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The capture of aerosol in a granular moving bed

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ABSTRACT

Flue gas from process plants usually contains contaminants which require scrubbing prior to discharging to atmosphere. There are various techniques used to scrub the exit gas, such as packed columns, spray scrubbers, fluidised beds, filters, etc. One of the key design parameters required in order to select and design a scrubber is the capture efficiency. This efficiency is dependent on a number of factors such as the contacting mode, feed composition and operating conditions.

This paper describes an experimental technique to quantify the efficiency of liquid aerosol capture in a bed of moving particles. The experimental technique provides an effective means of generating and capturing the tracer aerosol and determination of the overall aerosol capture efficiency. The results show the influence of the superficial gas and particle velocity, bed height, as well as the aerosol concentration, on the overall capture efficiency.

Three possible predictive methods are considered to describe or quantify the aerosol capture efficiency. These are a capture parameter based on the available surface area, a capture parameter based on dimensionless groupings, and a dispersion model based on aerosol particle filtration by fixed bed porous filters. Each method is applied to the experimental data to determine their effectiveness in describing the capture in the granular moving bed. The dispersion model method showed good potential in quantifying the experimental capture efficiency.

Keywords: Moving bed; Aerosol; Capture efficiency; Gas cleanup; Gas scrubbing

1. Introduction

1.1. Capture technique

Various methods are available to remove solid and gas components from gaseous streams. Fabric and porous ceramic filters are often used to remove fine solids from gaseous streams. However these soon become blinded by the fine solids being captured and need to be cleaned to prevent an unacceptable increase in the operating pressure (Smid et al., 2005a). Alternatively, cyclones can be utilised to give collection efficiencies greater than 90%, or electrostatic precipitators to give collection efficiencies greater than 99%. However, the electrostatic precipitators have moderate to high energy requirements (Smid et al., 2005a). Fluidised beds have been used as dust filters e.g. the removal of fly ash in a separate fluidised bed post-combustion (Liu and Wey, 2007; Liu et al., 2009; Wang et al., 2008), for in situ removal of sulphur dioxide during coal combustion (Boskovic et al., 2002), and for capture of volatile compounds by condensation effect (Yazbek and Delebarre, 2005). Granular filter beds (fixed bed) have been studied as a means of filtering aerosol particles. The capture is more efficient when they are coupled with electrostatic forces such as in the electric charging of the aerosol particles, electric charging of the filter granules or the application of an external electrostatic field to the filter bed (Shapiro et al., 1988; Zevenhoven et al., 1993).

Moving granular beds have advantages over fixed bed systems in that the capture medium is continually being refreshed preventing localised blockage of filter media. They are considered in industry in various applications such as separation processes, continuous catalyst regeneration reactors, drying, heat transfer, adsorption and desorption processes, blast furnaces, and gasifiers. An example is for particulate

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