South Africans pioneer heat transfer technology for conversion of waste to energy

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In order to develop Africa and assist communities, particularly those with limited or no access to energy, more environmentally responsible and sustainable ways to supply energy need to be found. Transportation fuels and electricity are critical components of the energy mix – making our recent invention for improved reactor and process performance a potential game-changer.

While developing countries face a myriad of challenges, some of the most pressing ones they often face are access to energy and simultaneously reducing greenhouse gas emissions. These two needs conflict if fossil fuels are used. With this in mind, we started looking at renewable resources as an answer to energy problems – more specifically in terms of how municipal, agricultural and industrial wastes are potentially valuable resources, given that carbon and energy are locked in these wastes.

As a result of our research, we have developed a process that uses municipal waste, manure, woodchips from wood factories and forest waste and converts these waste products into fuel and electricity. One ton of forest waste can be converted to about one barrel of synthetic fuel. As such, we could produce around 40 million barrels per year of synthetic crude oil from the waste that is currently going to landfills in South Africa.

Together with our team, we invented an intensified heat transfer method for fixed-bed reactors that will improve the efficiency of this waste-to-energy technology on a small to medium scale. The invention is the culmination of the team's collective knowledge and experience over the past 20 years.

As a starting point, we wanted a system that was simple and robust to protect the catalyst. The invention, being patented as a 'tubular fixed bed reactor with heat pipe for internal heat removal for Fischer–Tropsch synthesis' improves the performance of the reactor which is the heart of the process. Our objective was to improve the efficiency of the reactor by reducing hotspots so that the catalyst life and online time can be longer, resulting in catalyst cost reduction.

Catalysts are components vital to convert feedstocks to fuel. The longer they last and the more efficiently they work, the smoother and less expensive production is likely to be. One of the most common ways in which catalysts are damaged or destroyed is when the reactor overheats during the conversion process. Based on this, we specifically looked at the stability of the catalyst and analysed the temperatures in the bed.

Although the reactor is a key piece of the invention, the whole process is important. The reactor makes the process as simple and cheap as possible. As such, the reactor is part of the development of the whole process for the waste-to-energy technology. The process uses the Fischer–Tropsch reaction to produce a synthetic fuel, which can then be separated and upgraded to produce marketable products including fuel and chemicals.

As part of the Unisa team, we have been involved in numerous synthetic fuel projects such as the Golden Nest pilot plant in China, the Linc Energy in Australia, and a GTL plant in Houston, Texas amongst others. We are looking forward to seeing the full impact of our work across the sector internationally – bringing communities that much closer to sustainability and a cleaner environment.