

Alternative Fuels – Alternatives & Production

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Outline

- Jet fuel approvals
- Pathways & processes for Jet fuels
- First approvals
- Options in the pipeline
- Challenges
 - Time to market
 - CAAFI R&D prioritisation

ASTM D4054 approach to approval via ASTM D7566

 Test programme is a four-tier, gated process – developed with Fischer Tropsch (FT) fuels following approach used for UK MoD Coal to Liquids approvals



Final Research report – approved by Original Equipment Manufacturers (OEMs) - is basis for approval via new ASTM D7566 annex and then into standard Jet A/Jet A-1 specifications.

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First approvals - FT Synthetic Paraffinic kerosines (SPKs)



HEFAs approved now other pathways being examined



Gas To Liquids – Process and Products (Pearl)



ASTM J06 Emerging Fuels Task Forces – Routes in approval process or Emerging

- Synthetic kerosine containing aromatics (SKA), e.g. Sasol, Rentech
- Alcohol to Jet (ATJ), e.g. Gevo, Byogy, Navy/Cobalt, Swedish/Lanzatech, Logos Technologies
 - ATJ-SPK and ATJ-SKA (with aromatics) pathways
- Hydrotreated Depolymerised Cellulosic Jet (HDCJ) task force, e.g. Petrotech/Kior
- "Direct Sugar to Hydrocarbon" (DSHC), e.g. Amyris
- Aqueous phase reforming (APR), e.g. Virent
- Catalytic hydrothermolysis process, e.g. ARA (+Chevron Lummus)
- Co-processing with traditional crudes (Jim Kinder, Boeing) Veg oils or Pyrolysis oils (coal, biomass)
- SWIFT

Alcohol to Jet (ATJ) options include SPK products



Waves Deployment

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Routes can produce wide type and C number products

ARA's process

Biofuels ISOCONVERSION Process



Or essentially single chemistry products



Waves Deployment

Used with permission of Fernando Garcia, Amyris

Virent's BioForming Concept

Biobased feedstocks to direct replacement products



HDO/APR = Hydrodeoxygenation /Aqueous phase reforming

Challenges – Technical and Economic

Timescales – to build and make an impact \$ - Feedstocks and/or Production plants Quality Assurance

Shell's 35+ Years of Development of GTL products



Waves Deployment

Pearl Gas to Liquids Project



- The largest energy project ever launched within the borders of Qatar.
- Will convert 1.6 bcf of gas into 140kb/d of GTL products and 120kboe/d of upstream products
- Shell's largest single investment (\$18-\$19bln) but still within budget set in 2006.
- Size of Hyde Park and Kensington Gardens. Enough steel to build over 40 Eiffel towers.
- Enough concrete for 8 Wembley Stadiums (Two Burj Khalifas).
- Largest Oxygen plant ever built (28, 800t/d).
- Largest Process Water with zero discharge (45,000m³/d)
- Largest Quality lubricants plant in the world. (> 1 mpta Group III)



Waves Deployment

Bio-jet technically feasible... World-scale production some way away



HEFAs are a possible solution for the near term...

But, they are not a cheap source of energy and limited by supply constraints

- Competition with biodiesel mandates
- Lower yields for jet cut vs diesel
- Higher cost and limited supply (only 2m tonnes in production)
- Sustainability concerns (land use change) and limited (RSPO, ISCC) supply available



CAAFI White Papers - R&D topics under discussion

- HEFA Feedstock costs
- Efficient conversion of waste to advanced alternative fuels
- Diversity-focused biofuel feedstock production
- Relative economics of alternative jet fuel compared to other fuels

- Alternative methods of CO₂
 capture
- Alternative methods of conversion of CO₂ to fuels
- Fuel specifications & testing
- Bringing down fuel costs (Dept of Energy effort)

These topics are due to be discussed and prioritised at the CAAFI R&D meeting to be held 28-29 November in Arlington, Virginia, USA. Registration details:

http://events.r20.constantcontact.com/register/event?oeidk=a07e65v0jn a3a889077&llr=5v98t9bab

Shell is committed to ensuring sustainability

- Biofuels supply chain is complex
- Sustainability must be traceable and auditable
- Must ensure product quality





Q&A

