ACARP Matters

Novel Technology Boosts Fine Coal Flotation Performance

A cheap and flexible oscillatory air sparging system developed by researchers at University of Queensland is set to improve coal flotation performance and significantly lower the cost of processing ultrafine coal.

Pilot-scale studies using a 17cm-diameter flotation column delivered yield increases of 13%, frother dosage reductions of up to 50% and lower energy consumption compared with conventional flotation technology. The oscillatory air sparging system also increased throughput by 200-300% without sacrificing yield, improved coarse particle flotation by more than 10 percentage points and showed greater tolerance of changes in water quality – requiring no reagent in saline water.

The system was developed around the premise that bubble size affects separation performance; decreasing the size increases the coal particle-bubble collision efficiency, which improves recovery. The objective is to generate microbubbles cheaply; that is, bubbles of 500μm or less in size. In conventional industrial flotation, the average air bubble size is 1mm-1.5mm, while advanced coal flotation technologies, such as Jameson™ cell and Microcel™, produce bubbles around 0.5mm. In mechanical cells, bubble size is dependent on airflow rate and impeller rotation speed. This means that bubble size cannot be controlled independently.

To overcome this limitation, the research team led by Liguang Wang aimed to generate microbubbles using oscillatory-air flotation technology. By connecting a sparger (diffuser) to the outlet of an oscillatory air-generation device, a stream of continuous airflow is transformed into an oscillatory flow at a specific frequency (e.g. 40 Hz). As air flow is oscillating, a pulse is created, which provides a lifting force that enables bubbles to break away much earlier than occurs with continuous airflow. Fine bubbles almost the size of their exit nozzles can be generated. This process is expected to consume much less energy density than dissolved air flotation and traditional dispersed air flotation, with significant capital cost reduction.

The team tested three different oscillatory airflow devices – a fluidic oscillator, a solenoid valve and their own design, a motor-driven system, which they have called Device B. The fluidic oscillator was found to be too complex to operate effectively. The solenoid valve produced excellent results but was unable to be scaled up to meet industrial requirements. Device B is able to be scaled up, but initial results were not satisfactory. The device was further modified, which was sufficient to improve flotation performance to the same standard as the solenoid valve.

The team also evaluated six spargers by comparing the gas dispersion conditions before and after applying oscillatory airflow. Sparger A – a punctured plate with 200μm holes – proved to be the preferred system due to better flotation yield, low maintenance requirements (easy to clean) and low manufacturing and operation cost.

Liguang said the project had been challenging due to the complex interactions between the oscillating air supply and the sparging system. For this reason, his team – which included Hangil Park and Chun Yong Ng from the School of Chemical Engineering – had taken a systems approach, delivering a suite of innovations.

“The next challenges are how to make the system bigger and to build a sparging system that is suitable for Device B. We are doing some modelling work to predict bubble size by changing different variables. The modelling work will guide the design of the new version of Device B – a prototype suitable for full-scale flotation operation," he said.

Feedback from ACARP industry monitors has been positive.

"They were very excited by this development. They can see the potential to cut costs and improve flotation performance," Liguang said.

Industry monitor Kevin Rowe agrees. He said the project delivered a measured increase in coal recovery and lower energy consumption of existing installed equipment without the need for extensive capital or additional operating spend.

"The research outcomes have been of a high standard. Due to the quality of the outcomes and the importance of the research, the project has been fast tracked by the Coal Preparation Committee," he said.

"Sometimes research is focused on newly developed products which can take years to realise. The innovative approach taken by the research team has focused on installed equipment and targeted major components with research. That improves the overall outcome."

Kevin said the ultimate goal of the project was commercialisation of the technology, supported by a targeted roll-out.

For further information:

The final report is available from the ACARP website. Report number C27004

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