases mass transfer coefficient considerably. They used inert particles like glass beads. Thakare and Jana studied expanded beds for wastewater treatment

[17]. They discussed expanded bed as process solution for wastewater treatment. The clogging of insoluble particles in the adsorption bed increases the pressure drop. So use of liquid solid stable fluidized bed, termed as expanded bed helps in solving this problem. This bed has the combination of both, plug flow characteristics of the packed bed and hydrodynamic properties of fluidized bed. They used this bed for copper removal from water. They used commercial grade copper sulphate for the sample preparation. After reaching minimum fluidization velocity, the bed started to expand. This system offered higher bed voidage and hence was operated at lower pressure than typical packed bed. Albuquerque and Santana investigated hydrodynamic behavior of a biological packed bed under different hydraulic and organic loading [18]. They experimentally investigated the hydraulic characteristics of a biological laboratory packed bed, filled with a volcanic stone. As the carbon loading was increased, considerable amount of dispersion was observed through filters. The hydrodynamic behavior approached plug flow. In the presence of biomass, the influence of dead zones and short-circuiting was more important in the upper filter. Solomon et. al. carried out research on hydrodynamics in fixed bed of composite granular materials [19]. Their study was aimed at the experimental determination of pressure drop and friction factor. Fixed beds of granular silica gel, alumina and activated carbon were used for the studies. Muthusamy and Murugan studied hydrodynamics of a packed bed column for the removal of zinc ions from aqueous solution [20]. According to their studies, the results of this column studies were good enough to scale up the column for higher capacities. Shahavi et.al. used

expanded bed column for protein purification [21]. They studied biochemical characterization and hydrodynamic behavior. Their evaluation exhibited good capacities and adsorption/desorption performance. Krishna et.al. studied expanded bed adsorption column for protein recovery [22]. Their experimental results were in close agreement with the predicted porosity of Stokes law. Padhi et.al carried out review on hydrodynamics studies of gas-solid fluidization in non cylindrical conduits for spherical and non-spherical particles. [23]. According to the author there is need for innovation and research to minimize the dilemmas and problems associated with gas liquid system.

## Conclusion

Adsorption is very efficient operation for removal of organic matter and heavy metals. The contactors used can be packed bed or fluidized beds. The problem of high pressure drop can be minimized by using expanded bed. Use of inert material in packed bed increases mass transfer coefficient. It helps in increasing porosity. There is still scope for research in order to minimize operating difficulties in the packed columns.

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