Ethanol to Ethylene Conversion, Hummingbird Technology

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TechnipFMC Process Technology (PT)

- A global technology licensing business that combines leading proprietary process technologies from TechnipFMC, Badger, Zimmer and others
- Offers a market-leading portfolio of technologies, proprietary or through alliances in Refining, Syngas, Petrochemicals, Polymers and Gas Monetization
- In line with TechnipFMC’s strategy to focus on technology to differentiate us from our competitors
- Headquartered in Houston with centers around the world
- R&D and piloting facilities in US and Europe
Ethylene Production From Sustainable Feedstock

Steam cracking of liquid or gaseous hydrocarbons is industry standard ethylene production technology.

Hummingbird® provides a sustainable ethylene production route:

**Bioethanol dehydration to produce bio-ethylene**
Ultra-Selective Ethylene Production Process

Hummingbird® is an IChemE award winning gas phase reaction process, using a proprietary heteropolyacid heterogeneous catalyst.

The reaction occurs via diethyl ether [DEE] intermediate, with **Ultra-selective performance:**

- With over 99% carbon conversion of ethanol to high grade ethylene.
- Low temperature operation.
- Simple separation and purification.
- Reduced utility requirements.
Demonstrated Technology

The process has been **demonstrated in a fully recycling facility** with purification columns similar to a commercial plant.

- The plant was operated from 2009 to 2015 for over 36,000 hours.
- Gained understanding on start-up, shutdown, and steady state operations.
- Catalyst lifetime was proven for 2 years operation.

The programme completed by producing commercial grade ethylene product using commercial grade ethanol feed and commercially produced Hummingbird® catalyst.
Simple clean-up processes are used to maintain the productivity of the Hummingbird® catalyst. A few simple process operations are sized according to the expected ethanol feedstock quality. A series of ultra-selective adiabatic reactors operate at mild temperature and pressure. The Hummingbird® process does not require addition of dilution water or steam to prevent catalyst coking. Ultra high selective operation minimizes by-product production. Separation and purification systems are simplified. A high purity ethylene product can be produced with a system of distillation columns, with a low utility usage.
Typical GC Analysis Output

Bioethanol #1
► A typical high purity 1G Ethanol

Bioethanol #2
► A potential fuel grade ethanol
Hummingbird® technology includes an bioethanol clean-up ‘toolkit’:

- Bioethanol is analysed for certain trace chemicals.
- Design of pre-treatment unit and E2E process is tailored to analysis.
- Growing reference library of commercially available bioethanols, with over 60 ethanol samples already tested.

Process designs can accommodate a variety of bioethanol feedstocks.

- Process design to characteristics of specific bioethanol feedstock.
- Opportunity to process less expensive bioethanols.

![Contaminants in bioethanol samples from various sources]
The process can use a variety of bio-ethanol feedstocks.

- Hummingbird® was developed to use fuel grade bio-ethanol feedstock, which has variable quality.
- Bioethanol is analysed for certain trace chemicals.
- Design of the process is tailored to the bioethanol analysis.

TechnipFMC pilot plant

- Providing an accurate platform for process design and performance guarantees.
- Assures Hummingbird® catalyst manufacturing quality.
- And is used to develop technology improvements.
Thank you.

Paul Langston
Business Development & Licensing Manager