

Cellulose Ethanol



IOGEN[®]
CORPORATION

CELLULOSE ETHANOL: Clean Fuel for Today and Tomorrow

▶ Cellulose ethanol is a liquid transportation fuel made from agriculture residues such as cereal straws (e.g., wheat and barley straw) and corn stover. Iogen's unique process uses specialized enzymes to convert this plant fibre into sugars that are then fermented and distilled to make low CO₂ cellulose ethanol.

CELLULOSE ETHANOL IS READY TO GO

Following years of research, Iogen has developed an economical process for converting plant fibre into ethanol. This fully integrated process is being used at Iogen's cellulose ethanol demonstration plant in Ottawa, Canada. Iogen's cellulose ethanol technology is now ready for widespread commercial roll-out.

FUELS TODAY'S VEHICLES

Blending cellulose ethanol with gasoline reduces fossil fuel consumption in today's vehicles and enables them to burn fuel more cleanly and efficiently. All automotive manufacturers warrant the use of cellulose ethanol blends: 10% (E10) in North America, and 5% (E5) in Europe. Additionally, manufacturers worldwide make flexible fuel cars, trucks, SUVs and minivans that are designed to use ethanol blends up to 85% (E85).

REDUCES RELIANCE ON FOSSIL FUELS

Biorefineries use the residues from locally grown agriculture crops to produce cellulose ethanol. This domestically produced renewable fuel reduces the need for fossil fuel imports, increases energy independence, and improves energy security. It also offers the opportunity of improved sustainability in the transport fuels sector.

SUBSTANTIALLY LOWERS OVERALL GREENHOUSE GAS EMISSIONS (GHGs)

According to U.S. Department of Energy life-cycle analysis, ethanol from cellulose reduces greenhouse gas emissions by 90% compared to gasoline.

DELIVERS SUBSTANTIAL ECONOMIC IMPACT

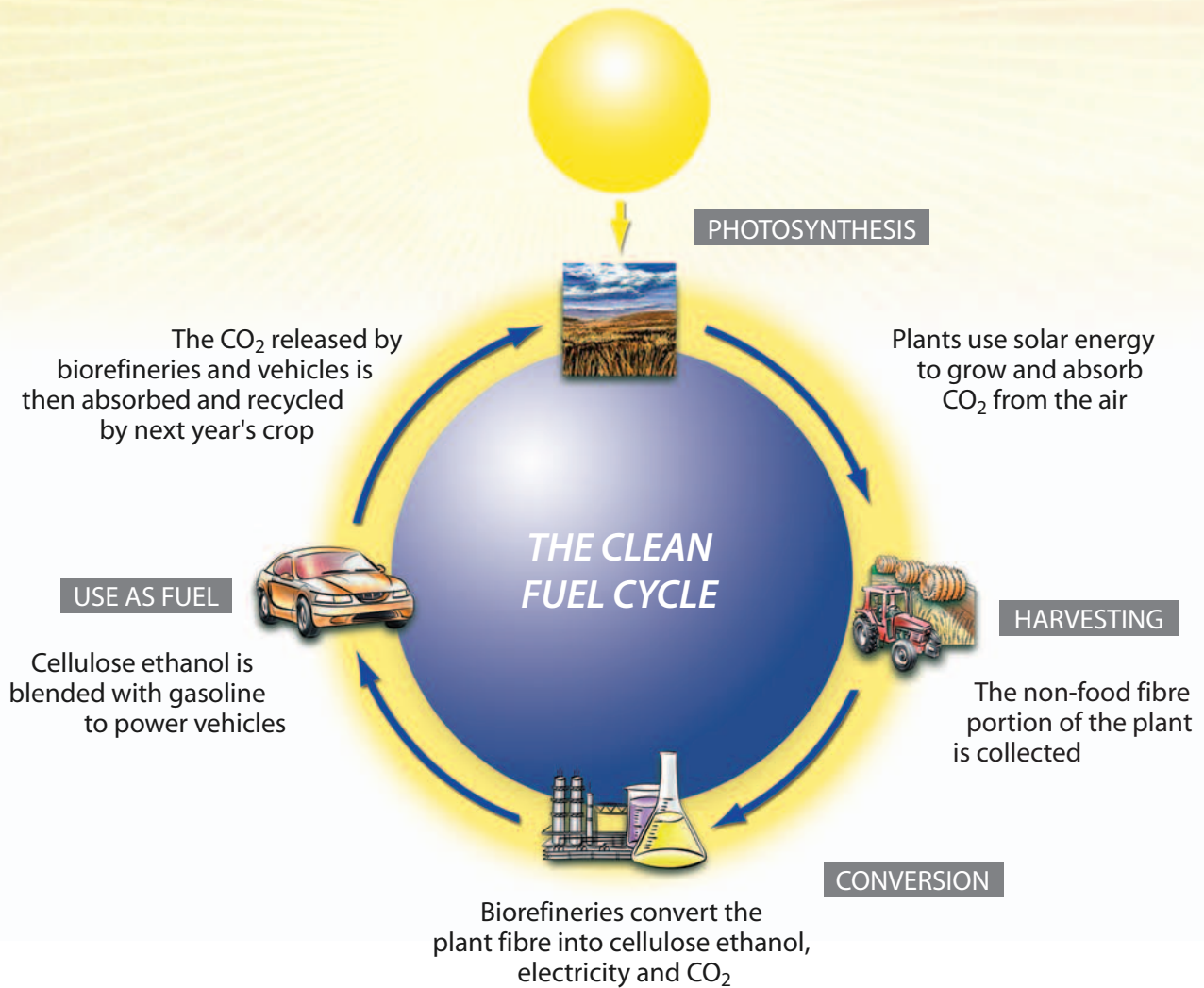
The supply of cellulose feedstock is large enough to make a real difference toward curbing fossil fuel use in transport. Biorefineries of the future will contribute to massive gasoline displacement, improve farm incomes, strengthen local economies, create thousands of jobs, and make agriculture and transportation fuel industries much more sustainable.

COST EFFECTIVELY REDUCES GASOLINE CONSUMPTION

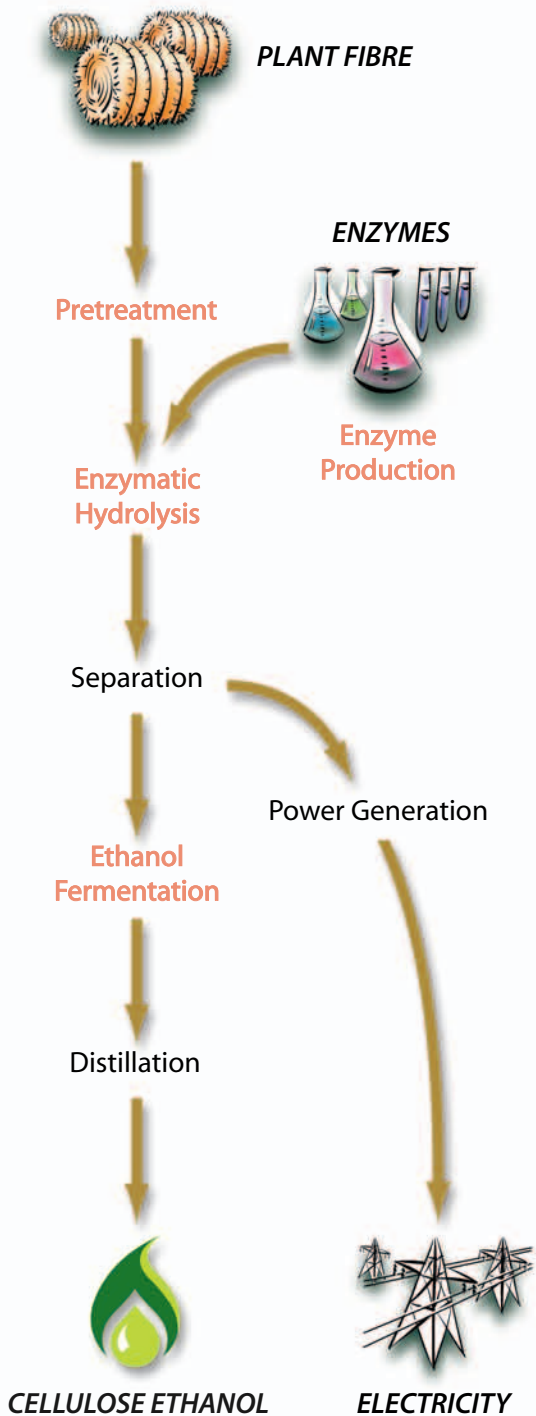
For both automotive manufacturers and consumers, cellulose ethanol represents a more cost effective way to reduce gasoline consumption in today's vehicles. The cost of cellulose ethanol now compares favourably to the cost of conventional ethanol, and is more economical than many vehicle technology improvements such as hybrids, for reducing fossil fuel use in transportation.



▶ Plants use the energy of the sun to grow. Plant fibre contains cellulose, which is the most abundant organic material on earth. Iogen's unique process takes cellulose and, using specialized enzymes, turns it into fermentable sugars and subsequently into ethanol. Using CO₂ absorbing plant material as an ethanol feedstock offers environmental advantages unequalled by other feedstocks or fuels.



IOGEN TECHNOLOGY MAKES IT POSSIBLE



Process Overview

Iogen technology makes it economically feasible to convert biomass into cellulose ethanol using a combination of thermal, chemical and biochemical techniques. The yield of cellulose ethanol is more than 340 litres per tonne of fibre. The lignin in the plant fibre is used to drive the process by generating steam and electricity, thus eliminating the need for fossil CO₂ sources such as coal or natural gas.

Technology Innovations



PRETREATMENT

Iogen developed an efficient pretreatment method to increase the surface area and "accessibility" of the plant fibre to enzymes. We achieve this through our modified steam explosion process. This improves ethanol yields, increases pretreatment efficiency, and reduces overall cost.



ENZYME PRODUCTION

Iogen has new, highly potent and efficient cellulase enzyme systems tailored to the specific pretreated feedstock. Iogen already has a worldwide business making enzymes for the pulp and paper, textiles and animal feed industries.



ENZYMATIC HYDROLYSIS

Iogen developed reactor systems that feature high productivity and high conversion of cellulose to glucose. This is accomplished through separate hydrolysis and fermentation using a multi-stage hydrolysis process.



ETHANOL FERMENTATION

Iogen uses advanced microorganisms and fermentation systems that convert both C₆ and C₅ sugars into ethanol. The "beer" produced by fermentation is then distilled using conventional technology to produce cellulose ethanol for fuel grade applications.



PROCESS INTEGRATION

Large-scale process designs include energy efficient heat integration, water recycling, and co-product production that make the overall process efficient and economical. Iogen has successfully validated these improvements within its demonstration scale cellulose ethanol facility.

ABOUT IOGEN

- ▶ Iogen Corporation is a world leader in cellulose ethanol, a fully renewable, low CO₂ biofuel that can be used in today's cars. Cellulose ethanol lowers overall greenhouse gas emissions, reduces reliance on imported oil, and helps build rural economies. Iogen also develops, manufactures and markets industrial enzymes used to modify and improve the processing of fibres. Iogen enzyme products are sold worldwide and used in a diverse range of applications including the pulp and paper, textiles and animal feed industries. Iogen is a privately owned, Canadian company, based in Ottawa.



Iogen Corporation
300 Hunt Club Road East
Ottawa, Ontario
Canada K1V 1C1
Tel: (613) 733-9830
Fax: (613) 733-0781
www.iogen.ca



This paper contains pulp treated with Iogen bleaching enzymes
The Iogen logo is a registered trademark of Iogen Corporation © 2005