ACARP Matters

A new twist to an old approach boosts fine coal recovery

A new fine coal beneficiation process developed at the University of Newcastle is showcasing promising results in laboratory trials, recovering much finer coal particles than flotation in relatively short residence times.

A modification of conventional oil agglomeration, this patented process uses a concentrated water-in-oil emulsion (oil-like medium) to agglomerate fine, hydrophobic coal particles. Conceptualised by Kevin Galvin, the process replaces diesel, the traditional binding agent used in oil agglomeration, with an emulsion. In the conventional process, oil is dispersed throughout a mixture of coal and mineral particles, preferentially binding to the coal. Increasing the size of the fine coal agglomerates enables the coal to be recovered through a screen or sieve bend. Due to its excellent recovery of combustible material at low ash content and its ability to handle very fine coal feeds, oil agglomeration was a popular research topic in the 1970s and 1980s. However, the

large quantity of oil required for the process made it uneconomic and it fell out of favour with researchers. Kevin's idea was that by using an emulsion largely comprised of water to agglomerate the fine coal, the volume of oil required would be reduced, making the process more economic.

To examine the idea, Kim van Netten undertook a three-stage project with the original aim of achieving a 10 to 20-fold reduction in oil.

- The first stage was to establish whether the novel emulsion could agglomerate coal in a similar way to pure diesel and, thereby, establish the general operating conditions that were needed when the emulsion was used as the binding agent.
- Stage two was to investigate the ability of the emulsion to beneficiate.
- Stage three was to improve the stability of the emulsion as it tended to break down in the turbulent agglomeration process. In this stage, the researchers tested whether the addition of salt would help to stabilise the emulsion.

After four years of development, the researchers realised their aim of a 10 fold reduction in the oil required to achieve agglomeration. This means that through the use of the novel binder, the processing of one tonne of fine coal feed, which would ordinarily require 100 kilograms of pure oil, now only requires 10 kilograms of oil.

Kim said the agglomerates formed from this process were smaller and weaker but sufficient to withstand the high shear conditions of the binding process.

"Moreover, due to some unique properties of the emulsion, this process appears to be more than 10 times faster and capable of recovering much finer particles than flotation. We can also obtain moistures levels of around 12%, about half normal levels achieved for flotation products," she said.

"The agglomeration is highly selective, favouring hydrophobic particles, therefore comparable ash levels are achieved. Where there are composite particles, the agglomeration will tend to recover those particles as well.

"People are always amazed when they see the process in real time, hence the technology readily attracts significant interest. It is very different to fine coal beneficiation processes developed in the past and it appears to be very economic."

Kim said that over the life of the project she had tested many emulsion parameters. Starting with what she knew about traditional oil agglomeration, she changed one parameter after another, but was initially only able to achieve a two fold reduction in oil.

"We then realised that the mixing conditions that were appropriate for pure oil might not be appropriate for the emulsion," she said.

“Pure oil takes quite a long time to agglomerate the coal. You have to disperse the oil. It has to collide with a particle. Then it has to spread over the surface of the particle and join the particles together into an agglomerate. So we reduced the amount of mixing time because the emulsion is somewhat delicate. If you chop it up enough, with enough energy and enough time, you can destroy it. And it turns out that’s what we were doing.”

Kim spent the rest of her PhD continuing to investigate how to use less oil in the agglomeration process. Successful modifications included:

- Increasing the volume of water from 85 per cent to 90 per cent and then 95 per cent, achieving a six-fold reduction in oil;
- Using a cheaper, less viscous emulsifier, achieving a 7.5-fold reduction in oil;
- Replacing diesel with kerosene, which has a lower viscosity. This achieved a 10 fold reduction.

“So that’s where I wrapped up my thesis and I have continued working on the project as a research associate,” she said.

Along the way, Kim also found time to compete in the Falling Walls competition. Named after the falling of the Berlin Wall, Falling Walls aims to promote innovation across diverse research domains. Academic and professionals have three minutes to present their innovative ideas, research projects and social initiatives. Kim won the inaugural Australian and New Zealand competition from a field of 25 people, and represented Australia in the final in Berlin in November 2016. She said the work on the novel binding agent was well received.

Kim said the work had also been well received by ACARP coal preparation committee members and the industry more generally.

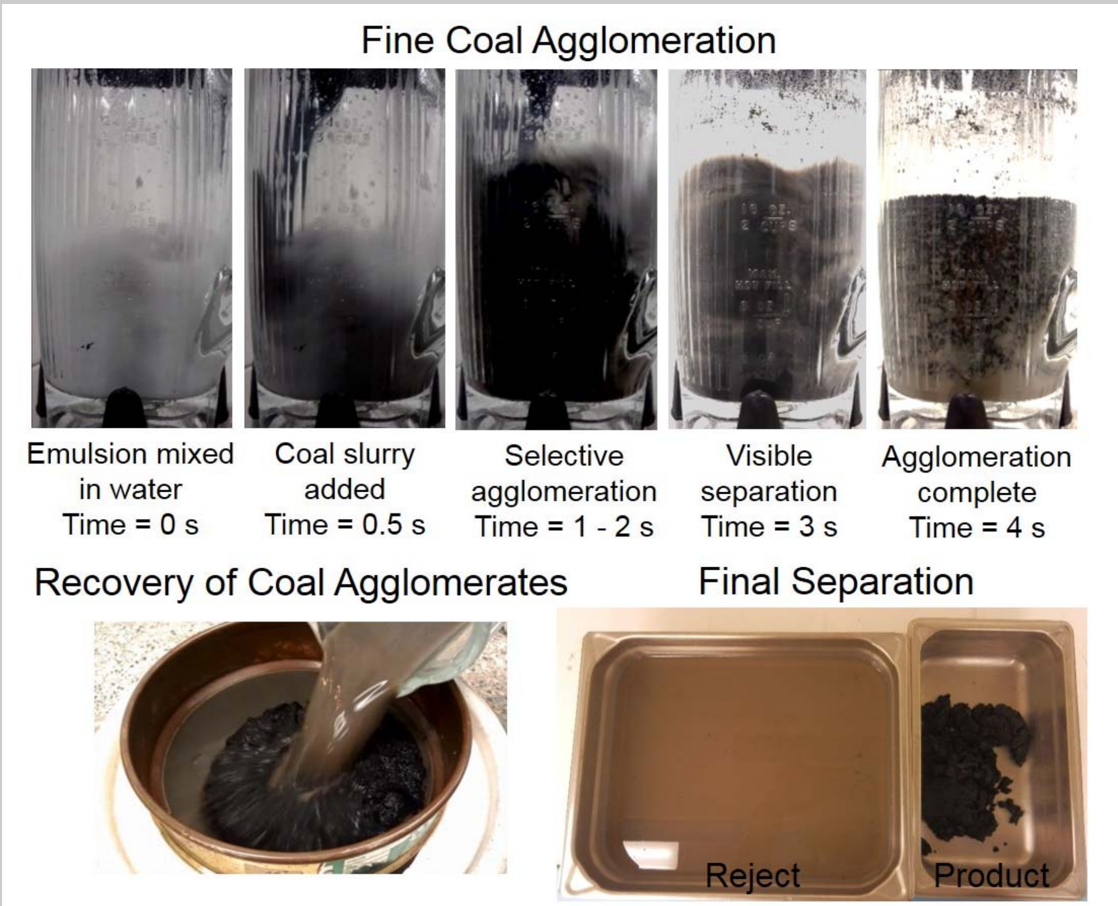
“I’d say the general interest and support from the coal processing community has been really good. It’s been encouraging to get their feedback whenever I’ve presented or they’ve come to visit,” she said.

Industry Monitor Dion Lucke said in coal processing plants, fine coal recovery was inherently more expensive and less efficient than coarse coal recovery. This had made the development of new fine coal technology an ongoing research priority within ACARP.

“While agglomeration has been available to the coal industry for some time, its application has been limited due to the consumables cost associated with the process. The objective of the project was to overcome this by delivering a step change reduction in the binding costs. This was achieved, thanks to an innovative approach for the manufacture of ‘white goo’ – a stable emulsion of water and oil. As it consisted mostly of water, the white goo binder greatly reduced oil costs while maintaining selectivity,” he said.

“The research was delivered in a staged manner that focused the work and limited the risk of failure. The researcher leveraged funding from ACARP and ARC to create a program of work that has significantly improved the viability of agglomeration.

“If adopted by industry, this technology will increase resource utilisation and also has potential to create new marketable products.”



The stages of fine coal agglomeration using a novel binding agent.

Kim van Netten is presented with the Falling Walls Australia award by Alan Finkel and Brian Schmidt.

For further information:

The final report is available from the ACARP website. Report number C21045

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