




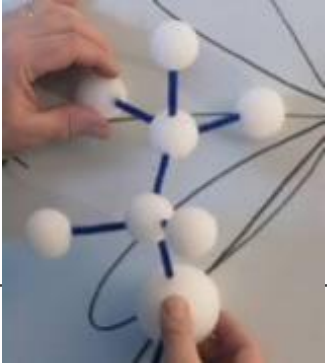
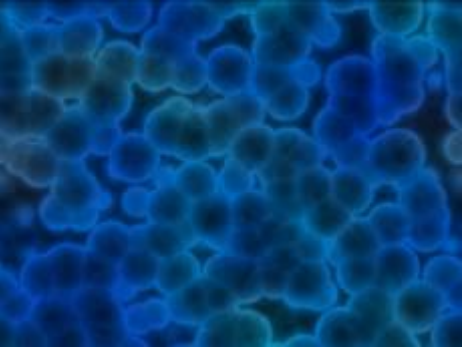
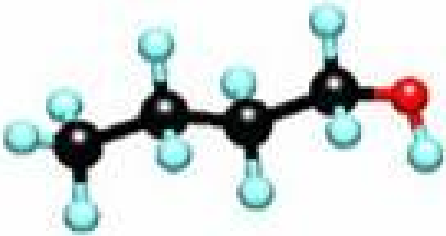
Biobutanol

Second Generation Biofuels

Second Generation Biofuels

25 March 2009

Generations of Biofuels

<p>“0” Generation Late 1800’s e.g. Rudolf Diesel</p>		<p>Peanut Oil Ethanol</p>	
<p>1st Generation 1980’s to present</p>		<p>Corn/Sugar for Ethanol Canola/Soya/etc for Biodiesel</p>	
<p>2nd Generation Currently pilot/demo. Facilities (3rdG= ...)</p>		<p>LignoCellulose/Algae/? for Biobutanol ?</p>	

Why Biobutanol ?

Product

- Diesel @40%, Petrol @100%, Aviation Kero @100% (fleet testing?)
- Mixes in Diesel & Biodiesel, Petrol & Ethanol, or Kero
- Feedstock + solvent
- Quality known + reliable

Substrate

- Sugar / Whey ... (simple sugars)
- Corn / Potato ... (starch)
- (Hemi-)Cellulose ... (also pentose)

Infra-structure

- Use existing oil distribution net
 - Bulk chemical traded > 150 years
- e.g. Solvent for earliest cars and movie celluloid



History

Early to
mid 1900's

Massive commercial production
e.g. acetone -> explosives, solvents (cars, movies, etc.)

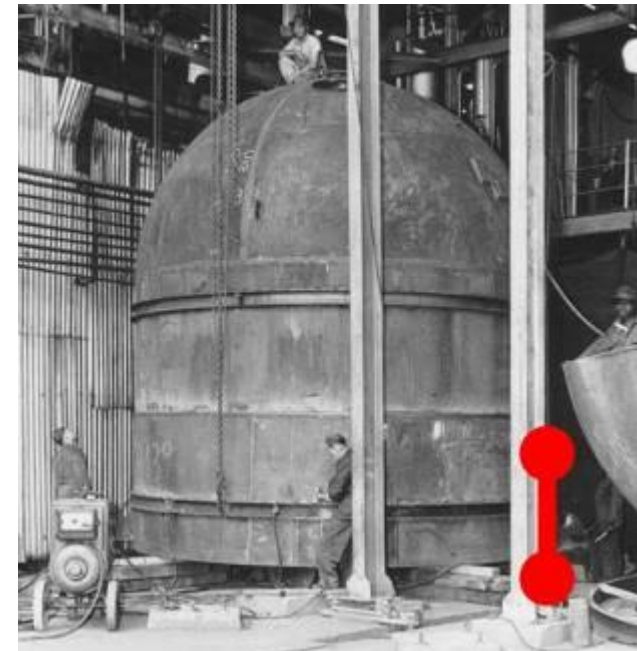
UK, Europe, USA, Australia, USSR, China, South Africa, etc

Currently

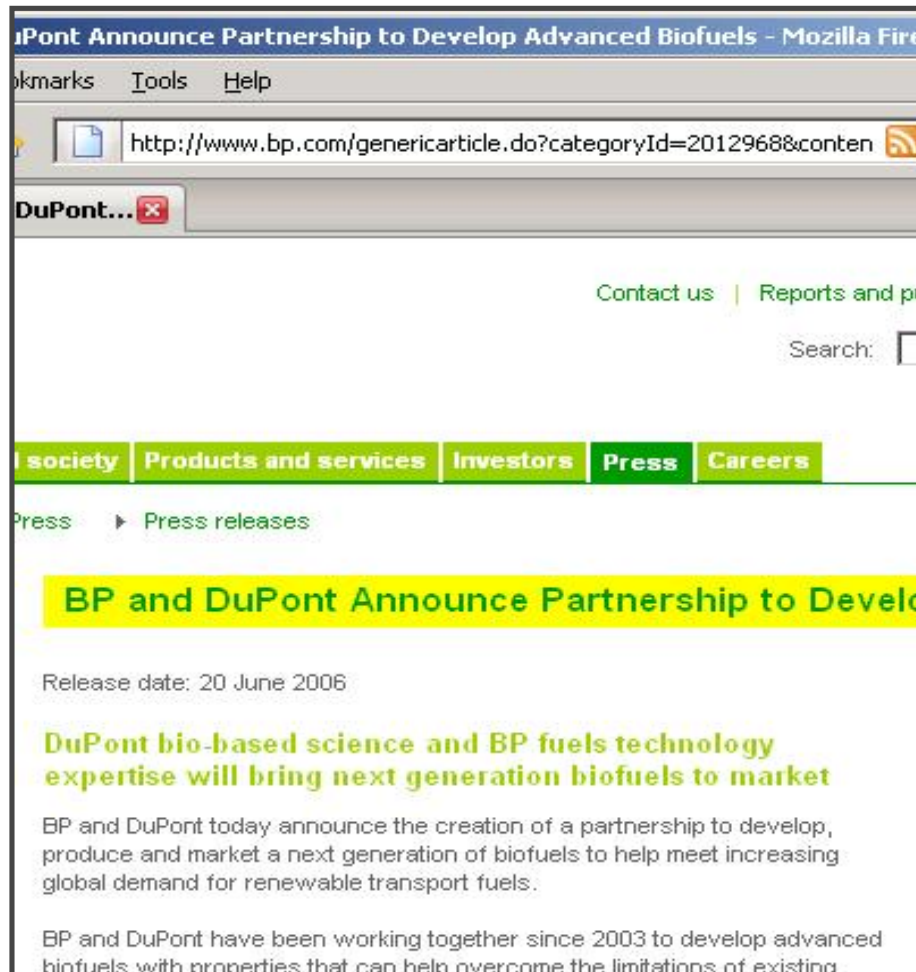
No commercial production
(perhaps China?)

Soon

Much interest
In UK, USA, and China
e.g. BP & DuPont (perhaps with British Sugar)



BP and DuPont



“... bring next generation biofuels to market ...

*The first product ... will be **biobutanol**, which will be introduced in the United Kingdom as a **gasoline bio-component**.*

... BP and DuPont are working with British Sugar, a subsidiary of Associated British Foods plc, to convert the country's first ethanol fermentation facility to produce biobutanol.”

Technology

Bacteria	Non-harmful Anaerobic, 37°C -> n-butanol, i-propanol/acetone (also H ₂ , CO ₂ , ethanol)
Process	
Historically	Batch Massive fermenters Distillation
Modern	Continuous ? Energy efficient Product Separation



Fig. Biobutanol Testing in an agricultural Bioethanol Facility

Energy, Yields, Economics

Energy

Anaerobic life

-> uses approx. 5% (95% left)

Product Energy Density High

-> less weight to transport

Yield

Energy Yield

≈ 95% (“EXCELLENT yield”) (ca.10% as H₂)

Mass Yield

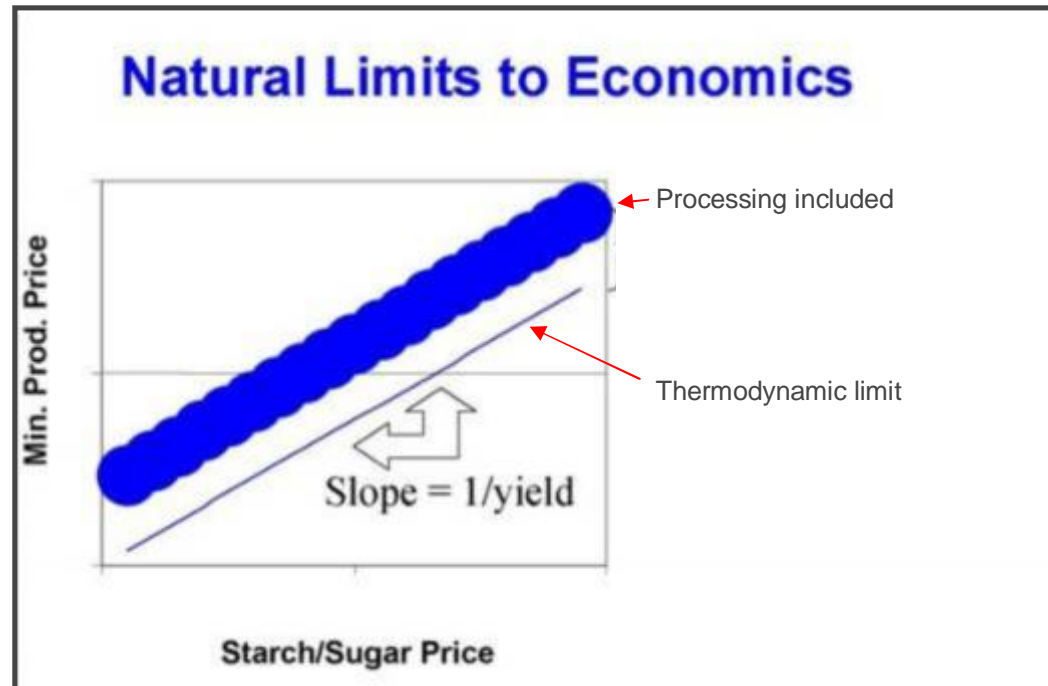
≈ 33% (historically proven)

theor. Mass Yield

≈ 40%

Yield Limits

1st Law of Thermodynamics



Challenges

Process Reliability

Fermentation process **reliability requires experience**

-> Bacteria very sensitive -> Experience required
("Scale-Up", largely solved, needs demonstration)

Capital Costs

High **capital** (ramp up over several years)

- but NPV & IRR dominated by **substrate costs** (incl. transport)

Process Energy

Product Separation = **energy** intensive

-> Modern Processes MUCH improved
("Mass & Energy balances")

Maunsell AECOM Renewable Energy Services

Wind

Maunsell AECOM has recently been involved in a number of wind farm projects for New Zealand and International clients including Te Rere Hua 48MW, Whitehill 58MW and PTI-Siemens USA, and are currently contracted for a new wind farm in the Manawatu.

Hydro

Our team of over 30 dedicated hydropower engineers provide fully integrated design, project management and operation services in over 15 countries. We have been involved in hydro projects for plants ranging from hundreds of megawatts down to mini-hydro such as Manapouri Fishpass, Manapouri Tailrace Review, Benmore Automation and Remote Control.

Geothermal

We have contributed to many successful major thermal and geothermal power development projects in NZ and South East Asia, such as Owner's Engineer for Kawerau Geothermal, the Binary Cycle plant at Wairaki, and Indonesian Geothermal including Wayang Windu Geothermal

Wood

Maunsell AECOM has capabilities in wood to energy projects such as combustion and gasification, from conception through planning to supervision roles.

Public Transport

Maunsell AECOM performs transport planning and consent activities and has extensive power transmission and distribution capability. We are currently involved in the electrification of the Auckland Railway Network and were recently contracted to the Sydney North West Metro.

Total Project Delivery

- Proven engineering experience
- Total project delivery service offered
 - e.g. Owner's Engineer for turnkey projects
- Conceptual & detailed design
- Project planning
- Costing & management
- Construction supervision
- Commissioning



Biobutanol

- Versatile product(s)
- Wide substrate range



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Experience:

Dairy & Bioethanol, Mining, Renewables (incl. Biobutanol)

Last 4 years Biodiesel, Biogas, elec. Power

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