Research Project Proposal

Studying the effects of vertical vibration on Fluidization behavior of fine (Geldart A) particles of coal and biomass mixtures

Introduction:

Fluidized beds are widely used in many modern technologies for efficient implementation of various physical and chemical processes. The nearly isothermal condition, rapid mixing of particles, high heat and mass transfer rates, large available surface area, and resistance to sudden changes in operating conditions are some inherent advantages of fluidization technology. Fluidization behavior of particles depends on particles size and density. For fine particles of Geldart A (1), which have small diameters (20-100 μm) and/or low densities (< 1.4 g/cm^3), significant cohesive inter-particle forces are reported. These forces could cause serious problems such as particle agglomeration and segregation. To avoid these problems, vertical vibration can be added to the fluidized bed.

The existence of these vibrations also has a huge impact on mixing behavior of the material in fluidized beds. Mixing characteristics are an important feature that can induce better particle contact, which is essential for increasing the efficiency of the process and providing a relatively uniform temperature throughout the fluidized bed. Also mixing characteristics for each mass ratio will also be studied, which is an important parameter that is a representative of particle contacts. Studying mixing characteristics will help increase the efficiency of the whole fluidization process and avoid common fluidization problems such as agglomeration and clustering.

The focus of this research will be on coal and biomass mixtures. Although harnessing solid fossil fuels energy (such as coal) using fluidized beds has been one of the respected ways; long-term availability of coal and its carbon emission level have always been a problem. Attempts to solve these problems have drawn attention to biomass as a renewable energy resource. Biomass has a great potential to be substituted for the Nation's coal needs that potentially can reduce the amount of produced carbon dioxide due to its carbon neutrality nature (2), however using biomass alone is not

economically efficient (3). As an effort to solve the common problems of using coal and benefit from positive aspects of biomass as a fuel, using coal and biomass mixtures as fuel is being considered. Since biomass materials are mostly waste materials, they mostly are in the shape of fine powders, which may create fluidization problems mentioned before and require extra attention.

Objective:

The purpose of this project is to computationally investigate the effects of vertical vibration on fluidization behavior of Geldart A particles of coal and a few biomass mixtures, resulting in a better understanding of the fluidization velocity, pressure drop and bed expansion at different mass ratios.

Deliverables:

Student is required to provide two presentations and one final report following the guidelines provided by Dr. Estejab. In the first presentation, the student will explain the outcome of his literature survey on existing models. Then, he learns the required techniques, and present the outcome of his research in a complete report and presentation, toward the end of the semester. The student is required to submit all the calculation along with the codes. The presentation dates are set by the department Graduate Program Director, Dr. Litkouhi.

Erik CUEVAS Erik Cuevas O. Date: 05/27/2020
Graduate student

Dr. Bahareh ESTEJAB Bahareh Estejab Date: 05/27/2020
Advisor

Dr. Bahman LITKOUHI Date: 05/27/2020
Graduate Director

Appendix:

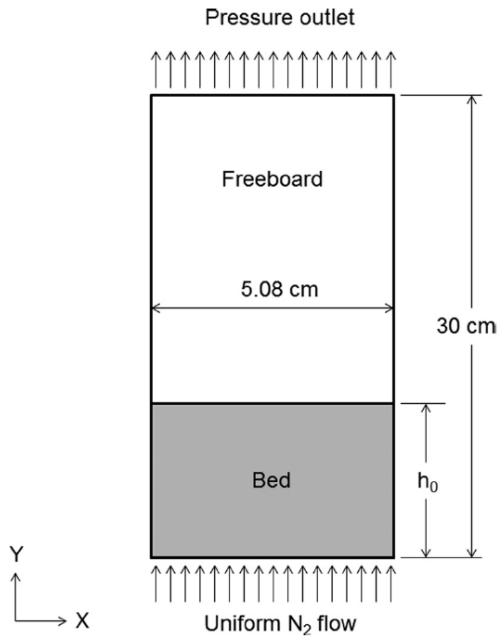

Figure 1: Fluidized bed reactor example. (4)

References:

(1) Geldart, D., 1973, "Types of Gas Fluidization," Powder Technol., 7(5), pp.285–292.

(2) Hartmann, D., and Kaltschmitt, M., 1999, "Electricity Generation From Solid Biomass Via Co-Combustion With Coal: Energy and Emission Balances From a German Case Study," Biomass Bioenergy, 16(6), pp. 397–406.

(3) Prins, M. J., Ptasinski, K. J., and Janssen, F. J. J. G., 2007, "From Coal to Biomass Gasification: Comparison of Thermodynamic Efficiency," Energy, 32(7), pp. 1248–1259.

(4) Estejab, B., and Battaglia, F., 2013, "Modeling of Coal-Biomass Fluidization Using Computational Fluid Dynamics," ASME Paper No. IMECE2013-63339.