RENEWABLE FUEL OIL
A Sustainable Alternative

ENSYN fuels

Ensyn's patented *RTP* technology is a processing system that uses heat to thermally crack carbon-based feedstocks such as wood biomass (cellulose, lignin) into high yields of a higher-value liquid product, **Renewable Fuel Oil (RFO).** Dried wood is typically converted to approximately 75% (by weight) liquid with a the balance converted to combustible gasses and char. Relative yields can be varied in response to customer product requirements. *RTP* is the only know commercial technology, worldwide, that can convert wood and other woody biomass to such high yields of liquids.

With *RTP*, conversion typically takes place in less than two seconds. This allows for production of new, higher value products, at high yields and with low capital costs.

The *RTP* pyrolysis process is based on the application of a hot "transported" bed (typically sand) that is circulating between two key vessels. Feedstocks, such as wood residues, are subjected to fast, intimate contact with the hot sand for under a few seconds, resulting in thermal cracking of the feedstock to gases and vapours. Product vapours are rapidly quenched, or cooled, and recovered as a light liquid product.

Ensyn's *RTP* process is an analogue to Fluid Catalytic Cracking, or FCC, a very common and mature process used in most refineries around the world. An FCC system circulates catalyst in a closed loop between two key vessels in order to convert vacuum gas oil to gasoline. Ensyn uses a similar mechanical process, but typically circulates readily-available sand while converting wood residues to high yields of a light liquid product.

The Renewable Fuel Standard

Congress first established a Renewable Fuel Standard (RFS)—a mandatory minimum volume of biofuels to be used in the national transportation fuel supply—in 2005 with the enactment of the Energy Policy Act of 2005 (EPAct, P.L. 109-58). The initial RFS (referred to as RFS1) mandated that a minimum of 4 billion gallons of renewable fuel be used in the nation's gasoline supply in 2006, and that this minimum usage volume rise to 7.5 billion gallons by 2012 (Table 1). Two years later, the Energy Independence and Security Act of 2007 (EISA, P.L. 110-140) superseded and greatly expanded the biofuels mandate to 36 billion gallons by 2022. In addition to gasoline, the expanded RFS (referred to as RFS2) applies to most transportation fuel used in the United States—including diesel fuel intended for use in highway motor vehicles, non-road, locomotive, and marine diesel. RFS2 directly supports U.S. biofuels production by providing a mandatory market for qualifying biofuels—fuel blenders must incorporate minimum volumes of biofuels in their annual transportation fuel sales irrespective of market prices. By guaranteeing a market for biofuels, RFS2 substantially reduces the risk associated with biofuels production, thus providing an indirect subsidy for capital investment in the construction of biofuels plants. As such, the expanding RFS is expected to continue to stimulate growth of the biofuels industry.

Ensyn Fuels' **RFO** is a qualifying fuel under RFS2 and thus generates RINs (Renewable Identification Numbers) when **RFO** is burned.

Renewable Biomass

In order to qualify under the EPA's Renewable Fuel Standard, Ensyn Fuels must use "Renewable Biomass" as defined by the RFS. The compliance certificates generated as a qualified renewable fuel are critical to Ensyn Fuels' economics so all **RFO** will be manufactured using feedstock that meets the "Renewable Biomass" definition. "Renewable Biomass" is defined as follows:

- Slash and pre-commercial thinning from non-federal forest lands.
- Planted trees and tree residue from actively managed tree plantations on non-federal forest lands.
- Biomass obtained from the immediate vicinity of buildings, public infrastructure and areas regularly occupied by people that are at risk from wildfire.
- Other activities, including planted crops and crop residue from non-federal forested agricultural land that is either actively managed or fallow.

Forest before thinning

Forest after thinning

GREENHOUSE GAS REDUCTIONS

Since **RFO** is manufactured from "Renewable Biomass" as defined by the EPA, it provides a significant reduction in life cycle greenhouse gases when compared to fossil fuels. **RFO** provides a 87.6% reduction in life cycle GHGs when compared to oil and a 81.7% reduction in life cycle GHGs when compared to natural gas.

GHG Emissions – Wood Feedstock

Fuel	Heating Oil	Natural Gas	PyOil (i.e., RFO)
Feedstock	Crude Oil	Natural Gas	Wood Residues
	g CO_2eq/GJ		
Fuel Dispensing	402	0	874
Fuel Distribution & Storage	698	2,063	361
Fuel Production	8,412	1,376	9,555
Feedstock Transmission	1,401	0	0
Feedstock Recovery	8,081	1,708	0
Land-use Changes, Cultivation	25	0	0
Fertilizer Manufacture	0	0	0
Gas Leaks & Flares	1,900	3,540	0
CO_2, H_2S Removed from NG	0	642	0
Emissions Displaced	-128	0	0
Sub-total Fuel Production	20,790	9,330	10,790
Fuel Combustion	68,718	51,432	301
Grand Total	89,508	60,762	11,091
% Change Compared to Heating Oil		-32.1%	-87.6%

(S&T)2 Consultants Inc.
11657 Summit Crescent
Delta, BC Canada, V4E 2Z2

The emissions from **RFO** are considered by the EPA to be from Biogenic Carbon and thus can be considered carbon neutral. Biogenic CO_2 emissions are defined as CO_2 emissions related to the natural carbon cycle, as well as those resulting from the combustion, harvest, combustion, digestion, fermentation, decomposition, or processing of biologically based materials. Examples of biogenic CO_2 emissions include:

- CO_2 from the combustion of biogas collected from biological decomposition of waste in landfills, wastewater treatment, or manure management processes
- CO_2 from combustion of the biological fraction of municipal solid waste or biosolids
- CO_2 derived from combustion of biological material, including forest-derived and agriculture-derived feedstocks

CAN THE RIN BE SEPARATED FROM RFO?

RINs (Renewable Identification Numbers) are used by obligated parties under the Renewable Fuel Standard to demonstrate their compliance with their renewable volume obligation and are not meant to measure greenhouse gas reduction. The RIN stays with the renewable fuel until the fuel is blended (or burned for heat) at which point the RIN can be separated from the Renewable Fuel. The renewable attributes of the fuel remain with the fuel and do not go with the RIN. This is the exact opposite of a REC associated with electricity. In this instance, the REC actually represents the environmental attributes of the electricity. If the REC is separated from the electricity and sold, the environmental attributes are sold and no longer remain with the electricity.

The only time greenhouse gases factor into RINs is to initially qualify the fuel as meeting the threshold (at least a 60% reduction in greenhouse gases compared to fossil fuels) as a renewable fuel under the RFS2. The actual amount of GHG reduction is never measured. The value of the RIN is based on the BTU content of the fuel when compared to ethanol and NOT the GHG reduction. For example, Ethanol has a BTU content of approximately 77,000 BTU/gallon. If another qualifying fuel has a BTU content of 115,500 BTU/Gallon, that fuel would be worth 1.5 RINs/gallon. The magnitude of the GHG reduction is irrelevant.

The ability to separate the RIN from the greenhouse gas reduction is critical to Ensyn Fuels' ability to provide **RFO** at a competitive price to other fossil fuels. The RIN provides an additional revenue stream that allows **RFO** to be sold to the end user at a much lower cost. The allowed RIN separation allows the end user to still calculate the reduction in in their greenhouse gases that a conversion to **RFO** has provided as part of their overall greenhouse gas reduction strategy.