Symposium Poster Title: Introducing a Competitive Biofuel Blend for Oil Furnaces

A Comparison of Liquid Biofuels in Home Heating Furnaces, Preliminary Study

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Abstract

We present the first comparison of all current liquid biofuels on home heating furnace platforms. A new biofuel blend made with less refined vegetable oil feed stocks is tested on stock equipment and over several seasons in home furnaces. The new blends are shown to be the first biofuel to be below the cost of petroleum while still producing emission benefits. An analysis of the production of biofuels in Connecticut for the heating fuels market shows that vegetable oils are most economically used in these less refined blends.

<u>Biofuel Price</u>

Using less refined plant oils reduces the end product price and finally brings these biofuel blends in range to break the “petroleum price barrier”. Rendered oils come in a two main varieties, Yellow Grease (the equivalent of the WVO studied here) wholesales at ~$1.18/gallon and less expense Brown grease at ~$0.48/gallon, which may also have potential furnace use. The current home heating oil grade No. 2 petroleum distillate is wholesaling at $1.60 for equivalent quantities. While rendered oils present the best price option and is the favorite feedstock for various biofuels discussions, the “production” is not expandable (CT estimated 4-7 million gallons[7]) so the price can be expected to rise substantially with demand in the near term[5]. Currently, the wholesale price for a WVO 20% blend would be $0.08 cheaper than straight home heating oil at the rack, making this blrend the first biofuel to break the petroleum price “barrier”, a major concern to biofuel introduction.

Soy oil, tested here as SVO (~$2.05), should remain considerably cheaper than soy-based Biodiesel (~$3.10) because close to twice the final net energy is required to bring the biodiesel to market[1]. More important are alternate feedstocks that can be varied to suit the local farming situation and, because of suitability, may face less market competition as a food or biodiesel feedstock. This test and others[3,4,5] have shown that heating furnaces have a substantial tolerance for biofuel variety. Particularly, non-food-grade (“heated”) canola and certain low-input crop oils would be cheaper than soy and more easily grown here in Connecticut. SVO oil prices could therefore be expected to also remain competitive against petroleum

Overview of Blending Stock Price

Heating Oil Blend-Stock	Current CT Production	Expandable CT Production?	Energy Production Efficiency Ratio (Sustainability)	CT Wholesale Price[a]
Petroleum Home Heating Oil (No.2)	0	no	.83[1]	$1.60
WVO Waste Vegetable Oils and fats	4-7 million gallons	no	n.a.	$1.18
SVO Soy (and 0ther) Vegetable Oils	0	yes	Soy 6.1[2]	$2.05
Biodiesel	Beginning production	Ye s	3.2[1]-3.67[2]	$3.18-$2.25[b]

[a]cost includes factor for transportation into CT [b]includes Federal Blending Credit

Part I: Home Furnace Multiplatform Comparison Data

Biofuel blends (and neat biodiesel) were compared against standard No. 2 on three common home heating furnaces (boiler, steam, and hot forced air) using standard testing for the HVAC industry. All fuels performed within acceptable standards for the equipment, and all combustion characteristics were within acceptable limits for home usage.

The tests for increased motor strain (increased amperage draw do to higher viscosity) yielded surprisingly little change vs. No. 2, as did flu-gas analysis. Qualitative analysis of the flames confirmed the oxygenate effect of all the fuels (stronger flames), and improved fuel and flame odor was a bonus for the testing crew.

Test data from 9/21/06 at labs Porter and Chester schools, Branford.
B20 data from 3/15/06

Test Rig 1 **Burner:** Carlin EZPro

Pump Pressure: 140 PSI
Nozzle: 0.85 gph, 60 degree B Solid

Boiler: Weil McClain rated for .95 gph, 114 btu/hr

	Diesel	**20% Biodiesel**	**20%SVO**	**20% WVO**	**100%Biodiesel**
Burner Motor Amperage	1.5	1.51	1.52	1.51	1.54
Cad Cell voltage ohms	545	639	601	796	1220
Smoke Number	0	0	0	0	0
CO_2 %	13.5	13.2	13.4	13	14
O_2 %	2.6	3.2	2.4	3.4	2

CO PPM	26	36	38	43	55
Stack Temp F	337	446	437	465	400
Efficiency %	86.1	83.4	83.9	82.8	84.9

Test Rig 2 **Burner**: Becket AFG

Pump Pressure: 140 psi

Nozzle 0.65gph 70 degree Hollow

Forced Air Furnace: Burnham V-74 rated for 1.35 gph, 136 btu

	Diesel	**20% Biodiesel**	**20%SVO**	**20% WVO**	**100%Biodiesel**
Burner Motor Amperage	2.17	2.26	2.52	2.2	2.4
Cad Cell voltage ohms	255	362	565	230	970
Smoke Number	0	0	0	0	0
CO2 %	9.9	10.1	10.4	10.2	8.6
O2 %	7.5	7.2	7.5	7	10.8
CO PPM	19	21	20	22	15
Stack Temp F	288	296	276	311	290
Efficiency %	85.1	85.4	85.6	85.2	84.6

Test Rig 3 **Burner**: Becket AFG

140 PSI

1.25 70* ES SOLID Nozzle

Furnace: Trane rated 1.5 gh,170 btu

	Diesel	**20% Biodiesel**	**20%SVO**	**20% WVO**	**100%Biodiesel**
BURNER MOTOR AMPS	2.4	2.25	2.15	3.2	2.35
Cad Cell OHM	180	129	97	95	135
Smoke Number	0	0	0	0	0
CO2 %	12.2	12.4	12.2	12.6	12
O2 %	4.3	4	4.5	4.1	4.7
CO PPM	59	35	33	40	38

Stack Temp F	*500	350	360	345	403
Efficiency %	81	85.4	85.3	85.6	83.5

* this data is suspect as this furnace had been unused for some time before burning. Soot accumulation could account for certain variation.

SVO: Straight Vegetable Oil, Soybean

WVO: Waste Vegetable Oil, unknown types, preparation is proprietary information

Diesel: Low Sulfer road diesel

Biodiesel: Commercial ASTM tested Soy based

Gas Testing instrument: UEI C75

O2 +/- 0.2%

CO2 +/- 0.3%

CO +/- 10 PPM

Temperature +/- 5.0 F

Efficiency +/- 1.0%

Smoke Testing Instrument is a standard draw and manual comparison +/- 0.5 number

Amperage Meter: Amprobe ACD-14

Ampergage +/- 1.9%

Ohms +/- 0.6%

Fuel and air temperature assumed to be equal, ranging 70-75 F

Part II: 20% SVO/WVO Field Tests, Preliminary Results

Field tests of the 20%WVO and 20%SVO blends are being conducted. All fuels are in secondary tanks added to the home's current systems for safety and convenience. There are no in-line filters[a]. Field testers are volunteers and were free to adjust pressure and air mixes under supervision as wanted. All maintenance issues were surveyed randomly, problems were to be reported immediately.

Preliminary results are from surveys of 4 of the field trials in three home furnaces over various lengths of time. No urgent problems were reported. Adjustments to older furnace settings (increasing pressure to 120+psi, increasing air mix) were expected. SVO mix had the lowest "satisfaction" total, but this is the only data point test and was from before adjustments were finalized for that furnace. Attention was made for pump seal leaks, a reported problem with biodiesel. No leaks have been reported with straight oils.

Test	Blended Fuel	Test Duration	Overall Satisfaction	Adjustments	H.E. Soot	Nozzle Condition	Motor Condition	Pump leaks	Lines
1	WVO 10-20%	6 months	normal	Increased to 140 psi	normal	normal	normal	none	normal
2[a]	WVO 20%	1.5 years+	normal	none	normal	normal	normal	none	normal
3[b]	SVO 10-20%	3 months	unsatisfied	Increased air mix, pressure to 140 psi	increased	Increased residue	normal	none	normal
4	WVO 20%	6 months	normal	none	normal	normal	normal	none	normal

[a] 2 uses an in-line filter from the test tank.
[b] 3 did significant changes to m ixes over course of use until he was happy with flame. Other results were probably from early problems

Discussion

A biofuel that is competitively priced with petroleum has long been the goal of those both wanting to lower dependence on fossil fuels and to clean exhaust streams. The 20% WVO blend for home heating oil presented here is the first biofuel fuel that can offer the consumer a price incentive for achieving those goals. Further study on practical usage, delivery and long term wear are needed to help protect consumers. With minimal refining and infrastructure needed compared to other biofuels, WVO and SVO furnace use will be attractive to potential local producers.

Currently, Connecticut has one limited resource for generating biofuels: waste vegetable and animal oils from food service. The potential biofuels producers will be competing in an open market for these resources, so a biofuel with an economic advantage will inevitably be important in strategic planning for a local biofuel capability. Equally important is a biofuel with feedstock flexibility so that Connecticut can have more options for developing a locally produced resource for fuels. The raw oil blending research presented here should be expanded to help the state plan its energy future.

Topics for Future Study

-Long-term storage issues, particularly biotic contamination of rendered oil blends.
-Delivery issues including cold flow properties and additives, wax crystallization in waste oil
-BTU content vs. oxygenate assistance in total combustion efficiency
-Brown grease solubility and use
-Alternate renewable feedstock use (non-food grade canola, etc)