Distillers Corn Oil for Renewable Diesel FELC 2021

Billy Whitlock October 6, 2021



Rethink Tomorrow

Key Takeaways

A growing Renewable Diesel industry is going to increase the demand for vegetable oils – including Distillers Corn Oil. There is an opportunity to sell DCO for use as a feedstock for Renewable Diesel - and earn a premium! DCO has impurities that need to be removed in order for it to be used as a substrate for Renewable Diesel.

Novozymes has a new enzyme application to reduce impurities in DCO. We're looking for test partners.

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Biodiesel and Renewable Diesel are not the same

Biodiesel	Renewable Diesel
Biofuel produced by transesterification of fatty acids – also called Fatty Acid Methyl Ester (FAME)	Hydrocarbon diesel fuel produced by hydroprocessing of renewable feedstock – also called Hydrotreated Vegetable Oil (HVO)

Biodiesel doesn't go into the regular distribution chains and there are limits on blending.

ASTM standard spec for diesel oil, D975, allows up to 5% FAME.

Renewable diesel is completely interchangeable with petroleum diesel.



Renewable diesel Blending is Outpacing Biodiesel Blending

LCFS Renewable Diesel (RD) Consumption



LCFS Biodiesel (BD) Consumption





Oil Feedstock Demand and Price on the Rise



100% of the DCO from 1000 Ethanol Plants!

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Product	Carbon Intensity
Gasoline	101
Diesel	100
California grid electricity	100
Vegetable oils for biomass-based diesel	55
Waste oils for biomass-based diesel	10 - 30



Current CI scores in CARB Pathways

Refinery in ND. Renewable Diesel Production using Nat Gas and Electricity. RD transported to California by rail.

Feedstock 1: Soy Bean Oil	CI =54
Feedstock 2: Distillers Corn Oil	CI =35

RD produced from DCO is 20-25 CI points below that produced from Soy Bean Oil. Today this CI difference is worth ~40 cents per gallon of RD (or ~5 cents per lb of corn oil).



The Opportunity

- Refined Soy Bean Oil is very low in impurities and costs ~40 cents/lb more than DCO
- DCO is high in impurities but has better Carbon Intensity worth ~5 cents/lb to a RD refinery
- That's ~45 cents/lb of room to negotiate a premium price if an ethanol producer can differentiate their DCO by ensuring it's low in impurities.











Consequently RD plants can add pretreatment to remove metals from corn oil feedstock

Metal catalysts are susceptible to poisoning with metal impurities



Diamond Green process in Biofuels Digest 7/2020

Metal Impurities in Feed Oil Degrade Catalysts

Public information on RD feedstock oil specs

- <10 ppm total earth metals
- <1-3 ppm phosphorous
- The Lower the Better

- <5 ppm Chlorides
- <20 TAN (total acidity number)**

"Renewable diesel is much more sensitive to those metal contaminants in the process. They need to be very low."

Hendrix explains that total metals need to be in the 5-10 ppm range for renewable diesel, and phosphorous needs to be 1-3 ppm in order to maintain the life of process catalysts. "Phosphorus is a real catalytic poison in the renewable diesel process, as are the other earth metals,"

-Blake Hendrix, president and CEO of Desmet Ballestra North America from Biodiesel Magazine article

 Formation of a high P containing crust around the catalyst pellet affects the access to the pore structure.



Figure: High P containing crust around guard catalyst from a commercial unit processing 50% renewable feedstock

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True Target total metals is as low as possible





Metals Analysis – ICP-AES

Most common used methods for elemental analysis are listed below. (All methods require modification for sample matrix.)

ASTM D5185

Standard Test Method for Multielement Determination of Used and Unused Lubricating Oils and Base Oils by Inductively Coupled Plasma Atomic Emission Spectrometry (ICP-AES)

ASTM D4951

Standard Test Method for Determination of Additive Elements in Lubricating Oils by Inductively Coupled Plasma Atomic Emission Spectrometry

AOCS Ca 17-01

Determination of Trace Elements in Oil by Inductively Coupled Plasma Optical Emission Spectroscopy

Labs that offer this analysis:

Foundation Analytical

Intertek





Chloride Analysis – X-Ray Fluorescence

XOS Clora 2XP Benchtop XRF analyzer

ASTM Method D7536

Chlorine in Aromatics by Monochromatic Wavelength Dispersive X-ray Fluorescence Spectrometry

Labs that offer this analysis:

- Bureau Veritas
- AmSpec
- Foundation Analytical (coming soon)



Twice the Precision - Twice the Performance - Improved Sub-ppm Analysis





Traditional Vegetable Oil Refining Process



Chevron, Bunge partner on renewable fuel feedstocks

By Bunge | September 07, 2021

Chevron U.S.A. Inc., a subsidiary of Chevron Corp., and Bunge North America Inc., a subsidiary of Bunge Ltd., announced Sept. 2 a memorandum of understanding (MOU) of a proposed 50/50 joint venture to help meet the demand for renewable fuels and to develop lower carbon intensity feedstocks.

Upon finalization of the joint venture, Chevron and Bunge's partnership would establish a reliable supply chain from farmer to fueling station for both companies. Bunge is expected to contribute its soybean processing facilities in Destrehan, Louisiana, and Cairo, Illinois, and Chevron is expected to contribute approximately \$600 million in cash to the joint venture. Through the

BUNGE

Planned ADM Soybean Crushing Plant in North Dakota to Process 54 Million Bushels Annually

Date Posted: Aug 26, 2021



Spiritwood, ND — **Marathon Petroleum Corp.** and **Archer Daniels Midland Co.** (NYSE: ADM) announced Aug. 19 an agreement to form a joint venture for the production of soybean oil to supply rapidly growing demand for renewable diesel fuel.

Under the terms of the agreement, the joint venture will own and operate ADM's previously announced soybean processing complex in Spiritwood, North Dakota, with ADM owning 75 percent of the joint venture and MPC owning 25 percent.

When complete in 2023, the Spiritwood facility will source and process local soybeans and supply the resulting soybean oil exclusively to MPC.



What can be done at an Ethanol Plant Today



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Enzymatic Oil Quality Improvement Plant Scale Trial Results



Trial Start



Improved Quality Demonstrated

A R	Dates		Clarified oil outbound truck calcium	Clarified Oil Outbound Truck Magnesium	Clarified Oil Outbound Truck Phosporus	Clarified Oil Outbound Truck Potassium	Clarified Oil Outbound Truck Total Metals	Clarified Oil Outbound Truck Total Chlorides (ppm)
	10/1/2020	Average	0.33	0.79	0.71	0.50	2.78	3.08
	12/10/2020	Stdev	0.16	0.44	0.54	0.08	0.85	0.32
		Min	0.20	0.25	0.25	0.03	1.57	2.53
		Max	1.11	2.85	1.93	0.94	5.64	3.80
		Count	84	84	84	84	84	79



"We conclude that (PRODUCER) clarified corn oil is an excellent feedstock to the Haldor Topsoe HydroFlex[™] **Technology.** The P content is less than 1 ppm (wt) and the sum of all the other contaminants is about 2 ppm(wt) on average. These contaminant levels are less than most of the feedstocks that we are processing in our commercial units and will have a **Positive impact on the catalyst life** of our HDO catalyst used in the HydroFlex[™] unit"



Trial Results at Ethanol Producer with Low Baseline Metals

FFA content in DCO loadout samples



FFAs reduced from 11% to 6%



DCO Settling and Water Removal is Key



Blue Dashed Line – moisture content of DCO Red Line – 10 ppm total metals target





Wrap up

The Price of Vegetable oils are going through the roof. This is in part driven by a growing Renewable Diesel industry.

Renewable Diesel feedstocks need low metals. Companies are scrambling to figure out how supply low metal oil.

There is an opportunity to find new buyers for your DCO and earn a premium if your oil is low in metals.

We're looking for ethanol producers to try a drop in enzymatic solution now.



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