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Experimental Investigation Of the Thermal-Hydraulic Characteristics of Agglomerates in Gas-Solid Fluidized-Bed Reactors

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Extended Abstract

Gas-solid fluidized-bed reactors constitute an important chemical reactor technology, largely implemented in chemical and nuclear industries [1]. The intrinsic good mixing of these reactors guarantees optimal mass and heat exchange, which, in turn, enhance, respectively, chemical reactions and temperature homogeneity within the reactor. These characteristics make the use of fluidized-bed reactors convenient in processes such as thermal denitration of nuclear spent fuel. However, one operational problem occurring in this and other industrial applications of fluidized-bed reactors is the formation of bed particle agglomerates, partially due to the presence of moisture and partially due to sintering, which usually takes place in hotspots or in regions of uneven fluidization [2]. These agglomerates may then, in turn, compromise the fluidization quality of the reactor, leading to the formation of dead zones and, hence, further agglomeration, establishing, therefore, a positive feedback loop that compromises the proper functioning of these reactors [3]. A good understanding of the thermal-hydraulic behaviour of these agglomerates is of fundamental importance in order to prevent any disruptions from happening.

This study aims to experimentally determine the characteristics related to the motion and heat transfer of such agglomerates in gas-solid fluidized-bed reactors. A first part of the work entails monitoring, with a previously calibrated short wave infrared camera, the temperature evolution of agglomerates in a fluidized bed. The studied experimental setup is constituted by a flat pseudo-2D fluidized bed with PMMA walls. The range of materials and potential setups is strictly limited by the nature of the infrared radiation, by the transmittance to it of the materials used and by thermal limitations. The resulting agglomerate temperature evolution will allow to study the heat transfer process between the agglomerate and the bed.

In parallel, the motion of agglomerates inside the fluidized-bed reactor will also be studied. For example, the probability distribution for agglomerates, indicating where they are most likely to be found, will be obtained, and specific attention will be paid to locations of the fluidized bed where such agglomerates may accumulate, leading then to partial or total reactor defluidization. This study will be performed by the means of x-ray imaging, which allows to distinguish between zones of larger density, corresponding to the emulsion regions, and areas of smaller density, i.e. in the presence of bubbles.

The outputs of this work will be a deeper understanding of the agglomerate behaviour in gas-solid fluidized-bed reactors, which will then allow to implement techniques to predict and prevent potential disruptions they may cause, as well as the optimization of methodologies to study the thermal-hydraulic characteristics of such agglomerates.

References

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