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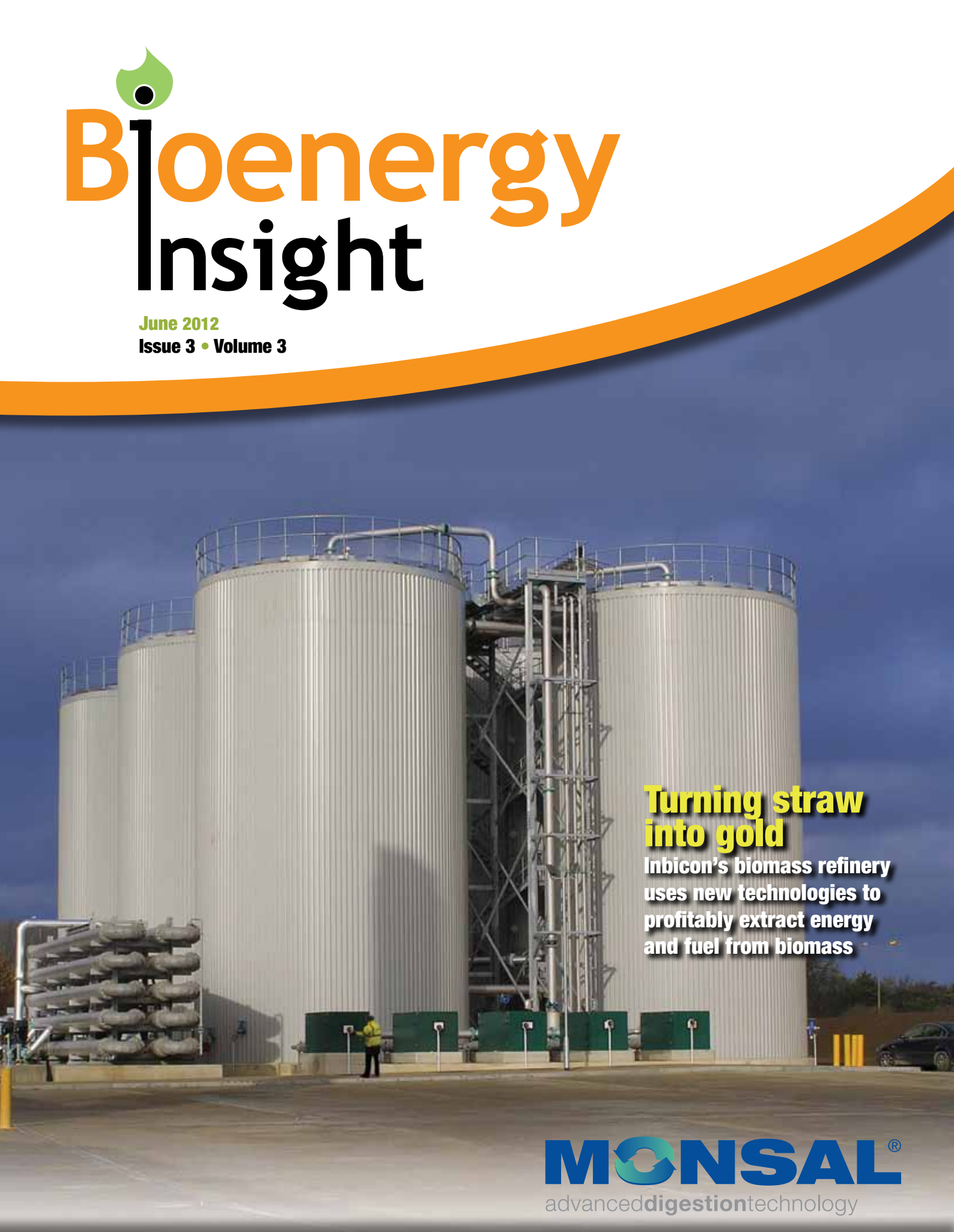

Turning straw into gold

Inbicon's biomass refinery uses new technologies to profitably extract energy and fuel from biomass

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Turning straw into gold

When Inbicon built a new biomass refinery in the Danish port of Kalundborg, the company set an ambitious goal: to turn 30,000 tonnes of harvest leftovers — baled wheat straw — into 1.5 million gallons of clean, second generation ethanol per year.

Thanks to an innovative energy exchange system, plus a series of patented techniques for extracting renewable fuel from biomass, the Inbicon plant has reached those targets, setting a new standard for energy efficiency and waste reduction.

Officially opened in November 2009, the Inbicon Biomass Refinery cost 400 million Danish Krone (€54 million) to build, and was the brainchild of Dong Energy, Inbicon's parent company.

With this project, Dong wanted to take second generation ethanol further. The company knew that by pioneering new extraction technologies, it could produce second generation bioethanol from waste products and make it a profitable endeavor.

The plant demonstrates that large-scale production of ethanol from straw is possible

Ethanol is made from straw but all sorts of cellulosic material can be used in the future

A series of industry firsts

The refinery marked a series of firsts in the biofuel industry. It was the first demonstration plant to successfully produce new ethanol and clean lignin biofuel. It was the first time ethanol production and power generation had been integrated into one seamless process. And it was also the first time such a wide array of useful and profitable products could be extracted from the biomass.

The Inbicon refinery benefited from adjacency to Asnaes Power Station, a coal-fired electrical power plant owned by Dong. By setting up an energy exchange between the two locations, Inbicon showed how profitable synergies could be achieved.

The exchange begins when the power station sends waste steam to the refinery, where it breaks down the biomass fibres into sugars and lignin. The lignin produced during the process can then be used as a replacement for the coal. As it is so clean, it requires no further refining (nor extra energy consumption) treatment before use.

Extracting more value from biomass

The Inbicon refinery is a model of frugal efficiency: every part of the biomass is recovered, thanks to a series of engineering breakthroughs in the conditioning, pre-treatment

Alfa Laval's self-cleaning spiral heat exchangers proved ideal for efficient process cooling

Inbicon biomass refinery facts

- Officially opened November 2009
- Built for approximately $76.7 million (€61 million)
- Operates 24/7, 365 days a year
- Run by 30 employees
- Processes 30,000 tonnes of straw annually
- Hits annual production levels of:
  - 1.4 million gallons of new ethanol
  - 11,400 tonnes of lignin pellets
  - 13,900 tonnes of C5 molasses

and liquefaction processes.

Although the processes are designed to convert straw into ethanol, animal feed and solid biofuel, they can be easily adapted to treat other types of biomass, such as corn stover, grasses, bagasse and empty fruit bunches.

In addition to producing ethanol, a future process can capture a range of additional by-products. CO_2 can be captured, purified and sold for use in carbonated beverage production and flash freezing applications. Molasses is siphoned off and used as animal feed. The remaining biomass solids are dried to a powder that can be used as a solid biofuel. A portion of this biofuel can be burned onsite by a co-generation plant, creating more than enough steam-powered electricity to operate the entire refinery. The excess is sent to the power grid to provide electricity for nearby homes.

New twists solve a big problem

One of the issues that threatened the viability of the ethanol production was the poor performance of existing biomass processing options. The highly fibrous raw materials had a habit of quickly clogging the standard heat exchangers used during the liquefaction and pre-fermentation processes. When heat exchangers clog regularly, it slows production, adds to production costs, reduces energy efficiency and corrodes the heat exchangers, shortening both their lifespan and efficiency.

Unable to solve the problem by itself, and reluctant to divert focus from its core technologies, Inbicon turned to Sweden-based Alfa Laval to come up with a solution. Alfa Laval has expertise in difficult heat transfer, separation and fluid handling duties. Just as important, the company demonstrated a commitment to green processes that aligned with Inbicon's vision.

To address the issue, Alfa Laval recommended that Inbicon use self-cleaning spiral-shaped heat exchangers. Two of these heat exchangers are now positioned immediately after the pre-hydrolysis process, where the biomass slurry is cooled before being fed into the fermentation tank. The unique spiral shape can handle two types of highly fouling fluids simultaneously. The result: problem free heat transfer and no unscheduled stops.

'Without this innovation, we couldn't cool the product efficiently, which is integral to the process,' explains Carsten Skjødt, Inbicon project manager. 'On the surface, it may seem like a minor issue, but it's the difference between success and failure in a finely tuned operation like Inbicon's.'

Collaboration paves the way to the future

Today, the intelligent utilisation of biomass is an achievable goal. And the model is scalable, providing opportunities for countries worldwide. Inbicon has already licensed its patented technologies to a company in Japan and works intensively on projects in the US, Europe and southeast Asia.

'We are now on track to bring viable commercial production of new ethanol and other green energy products to the US,' says Inbicon's chief technology officer Niels Henriksen. 'The first US groundbreaking is expected to happen in 2013.'

There's a global call for biofuels

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