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Kruger's Biomass-to-Syngas Venture Pays Off

Chuck Stewart, general manager of Kruger Products' Western Region (left) and Frank van Biesen, vice-president, technology for Kruger Products, at the biomass infeed station.

By Cindy Macdonald, editor

Kruger Products' foray into the uncharted waters of biomass gasification for steam production is a success. The system has been operating for about six months, and is supplying about half the steam required by the tissue mill in New Westminster, B.C. Now it is time to assess the costs — financial and environmental.

The Kruger team chose biomass gasification to replace a temporary natural gas boiler because of the technology's low emissions, its use of a renewable fuel, and the lower fuel cost compared with natural gas.

Gasification of biomass is a relatively new technology, although the principle of gasification has been used for decades with coal. "It's a complex thermo-chemical process within an automated, simple mechanical process," says Jonathan Rhone, president and CEO of Nexterra Systems Corp., the B.C.-based company which supplied the gasification system for Kruger Products. "We're really focusing on developing rock-solid technology, that meets reliability and cost targets," he notes. "We focused on heating applications first, to complete our learning about the gasification process."

This Kruger project is the first installation of a Nexterra gasification system that direct-fires syngas, derived from wood, into industrial process boilers.

There are several opportunities for biomass-to-syngas systems in pulp and paper mills.

Syngas could replace fuel-oil or natural gas to fire lime kilns at kraft mills. And, as has been shown at this tissue mill, it can be used to replace hog fuel boilers or natural gas boilers to produce process steam.

How it works: Biomass to syngas to steam

At the heart of Kruger's biomass gasification system are two 35-ft. high, 16-ft. diameter gasifiers.

Biomass is trucked to the plant, at a rate of about six truckloads per day. Live-bottom trucks unload into a large, covered storage bin, refurbished from the days when Kruger had a hog fuel boiler at this plant. The bin holds about four days of supply.

From there, the biomass travels by covered conveyor across a road, across railroad tracks, along the roof of the plant to the gasifiers on the other side. There it drops into two metering bins, one for each gasifier. The metering bins discharge to twin-screw feeders, which vary the output to the gasifier chamber.

Within the gasifier, the temperature in the bed at the bottom ranges from 1500 to 1900°F. The air supplied to the gasifier is carefully controlled, so that only a small portion of the fuel combusts completely. The process produces enough heat to pyrolyze and chemically break down the balance of the fuel into a clean-burning, synthetic, combustible gas commonly called "syngas". As the syngas rises to the top, it cools to about 600°F, where it exits through a duct. Ductwork carries the syngas from both gasifiers to a single ignition chamber, where it is mixed with air and ignites. The combusted syngas is direct-fired to the boiler.

Gases exit the boiler through the economizer, and then proceed through the economizer to the ID fan and the electrostatic precipitator. Particulate matter from the precipitator joins the ash disposal system, while carbon dioxide, nitrogen and water vapor are released to the atmosphere.

Ash is collected at the bottom of the gasification vessels, conveyed to a covered bin, and periodically trucked away for disposal.

With two gasifiers, the system is capable of producing 40,000 lb/hr of steam. It currently provides about half of the plant's needs. The rest is provided by natural-gas fired boilers.

Control and monitoring of the gasification system is integrated into the plant's distributed control system.

Gasification proves to be clean and efficient

One advantage that Nexterra technology has over conventional combustion is its much lower air emissions. Particulate emissions can be equivalent to natural gas. NOx emissions can be 30 – 40% lower that conventional combustion of wood, and both VOC and CO emissions are both lower than those produced by conventional wood combustion or by burning natural gas. "That's what allows us to operate in urban areas and help our customers secure air permits and community acceptance," Rhone notes.

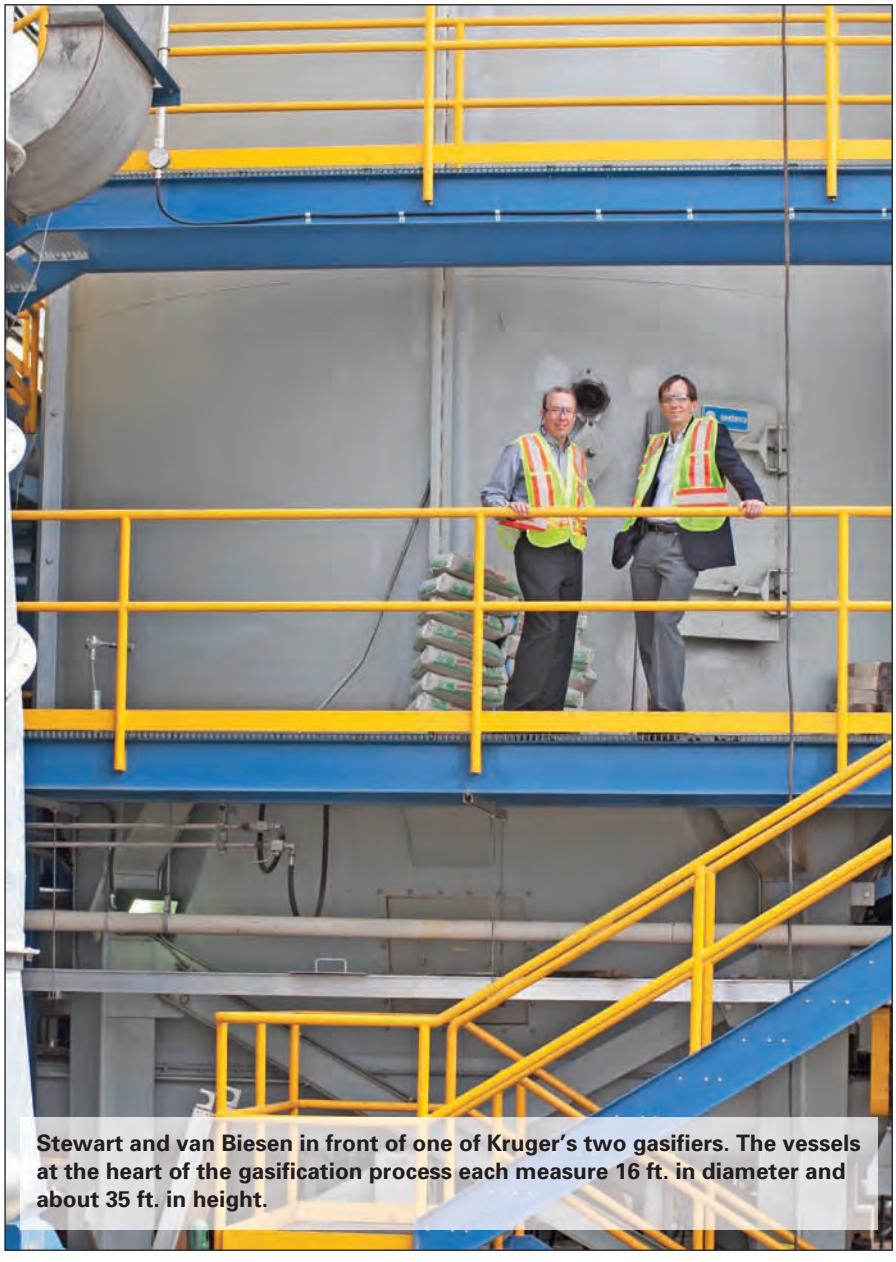
In addition, lifecycle costs are generally lower than typical wood combustion systems.

Kruger's system has been operating for about six months now. As part of the funding package granted to the project by federal and provincial governments, research institute FPInnovations will monitor and evaluate the installation.

"In terms of heat, it is producing about 5-10% beyond expectations, and they haven't even begun optimization," says Jim Dangerfield, executive vice-president of FPInnovations.

Once the system is optimized, FPInnovations will gather performance data, operating data, and data related to the system's environmental footprint. "We have all our baseline data, which was gathered before the old system was shut down," Dangerfield explains.

"My sense of it so far, is that there are mills where this technology could potentially be used. I don't see any reason why most of these couldn't use it, but it will come down to the hard economic facts."



Stewart and van Biesen in front of one of Kruger's two gasifiers. The vessels at the heart of the gasification process each measure 16 ft. in diameter and about 35 ft. in height.

All photography: Grant Harder Photography

Biomass is not the easy way out

There's no doubt that a thermo-chemical/mechanical biomass gasification system is more complicated to operate than a natural gas boiler. But the indisputable fact is that biomass is cheaper than natural gas, and will be for the foreseeable future, so "we'll put up with complexity to get some cost reduction," says Frank van Biesen, vice-president, technology for Kruger Products. Van Biesen is a strong advocate of the gasification project.

Another driver for the adoption of biomass instead of natural gas is concern over the company's carbon footprint. While for many companies, "carbon footprint" is a feel-good marketing measure, in B.C., carbon has a price tag. The province has a carbon emission tax, so the switch to carbon-neutral biomass will have a direct positive affect on the bottom line. The tax savings for Kruger Products in 2010 will be about $380,000.

"I don't see any reason why most mills couldn't use it, but it will come down to the hard economic facts."

– Jim Dangerfield, FPInnovations

The tight confines of Kruger's New Westminster site created some construction challenges. The mill houses four paper machines and 19 converting units, plus a small groundwood plant, and is a major distribution centre for Kruger Products' tissue brands in western Canada. It is hemmed in by a river, a busy set of railroad tracks, and the urban sprawl of a Vancouver suburb.

"Space was definitely an issue," recalls van Biesen. The construction site is sandwiched between the wall of the existing building and the river. An access road also runs along the riverfront so the installation team had to be very careful not to disrupt mill traffic for lengthy periods.

The construction phase took about 6 months. Overall, the project wrapped up on time and on budget, and the gasification unit began production in December 2009. "It started up almost transparently. We reached target steam output within a week," van Biesen recalls. He says the price tag for the Nexterra portion of the project was about $5 million. The original estimated ROI was 3 to 3-1/2 years, but natural gas prices have dropped since then.

Van Biesen says he's happy with the performance of the system, although there are still a few wrinkles to be worked out.

One of the problems in these early months of operation has been premature wear on some components of the biomass feed system. Another is the unexpected formation of clinkers (inorganic materials that melt and fuse together before cooling to form a solid chunk) that can foul the ash collection system. Both of these issues are being resolved through cooperation between the Kruger and Nexterra.

"Kruger's been a fantastic partner," says Nexterra CEO Jonathan Rhone. "They are one of the most technically savvy organizations we've worked with. That was an unexpected benefit.

"One thing we really appreciated is that they were prepared to be an early adopter of a new technology."

Does it measure up?

Various government programs have contributed funding to the biomass gasification project, which mitigates some of the risk for Kruger. Rhone says FPInnovations played a role by galvanizing all the parties around the project.

The research organization will also have a role as a third-party observer, monitoring and measuring the process to asses its suitability for other pulp and paper facilities. FPInnovations will also offer tours of the gasification site and disseminate information to the industry.

"Our role is to gather information, to provide third party independent information about what these technologies can actually deliver. We're looking at performance of the system and its environmental footprint," explains FPInnovations' Jim Dangerfield.

"I fundamentally believe, with many of these [biomass] systems, we have to keep in mind the environmental footprint.

"For example, ethanol from grain, from a carbon footprint point of view, is a pretty marginal advance. Being a sustainable industry, our industry needs to be sensitive to its environmental footprint."

Having the courage to be an early adopter of a technology that dramatically reduces greenhouse gas emissions shows that Kruger Products, at least, is being sensitive to its environmental footprint. Even better, thanks to government incentives pushing companies in the right direction, Kruger will reap bottom-line benefits for its environmental choice as well. **PPC**