Fundamental aspects of the rotating liquid sheet contactor

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Abstract

A new gas-liquid contactor – the Rotating Liquid Sheet (RLS) contactor was developed at the Newcastle CSIRO facility as a way of overcoming the limit on gas velocity (throughput) set by the flooding point of conventional packed beds with random or structured packing, and also to maintain the intensity of gas-liquid contacting while reducing the total pressure drop of the contacting device.

RLS technology utilises the formation of unbroken liquid sheets in the shape of multiple blades or continuous helices as the contacting medium. The liquid sheets are formed by forcing water through helical or blade-like slots from a rotating central tube. These liquid sheets ensure a large contacting area between liquid and gas while the rotation leads to a behavior equivalent to a screw pump able to pump gas through the contacting column. This feature allows the RLS contactor to be economically attractive as the pressure differential across the contactor will be less than a conventional packed bed contactor, leading to a reduced need for gas input blower. The control over the generation of the liquid surface also allows for the usage of solvents which may be too viscous for a conventional packed bed contactor.

In order for the RLS contactor to be fully functional as claimed, the RLS geometry must be designed such that the generated liquid sheet is continuous and the projected break up point should be just after the liquid touches the column wall of the contactor. The multiple liquid sheets also must not collapse onto each other as it will reduce the efficiency of the contactor. This paper will present the results of experimental and CFD modelling studies that develop the fundamental understanding of the formation, flight-path and breakup of liquid sheets emanating from multiple slots in a rotating tube.

In order to achieve stable continuous liquid sheet, this study has looked at multiple different geometry conditions, such as the slot width, slot angle, slotted tube thickness and the presence of different slot overhang sizes. It was found that by manipulating different geometry conditions, stable liquid sheet of required flight path length can be achieved, thus allowing for the design of a more efficient RLS contactor. The effect of gravity, liquid surface tension and air resistance towards maximum flight path length before breakup was also studied both via modelling and experimental tests.
The paper will also present preliminary results from a pilot scale RLS contactor currently being implemented to process a slip-stream of power station flue gas under a wide range of operating conditions. The performance data will then be used to determine the design of a full PCC system using the RLS contactor at demonstration scale, thus validating cost assumptions and estimates. This study will also measure the mechanical components of the system under conditions of corrosive gases, liquids and in the presence of erosive solids.

Thus, with the economical and ‘ease of implementation’ benefits of RLS contactor over conventional packed bed contactor, combined with the current research on the optimization of RLS contactor, it can be seen that the RLS contactor has the potential to become a competitive gas liquid contactor for many different applications in the near future.