Commercializing bio-paraxylene to make 100% bio-based PET bottles a reality
Aromatic Chemicals: **Benzene, Toluene, Xylenes**

The Bio-TCat™ Process --- Thermal Catalytic Biomass Conversion
Bio-TCat: It’s happening now

Georgia (US State) grown loblolly pine

TCat8 Pilot Unit (Silsbee, Texas)

BTX Product
Enabling a world of biobased BTX polymers

Synthetic Rubber

Nylon

Polycarbonate shatterproof lenses & mobile phone cases

Polyurethane

ABS Plastic Toys

Polyester Clothing & Shoes

Polystyrene insulation

December 2018
100% Bio PET Bottles

Bio p-xylene from TCat-8® will be used to make renewable PET resin for prototype bottle manufacture and product testing.
Partners With Fundamental Environmental Values
Brand Owner Funding for Pioneering Bio-Based PET bottle

Global consumer beverage company with market-leading brands
• $25B in annual revenues; 37,000 employees
• Promotes various initiatives to reduce environmental impact throughout entire value chain
• Features 30% plant-derived PET packaging in Japan
• Pursuing the development of 100% bio-bottle through Anellotech partnership
• Already provided over $30 million funding to Anellotech program since 2012
Anellotech Goals

...contribution to a global solution

• Significant reduction in greenhouse gas emissions

• Large, Global Markets in Fuels & Chemicals Applications

• Reliable – 90+% on-stream -- consistent with industry norms

• Cost effective/profitable/valued across the entire supply chain

• Commercial plant success is guiding investor/stakeholder goal
Anellotech Summary

- Thermal catalytic biomass conversion (Bio-TCat™) of non-food biomass
  - Cost competitive aromatics: benzene, toluene, xylenes (“BTX”)
    - Gasoline blend stock; high octane, low RVP, fungible, renewable fuel
    - Chemical feedstocks for drop-in bio polymers (PET, PS, ABS, PU)
  - Co-product options: ethanol for fuels/olefins, jet fuel, green electricity
- $80 million cash and in-kind contributions to date, 100% strategic partner funded
  - Significant resources and funding from long-term R&D partners
  - Investments by multinationals seeking early access to bio-products
- Commercial plant engineering planning underway
Anellotech’s Process Development Alliance
Technology, Catalyst, Engineering, Marketing

Anellotech

- Program Management
- Research & Development
- Pilot Plants

ifp Energies nouvelles

- Process Development
- Modeling & Hydrodynamics
- Scale-Up

Johnson Matthey

- Catalyst Technologies
- Formulations
- Catalyst Supply

Axens

- Process & Plant Design
- Technology Licensing & Marketing
- Start-Up & Operations Support
Anellotech Partnering & Oil Prices

Bio-TCat economics encourage continued investment
The Bio-TCat™ Process
1) BTX for chemicals or fuels, 2) jet fuel blendstock, 3) CO for cellulosic ethanol

- Catalyst Regenerator
- Bio-TCat Fluid Bed Reactor
- Product Recovery, Mild Hydrotreat, & Separation

Excess Heat to Power Recovery

Low % Oxygenates

Biomass Feed Prep Processes

Minerals (ash)

Recycle Compressor

Biomass Oxygen for CO chemistries

CO Combustion for Power Generation

CO-Containing Product Gas

CO Conversion

H₂

3rd party technologies

H₂

Jet fuel blend stock w/Hydro-treating

Wastewater

AnelloMate™ BTX Chemicals or Gasoline Blendstock

AnelloMate™ Distillate Fuel
Anellotech’s TCat8 Pilot Plant – Silsbee, Texas
Technology Development & Commercialization
TCat-8® demonstrating stable, consistent, and safe Bio-TCat Process operations in multi-month studies

- Demonstration of major continuous process operations, recycle loops
  - Continuous catalyst circulation
  - Fluid bed reactor, catalyst stripper, catalyst regenerator,
  - Quench tower
  - Recycle compressor

- Highly-accurate analytic confirmation -- 100% +/-2% mass balance closures

- Real world commercial feedstock -- loblolly pine recently harvested from Georgia (USA) forests

- Regularly completing uninterrupted, 24/7 runs
  - Over 2,000 hours since February 2018
  - Testing different experimental operating conditions and catalysts

- Operates inside a commercial chemical facility that is OSHA PSM compliant.
July 2018: 1,200+ operating hours, BTX product shipped to IFPEN for purification, separation studies

Developments at Anellotech Plant Bring 100% Bio-based Plastic Bottle Closer to Reality

July 16, 2018

Pearl River, NY, July 16, 2018 – Sustainable technology company Anellotech recently achieved new milestones at its TCat-8® pilot plant in Texas, thereby progressing its 100% bio-based bottle collaboration with global consumer beverage company Suntory.

Anellotech’s TCat-8® pilot plant is using Bio-TCat™ technology, an efficient thermal catalytic process which converts non-food biomass feedstock material into BTX aromatics, a group of renewable chemicals identical to their petro-based counterparts. The first shipment of BTX has now been sent to joint development partners IFPEN and Axens for purification studies to make bio-paraxylene – the key aromatic chemical needed to make 100% renewable beverage bottles a reality. Bio-paraxylene from TCat-8® will be used to make renewable PET resin for prototype bottle manufacture and product testing.

Since the announcement of a successful two-week continuous pilot plant trial in March 2018, over 1,200 hours of cumulative on-stream time have been achieved at TCat-8®, while BTX has been generated for product testing and evaluation and process development data collected for future commercial plant design. Anellotech also continues to produce other aromatic products through its Bio-TCat™ process, including benzene and toluene. These can be used to make a range of bio-based polymers such as nylon, polycarbonates, acrylonitrile butadiene styrene (ABS) and industrial chemicals such as LAB (linear alkyl benzene), which is used in laundry detergents.

David Sudolsky, President & CEO of Anellotech, said “Following our announcements earlier this year on process development and continuous operation, we are glad that significant progress continues at our TCat-8® pilot plant. We continue to move the technology towards commercialization, and shipping the pilot plant’s product for downstream evaluation is another major milestone. Having collaborated with Suntory since 2012 to advance development of cost-competitive bio-aromatics, we hope bio-based plastics made from our Bio-TCat™ process and a 100% bio-based bottle soon become a reality.”

Anellotech CEO David Sudolsky will be talking more about these developments and Anellotech’s work in a breakout session at the BIO World Congress tomorrow, Tuesday July 17. Join him from 10:15am at ‘Renewable Chemicals Making Headway Into New Materials and Consumer Biobased Products’.

IFPEN
Solaize,
France
October 2018: Anellotech, with partners IFPEN and Axens, begins planning engineering work for a first commercial plant

New Technology Advances Lead Anellotech to Announce Commercial Plant Engineering Plans

October 16, 2018

Pearl River, NY, October 16, 2018 – Sustainable technology company Anellotech confirms significant progress in its Bio-TCat™ technology development program and has begun planning for scale-up design and engineering of a commercial plant with its process development and design partner IFPEN and commercialization, engineering, and licensing partner Axens.

Anellotech is pioneering an innovative manufacturing process to produce cost-competitive renewable chemicals and fuels from non-food biomass. Its patented Bio-TCat thermal-catalytic technology produces a mixture of benzene, toluene and xylene (BTX) which can be used to make important polymers such as polyester, polycarbonate, and nylon, or high-octane gasoline blendstock. Jacobs, a globally respected engineering firm, recently confirmed that the Bio-TCat process enables a CO2 emission reduction potential of 70-90% when compared to petroleum-derived equivalents. Co-product gas streams from Bio-TCat can be used to make significant amounts of renewable electricity, hydrogen or cellulosic ethanol using third party technologies.

Commercially-viable process yields and catalyst performance has now been achieved at economic design conditions at Anellotech’s TCat-8® pilot unit in Silsbee, Texas. TCat-8 has demonstrated consistently stable operation of major process steps and recycle loops, with highly-accurate analytic confirmation. These attractive results have been achieved with real world commercial feedstock, loblolly pine recently harvested from Georgia forests. Anellotech’s MinFree pretreatment process, operational at multi-ton scale, has been used to ensure low mineral content in the TCat-8 feedstock which is critical for catalyst performance.
Jacobs confirms Anellotech’s Bio-TCat™ process provides significant carbon emission reductions compared to petro-derived aromatics

- **90+ % GHG reduction for aromatics as gasoline/petrol and distillate fuels (products are burned)**

- **70-80% GHG reduction for aromatics used for chemical and polymer applications**

- Jacobs Engineering Group Inc. a globally respected refinery and petrochemical engineering firm used by refiners for major EPC projects
  - Significant expertise in refinery life cycle analyses within their consulting business
  - Jacobs’ own industry-accepted refinery and petrochemical models

- Jacobs in-depth review of Anellotech’s greenhouse gas (GHG) emissions Lifecycle Analysis comparison
  - Refinery aromatics produced from three crude oils, which represented a range of carbon intensity
  - Compared to Bio-TCat aromatics produced using sustainably-sourced loblolly pine feedstock from the southern United States
THANK YOU FOR YOUR ATTENTION!

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