

Waste wood recycling and gasification



The gasification of residual forestry waste, recycled waste wood, MSW and ligno-cellulosic crop wastes is an emerging pathway to producing liquid fuels. At the high temperatures and pressures in the gasifier, these feedstocks are converted into syngas, a mixture of hydrogen, carbon monoxide and carbon dioxide. Subsequently, the syngas can be converted to methanol or synthetic Fischer Tropsch liquids such as sustainable aviation fuel (SAF). The handling of these non-homogeneous, solid materials is critical to the successful operation of the gasifier to enable a viable recovery and chemical recycling (chemcycling) pathway.

Certified residual forestry material is a sustainable source of biomass composed of branches, roots and cuttings from trees harvested in managed forests. Typically, these forestry clippings are left to rot on the forest floor, thereby producing methane. The conversion of this material to liquid biofuels therefore displaces fossil fuels and reduces methane greenhouse gas emissions.

“The conveying of irregularly shaped wood chips or wood pellets can be achieved using our RotoScrew Technology,” says Richard Sims of Clyde Pneumatic Conveying Ltd, based in the UK. “The use of internal negative rake flow liners or internal agitators are features we can add to our conveying vessel to deal with any bridging and flow issues and ensure the gasifier receives a continuous flow of fuel.”

Ligno-cellulosic crop waste is another excellent gasifier feedstock. Almond shells and vineyard pruning clippings are good examples. Due to the annual growing cycle, the gasification of seasonal crop wastes captures and releases CO₂ within a short period of time.

In many countries ligno-cellulosic post-harvest wastes, such as corn stubble and rice husks, are burned in the field causing CO₂ emissions without any beneficial energy yield.

“Depending on the size, shape and flowability of the feedstock,” adds Sims, “the discharge of our conveying vessels would be fitted with either one or up to three screw feeders. This creates a ‘live’ bottom discharge into the pipe that conveys the material to the gasifier.”

Municipal solid waste (MSW) can also be used as a gasifier feedstock. Industrial wastes such as car seat foam and fabric waste are also suitable. Post-consumer waste wood from building demolition or fitted kitchen replacements is also an ideal gasifier feedstock.

MSW consists of approximately 50% biogenic material. Furthermore, the reuse of the fossil components of MSW or industrial waste to produce fuel avoids the need to extract virgin fossil fuels and thereby reduces overall CO₂ emissions. In both cases, the life cycle analysis favours the use of these feedstocks over virgin petroleum.

Residual forestry material or waste wood may cost in the order of €100 per tonne when chipped and delivered to the gasifier. On the other hand, the use of MSW or industrial waste will generally result in a ‘gate fee’ revenue stream for waste disposal, which may be in the order of €50 to €100 per tonne. This gate fee supplements the revenue stream and complements the sale of fuels derived from the process. This additional revenue can improve the project

economics and tip the balance in favour of using MSW or industrial waste as part of the gasifier feedstock.

During gasification, in the ideal case, the hydrocarbon feedstock is converted only to hydrogen and carbon monoxide (CO), simultaneously minimising CO₂ emissions from the process and maximising the yield of liquid fuels. To achieve this operation as close as possible to this ideal condition, oxygen is fed to the gasifier instead of air. The injection of steam and the operation of the gasifier at a pressure of around 30 bar and a temperature of approximately 1,400°C can also help maximise the CO yield.

Sims says that “the RotoScrew feedstock injection technology can introduce MSW pellets and other feedstocks directly into pressurised gasifiers via injection lances. The method ensures a controlled, continuous, variable rate feed injection with a dosing rate accuracy of +/- 1%.” The RotoScrew injection vessel incorporates Clyde’s dome valve, which eliminates the risk of syngas backflow from the gasifier due to its inflatable seal.

“Additionally, there are requirements for other Clyde systems and valves to handle gasifier slag and ash filter residue,” adds Sims. These vessels also act as pressure let-down systems, taking the hot residues from the operating

pressure of circa 30 bar to atmospheric pressure without depressurising the gasifier.

Clyde's water-cooled ThermaValve HT can withstand temperatures of up to 900°C. This allows them to be used as isolation valves around the gasifier and means they are suitable to handle extremely hot gasifier residues.

In both the feed introduction systems and residue removal systems, the pneumatic conveying gas can be any compatible, compressible gas such as air, nitrogen, CO₂ or the process syngas, depending on safety and process requirements.

The challenge of using gasification alone to produce liquid fuels is that although the syngas produced by gasification is very rich in carbon monoxide (CO), it does not contain sufficient hydrogen to produce liquid Fischer Tropsch fuels such as kerosene and diesel.

Hybrid bio-electrofuels combine electrolytic hydrogen with syngas from biomass or MSW

gasification to achieve the perfect balance of hydrogen and carbon monoxide in syngas. The combination of these two processes can create a harmonious synergy. The forestry waste biomass can be stretched through the use of electrolytic hydrogen to mitigate any potential scalability concerns. Moreover, carbon from the biomass is fully utilised with minimal carbon dioxide emissions. The result is affordable, scalable, sustainable aviation fuel (SAF) production.

Bio-electrofuels projects are the sweet spot for clean energy investment. In addition to their broadly favourable economics, they are being catalysed by the biofuel and PtL sub-mandates within SAF adoption regulations in the EU and UK.

As an example, Varennes Carbon Recycling previously promoted a project for manufacturing bio-electrofuels in Canada's Québec province. An Enkern bubbling fluidised bed gasifier was to be fed with solid material derived from municipal and industrial solid

wastes. The syngas from the gasifier was to be boosted with hydrogen from four Accelera HyLYZER® 5000 PEM electrolyzers with a total power input of 90 MW. Bubbling fluidised bed gasifiers contain a particulate bed material such as alumina or sand, which must be discharged and replaced periodically. "Clyde offers gasifier bed media feed systems prior to a campaign, bed media removal systems after a campaign, and online bed media top-up systems for use during campaigns," confirms Sims.

Elyse Energy has proposed biomass torrefaction, grinding and entrained flow gasification using the thyssenkrupp Prenflow technology for FTS fuels production at their BioTJet project in Pardies, France. 32,000 tonnes per year of electrolytic green hydrogen will supplement the gasifier syngas to produce bio-electrofuels. Axens will provide a full EPC wrap and performance guarantee around this project.

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