

X-RAY IMAGING FOR DESIGN OF GAS NOZZLES IN LARGE SCALE FLUIDISED BED REACTORS

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Satisfactory performance of fluidised bed reactors in terms of bed characteristics, chemical conversion and power requirements is influenced by the design features of gas distributors. In industrial practice single or multi-orifice types of nozzles are frequently used. When there is more than one jet in a gas nozzle, jet interaction is to be expected in most cases. Thus jet interaction is an important phenomenon to study for operation and design, especially when horizontal or downwards buoyant jets are studied.

Numerous investigations have been devoted towards understanding the hydrodynamics of gas jets in fluidized beds. However, most of them address the problem in 2-D systems and/or upward jets from distributor plates, which do not reveal the true behavior in the jet region in a real industrial nozzle.

The present work aims to understand the jet behavior from a more realistic level, i.e. the industrial size level. Full-scale nozzle designs were manufactured using a 3-Dimensional (3D) printer and tested to obtain data of both quantitative and qualitative nature. All nozzles tested were designed to reproduce the behavior of real industrial nozzles from a TDN reactor used in spent nuclear fuel reprocessing. Holes of different shape, size, angle, number and spatial arrangement were located on the nozzle wall as opposed to on the top face, in an attempt to eliminate powder ingress issues. Some nozzles had holes on only one side of the nozzle wall, as these were designed to be installed in an area of the reactor close to the reactor wall. This design consideration was to prevent gas from being impinged on the reactor walls, which would likely result in erosion.

A 200mm ID gas fluidized bed of sand, constructed from Perspex, with a single nozzle located at the centre of the distributor was used in the work. A high power X-ray system with a camera speed up to 72 frames per second was used to observe the jets behavior in the 3 dimensional case. Analysis of large quantity of images allowed determination of voidage distribution, jet penetration and jets interaction in the nozzle region for different configurations (Figure 2).

Using the experimental data obtained in this study, a new empirical correlation for horizontal jet penetration is proposed as a function of the Froude number.



Figure 1: A selection of 3D printed nozzles

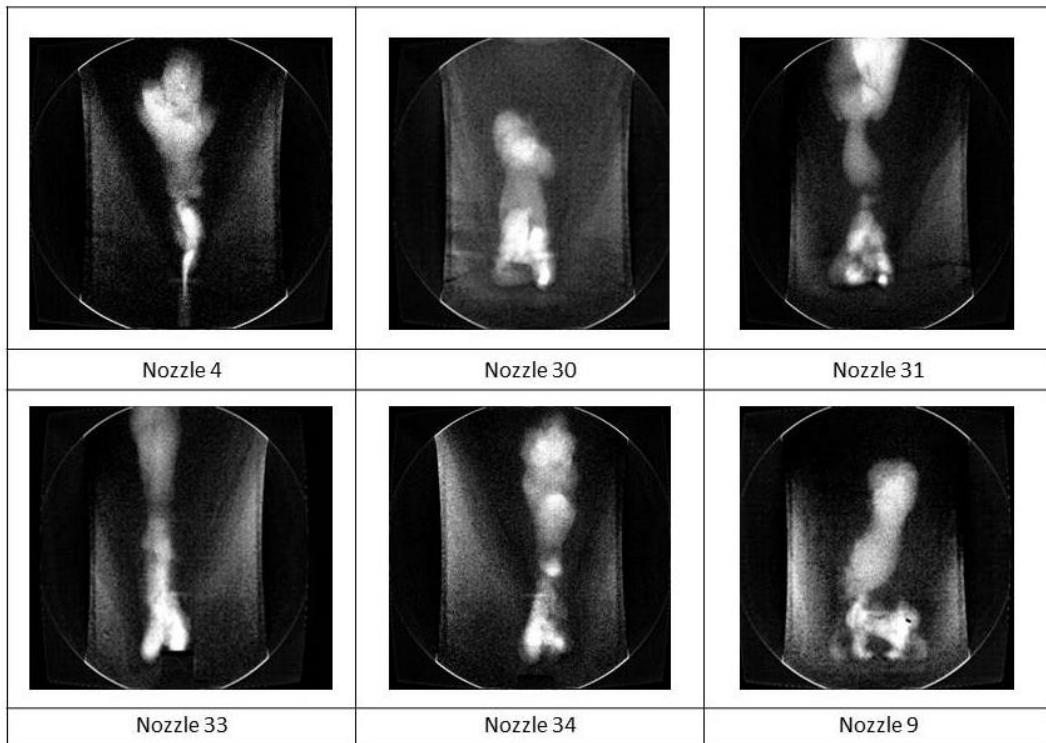


Figure 2: X-ray Images of jet penetration in sand at a 90 litres per minute flow rate