TMO RENEWABLES

FAQs

The Production Process

What is the TMO Organism?

The TMO Organism (TM242) is the patented thermophilic ('heat-loving') Geobacillus bacteria with the capacity for efficient production of bioethanol from a wide range of cellulose-rich feedstocks, a fact exploited in the TMO Process.

What differentiates your process from other ethanol production processes?

Three factors make the TMO Process different:

1. The TMO Molecular Toolkit.

- Allows TMO scientists to metabolically "engineer" TM242 to deliver a wide variety of valuable products.
- Combining the Molecular Toolkit with breakthroughs in metabolic engineering and synthetic biology will facilitate development of a flexible technology platform designed to take a range of cellulosic materials and convert them into useful fuels, chemical intermediates and other compounds.

2. Simplified cost-effective process.

- Avoids high operating costs as the natural ability of TM242 to consume and convert longer chain sugars means we can reduce the amount of enzyme used in our process and that means reduced cost.
- The TMO Process can utilise non-food feedstocks that would otherwise be considered waste materials thus eliminating the need to use high-cost food crops.

3. Ability to handle a wide range of feedstocks.

- TM242 can effectively utilise the variety of different sugars found in cellulosic plant-based materials, which has allowed our process to be applied to many diverse feedstocks.

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How did you develop your process?

TMO was formed in 2002 to commercialise early research carried out in the 1970's by of one of our founding directors, Professor Tony Atkinson. An extensive screening process was carried out on bacteria naturally found in soil and foliage to identify those capable of producing bioethanol.

Having found the appropriate organisms, the next step was to enhance their natural bioethanol-producing ability by applying metabolic "engineering" techniques. To do this efficiently we developed the TMO Molecular Toolkit, the application of which eventually resulted in our first commercially viable organisms.

Having established this strong scientific foundation we progressed by integrating our science and engineering technology by transferring our processes from laboratory to pilot scale and then to demonstration scale. Our Process Demonstration Unit (PDU) was constructed over an area of 12,000 square feet and became operational in June 2008. It has the advantage of built-in flexibility allowing it to handle multiple feedstocks for different feedstock programs. It also gives us further opportunity to test and develop the TMO Process at industrial scale.

What feedstocks can you use?

The TMO Process can deliver a process for the efficient production of bioethanol from a wide range of feed-stocks, but we are currently focused on:

- MSW (Municipal Solid Waste)
- Fractionated fibre of dried distillers grain which is the co-product of the existing corn ethanol industry
- Bolt-on facilities to existing plants utilising agricultural wastes (e.g. cassava stalk, straw, corn cobs, switchgrass and multiple energy crops)
- Stand alone plants utilising agricultural wastes

What patent protection do you have to preserve your advantage?

We have filed international patent applications covering strains of the TMO Organism and the Molecular Toolkit.

FAQs

The Product and the Market

How is the bioethanol typically used?

The principal use of the bioethanol produced by the TMO Process will be blending with gasoline to make vehicle fuel.

In addition to being used for cellulosic ethanol production, biomass as a renewable feedstock offers the opportunity to replace fossil feedstocks as a source of chemicals. Renewable feedstocks (e.g. agricultural and municipal wastes) can be converted into platform chemicals directly or as by-products from biofuels in processes analogous to the petrochemical industry.

What demand is there for bioethanol?

Since the beginning of the century, global interest in the production and consumption of biofuels has been growing. This interest has been caused by a number of factors including security of energy supply, rising oil prices, interest in diversifying the energy matrix, reduction of greenhouse gas (GHG) emissions and opportunities for economic and rural development. More recently there has been significant interest in both renewable biofuels and biochemicals as a progressive step towards creating a biobased society.

The U.S. strongly supports their biofuels market and has for some time. Most recently the revised Energy Independence and Security Act of 2007 set a target for 36 billion gallons of bioethanol to be produced by 2022. Of this, 21 billion gallons is to be derived from second generation cellulosic bioethanol or advanced fuels. Advanced fuels include cellulosic fuels and any other fuel that is not produced from a corn to ethanol process that meets a 50% GHG threshold.

Brazil will continue to strengthen their position as the world's second largest producer of bioethanol, behind the U.S. In addition they plan to help stimulate and commercialise second generation bioethanol technologies from sugar cane biomass material.

China has mandated the use of 3 billion gallons of bioethanol by 2020 although, as one of the world's largest producers of agricultural waste and MSW, it has the potential supply far more.

This demand trend is reflected in many other countries in order to secure energy supplies with renewable energy and reduce GHG emissions.

Will bioethanol ever take off as a mainstream fuel?

In parts of the world it already has. For example, the Brazilian car manufacturing industry has been instrumental in developing flexible fuel vehicles, which can run on any proportion of bioethanol and gasoline. Today, bioethanol powers 20% of the country's transportation system. EU biofuels policy has evolved over the years from modest support for bioethanol production as an agricultural by-product to the elaboration of targets for renewable fuels detailed in the Renewable Energy Directive. The EU has targeted the blend of 10% bioethanol in gasoline by 2020.

FAQs

Commercialisation

What exactly do you provide to your customers?

We license the TMO Process for use with cellulose-rich feedstocks.

For each customer we can apply our process to their cellulosic feedstock by subjecting it to a four stage testing program comprising process biotechnology; the laboratory; the pilot plant; and the PDU.

We then use the results from the testing program to develop a fully engineered design package for the customer to be able to build the appropriate plant.

Our customers will receive:

- the TMO Organism
- fully engineered solution
- process "know how' through supported control system design and a feedstock specific enzyme cocktail
- licensee support (operational support, continued process enhancement support and remote process control support) and
- a proprietary process engineered and mechanically designed and operated pre-treatment and high solids enzyme hydrolysis system

How long does it take to develop a process solution for a client?

If feedstock testing programs are successful the construction of a plant can begin within 12 to 18 months.

What success have you had in commercialising your process solutions?

We have secured a contract with Fiberight in the U.S to produce ethanol from MSW.

We have also has entered into agreements with COFCO and CNOOC in China to apply the process to cassava stalk and cassava residue.

Where do you see the greatest opportunity for future business?

Our opportunities lie where demand is strongest. The bioethanol market is driven by the U.S. and is strongly supported by Brazil and China. Together, the combined output of the U.S. and Brazil accounts for 82% of the global bioethanol production capacity in current operation. Japan, the United Kingdom and Germany also plan to expand their use of bioethanol.