

## CHEMICAL PROCESSING

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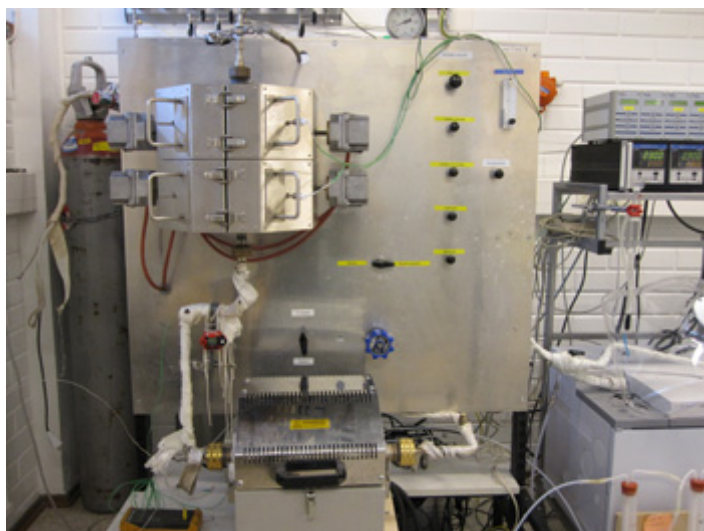
### Woody Biomass Yields BTX

**Process combines gasification of lignocellulose biomass with Fischer-Tropsch synthesis and aromatization to produce benzene, toluene and xylene at high yields.**

By Chemical Processing Staff

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Finnish researchers have developed a process that combines gasification of lignocellulose biomass with Fischer-Tropsch synthesis and aromatization to produce benzene, toluene and xylene (BTX) at high yields.



### Laboratory Reactor

Figure 1. This two-stage tubular reactor system was used to make about 1 liter of BTX from woody biomass. *Source: VTT Technical Research Centre of Finland.*

The woody biomass goes to a steam/oxygen-blown fluid-bed gasifier operating at about 700–900°C, explains Matti Reinikainen, principal scientist at [VTT Technical Research Centre of Finland](#), Espoo. Gas from that reactor is filtered; heavy hydrocarbons (tars) are removed by catalytic reforming using VTT-patented technology while sulfur and other catalyst poisons are eliminated by adsorption. The clean synthesis gas passes to a Fischer-Tropsch (F-T) reactor operating at 250–350°C and 5 bar where an iron-based catalyst speeds conversion to a mixture of hydrocarbons rich in olefins. The hydrocarbons, especially the olefins, then react further over a modified ZSM-5 zeolite catalyst to form aromatics. Over 80% of the output from the reactor consists of BTX (benzene, 9%; toluene, 47%; and xylene, 27%), which

are separated into high purity fractions by conventional distillation.

VTT says the production cost for BTX is higher than that for conventional petroleum-based technology but significantly less than that of other bio-based routes. It estimates the cost at €1.40/l (≈\$5.85/gal). This is based on a biomass price of €30/mt (≈\$30/t) and a 25,000-mt/y (27,550-t/y) plant and includes capital costs (amortized over 20 years) as well as operating costs.

“As a process based on gasification, this is a multi-product process (aromatics, aliphatic hydrocarbons, power, heat) and it is important to find good use for all the products. It is also important to find an application where the scale of the bio-based plant is adequate and the slightly higher price of BTX is acceptable,” explains Reinikainen. “The current very low oil price makes the development of all alternative routes very challenging,” he admits.

The researchers have produced about 1 liter of BTX in a small-scale two-stage tubular reactor (Figure 1). Tests at a larger scale should start in September at a new dual-fluidized-bed gasification pilot plant capable of handling 30 kg of biomass per hour at VTT’s Bioruuki Pilot Center in Espoo. That gasifier includes hot gas filtration and catalytic reforming of hydrocarbons (tar removal), says Reinikainen. A slipstream with F-T and aromatization reactors will be added later in the fall, he notes.

“We will focus on the development of gasification and gas cleaning. In the F-T and aromatization sections, we will try different catalysts and study the effect of operating conditions on the yield of desired products,” explains Reinikainen. “...We would like to develop the catalyst to increase the share of benzene versus toluene.”

VTT now is looking for companies interested in cooperating on further development of the technology.

An interesting article on this subject:

[http://www.rug.nl/research/portal/files/14412062/EES-2013-165M\\_AnneMeuwese.pdf](http://www.rug.nl/research/portal/files/14412062/EES-2013-165M_AnneMeuwese.pdf)

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Richard P. Vlosky, Ph.D.

*Director, Louisiana Forest Products Development Center*

*Crosby Land & Resources Endowed Professor of Forest Sector Business Development*

Room 227, School of Renewable Natural Resources

Louisiana State University, Baton Rouge, LA 70803

Phone (office): (225) 578-4527; Fax: (225) 578-4251; Mobile Phone: (225) 223-1931

Web Site: [www.LFPDC.lsu.edu](http://www.LFPDC.lsu.edu)



**President, Forest Products Society; President, WoodEMA i.a.**

