

US Filtermaxx Presents

# Black Diesel

Cheap Fuel from Waste Oil



Almost as easy as shootin' at some food,  
Y'all can make a batch of Black Diesel too!

Looks like Texas Tea...

By Stephen Chastain, Mechanical Engineer

# RUNNING ON WASTE OIL

## Tried and Tested

At US Filtermaxx we have been testing oil fuel and running diesel engines on waste oil since 2004. Over 4000 hours of actual engine run-time testing has gone into our waste oil program and we have had excellent results. The process is not complicated and in most cases, you keep the stock engine and fuel system configuration, with little or no changes.

## Author Background

My background is in mechanical engineering with concentrations in Power Generation (fuels and combustion) along with Materials Science. I also am certified in ASTM Diesel Fuel Specifications and Testing. We have a full machine shop here and I have machined and built over 60 engines for various projects, along with manufacturing custom pistons and cylinder heads. Although I don't know the details of every engine out there, I am a hands-on, get dirty in the middle of things type of engineer.



Stephen Chastain

I am shocked at the vast amount of bad information out there from sites, web forums, eHow and newsletters posted by other manufacturers. Bad information gets bad results and may cause expensive fuel system repairs. Other recommendations are downright dangerous.

## Why it Works

Petroleum is made up of two basic types of molecules, straight chains and rings. However there are also rings with chains. Ring type molecules make good gasoline blends and resist detonation during the engine's compression stroke. Longer chains are known as “knockers” as they easily detonate and cause a gasoline engine to knock. This is bad for a gasoline motor but good for diesel engines so diesel fuel has chain type molecules as opposed to rings.

When fuel is made, the lighter compounds that form gasoline, jet fuel and kerosene are distilled off. The heavier residue that remains contains long chains that if distilled under higher temperature and pressure, crack or break in half to form shorter chains that make diesel fuel. If distilled under vacuum at low temperatures, they come out as longer chains good for lubricating oil. So the main difference between diesel fuel and lubricating oil, is the length of the chain. However the longer chains make for thick oil that must be thinned and this is exactly the way diesel was made for many years. Heavier bottoms were blended with lighter oils to thin them enough to run in diesel engines.

*Making waste oil fuel is not difficult*, but it is process specific. This means it is easy to do but you must do it right. What I am about to tell you comes from both my science and engineering background and years of trial and error, testing, retesting and testing again.

Although ASTM specifications for Diesel Fuel are a number of pages long, only 3 or 4 things are technically required for proper operation. The rest of the specifications are politically motivated, generally to protect someone with a financial interest in the rule.

The important things for diesel fuel are:

1. Clean
2. Dry
3. Ignitable

Other good qualities are

1. Lubricity
2. Low temperature flowability

Luckily, all of these properties are easily attainable with waste oil.

## Waste Oil Cleanliness

Relative to waste vegetable oil, motor oil is fairly clean. WVO may have fish parts, batter, salt, corn meal, water or any number of large debris. Engine oil filters are generally around 20 micron, so the oil that comes out of an engine is relatively clean in comparison.

## Things You May Find in Motor Oil

Generally, debris found in WMO are leaves and large things that may be removed with a window screen. No extensive screening is needed before filtering.

Water is a byproduct of combustion, so engine oil will have various amounts of water in it. Longer drive times and higher temperature allow most of the water to evaporate from the engine oil. Short trips and cold running yield a higher percentage of water in the oil and in extreme cases you may get a mayonnaise looking substance in the bottom of the oil pan. This is a water-oil emulsion. Another source of water in WMO is rain getting into poorly sealed containers. Method of oil collection can also influence the amount of water in your oil, but more on that later.

Some oil may contain brake fluid, usually in fractions of a percent. The specific gravity of motor oil is about 0.88, while brake fluid has a specific gravity of 1.05. This makes brake fluid a little heavier than oil so it can be removed. Brake fluid does burn and has been run in diesel engine tests, so what doesn't come out will be OK.

Other contaminants that you may run into are antifreeze and paint. You can get antifreeze out, but there is nothing good about paint being in your oil and this situation should be avoided PERIOD. Under no circumstances should you try to run oil that contains paint.

## All Good Things Come in Time

The first step in proper oil cleaning is *settling*. You should have several large containers with drains in the bottom to store the oil for weeks or, even better, a few months before filtering. Don't be in a hurry, if you are patient, most of the work will do itself. After settling, there will be layers in the tank. The bottom layer will be dirt, followed by a layer of water. Above the water will be a layer of mayonnaise and above that will be good oil. Drain off all the settled contaminants until you reach good black oil. Now you are ready to filter.

Some people will tell you to filter your oil through something like an old denim pants leg or your grandmothers underwear. At best, denim is around 30 micron and no telling what the underwear is. Since a typical oil filter is 20 micron, this method does nothing to improve your situation.

Because the hole size in modern fuel injectors is about 0.005 inch, it doesn't take much goop buildup to change the injection pattern from such a small hole. Do you REALLY want to trust this to your grandmother's underwear?

# CLEANING WASTE OIL

## Centrifuge is Required

The only way to get oil properly cleaned for LONG TERM RUNNING without problems is a centrifuge. The idea is simple, things heavier than oil will come out, and since most of the problem causing things IN your oil are heavier than oil they WILL come out if properly centrifuged. However, many are present at the molecular level making them impossible to remove by just filtering. A strong centrifuge is required.



US Filtermaxx Centrifuge

Table 1: Specific Gravity of Things Found in Waste Oil

Oil	0.88
Water	1.00
Propylene Glycol	1.036
Brake Fluid	1.05
Ethylene Glycol	1.10
Glycerol	1.129
Calcium*	1.55
Magnesium*	1.738
Zinckiakylidithiophosphate*	1.60
Teflon*	2.20
Iron	7.85
Copper	8.96
Lead	11.35

\*oil additives, anti-friction, detergents or anti corrosives

Note that Automatic Transmission Fluid often contains friction enhancers to provide faster lock up and to prevent excessive slip.

## Centrifugal Cleaning

Like washing clothes, the longer the wash cycle, the more dirt will come out. The longer the oil is in the centrifuge, the cleaner it will be so nothing is gained by rushing the cleaning process. Another thing that affects the cleaning process is the thickness of the oil. It is more difficult for particles to “fall out” of thick oil. A rock dropped into a bucket of molasses will slowly sink to the bottom, while a rock dropped into to bucket of water will fall quickly to the bottom, so thickness matters. The good news is oil is easily thinned by heating.

## Serve it up hot!

Hot oil is a very good thing when it comes to cleaning and 160F up to about 220F degrees is an ideal range. The hotter the better! Oil thins quickly with heat and it also helps separate the water. You may look at that dark black oil and think it's dry but you have been fooled. There is still a significant amount of water in it. This is due to the detergents in the oil that hold the water in suspension. Because water is heavier than oil, it will come out in the centrifuge. The US Filtermaxx centrifuge creates a slight vacuum in the bowl, this and the fine spray created inside the centrifuge causes water to flash off as steam. If this steam was allowed to stay in the centrifuge, a large percentage would condense back into the oil as water. If the vapors are forced out of the centrifuge, then there is little chance for them to re-contaminate the oil. US Filtermaxx centrifuges are force ventilated to remove this water and other vapors coming from the hot oil.



## Almost Done

Now the oil is hot and flowing SLOWLY through the centrifuge at a rate of about 1 quart per minute or a little less, depending upon how clean you want it. The steam is coming out and the oil is flowing into a clean tank. Oil needs to be blended before it may be used as a fuel in most situations. However, long running industrial equipment with fairly constant loads like pumps and 1800 rpm generators may often be run on straight oil. Engines with light or highly variable loading need to have blended fuel. Cold oil is difficult to blend. About 100F is a good temperature so the oil should be blended in stages as it comes into the storage tank from the centrifuge, generally we blend at each 20 to 25% level in the storage tank. Blending is important and it must be done vigorously. More on this later.



Sludge pulled out of used oil that had already been filtered to 10 micron

# HOW TO BLEND OIL WITH FUEL

## Temperature and Fuel System Matter

What kind and how much blending depends upon several things but the one fundamental property is temperature. Obviously seasonal temperature determines the thickness of the oil, and another is the engine running or driving temperature. The third thing that governs your blend is vehicle specific. Your particular engine's fuel system may or may not require a thinner oil.

If the seasonal temperature is cooler, then more thinning is required than in warmer weather. Type of driving also changes the blend. All diesels soot up the combustion chamber when run cold. With a little hard running, this soot burns off in a few minutes and is a natural cycle in a diesel engine. Heavy oil will produce soot faster than light oil in a cold engine. If you make a lot of lightly loaded short drives like going to the post office a block away, then engine doesn't get hot enough to burn off the soot. Likewise if you spend a lot of time idling in stop and go traffic the engine doesn't run hard enough to burn off soot so you will have to run a lighter blend of oil. Pulling a load and highway driving are both good for running heavier blends. If you notice a sooty exhaust after extended idling or cold running, a trip on the interstate should clear this up.

## Blending Agent / Solvent Options

Now you are ready to blend the oil to reduce the viscosity. There are many things or "solvents" that may be used, regular gasoline, kerosene, jet fuel and diesel. There are reasons you don't want to use other solvents like acetone or toluene except as maybe an occasional fuel system cleaner.

Diesel is a common solvent and every 10 percent addition reduces the oil viscosity by one third.

Gasoline is a powerful solvent and every 10 percent addition cuts the viscosity by half. Heavy oil is slower burning. Gasoline also increases the burn rate. These two properties make it my solvent of choice.

Alcohol has both a high octane number and absorbs water, making it a poor choice for blending.

Acetone is hard on Buna, nitrile, NBR and fluoroelastomer rubber parts. Toluene is hard on almost all rubbers. Acetone also has a very low flash point of -4F. Because many fuel systems use the fuel to cool the injectors, fuel temperatures may reach well over 100 degrees. While the flash point will be higher with lower percent acetone mixtures, -4F is still pretty low for safe operation.



## How Much Solvent to Use

Generally, a 20% addition of gasoline will reduce the viscosity of oil so that it runs in most applications. Lower temperatures may require higher ratios up to 30%. More than 30% is not recommended.

Table 2: Reduced Oil Viscosity by Addition of Diesel or Gasoline

<b>Addition</b>	<b>Diesel</b>	<b>Gasoline</b>
<b>10%</b>	67%	50%
<b>20%</b>	45%	25%
<b>30%</b>	30%	12.5%
<b>40%</b>	20%	NA
<b>50%</b>	13.4%	NA

Many engines can run this straight 80/20 mix. Some situations may require blending the universal mix with diesel. But blending 20% regular unleaded gasoline is a universal starting point. This “blend” may also be mixed with diesel in various amounts as your running conditions dictate. If you are unsure of how much of this Universal Blend to use, start by mixing some into your diesel and run testing, increasing the mixture after each tank and checking for good performance

## Mixing Oil and Gasoline

Mixing is a very important part of a successful process and critical for proper operation. Oil and gas don't want to mix and will sit in layers in a tank. It requires vigorous mixing to get the oil blended with the solvent. Poorly mixed oil will go straight to the bottom of a tank and gas or diesel will float on top. If you pour cleaned oil directly into your fuel tank thinking it would blend, **WRONG**, it is guaranteed your engine will start smoking and running rough within minutes. Also, you can't just put a stick in the tank and swish it around for 5 minutes and expect it to work. Proper mixing is essential if your oil fuel is going to run properly. Small batches up to 100 gallons or so may be vigorously blended with a motorized paddle mixer. Twenty 20 minutes per one hundred gallons should be a minimum. Another option is circulating with a gear pump for a few hours. Once your 80/20 blend is well mixed, it will stay that way.

## Settle After Mixing

Air bubbles will be drawn into the oil with all of this vigorous mixing. After blending, the tank should sit overnight to allow the air bubbles to escape. Another good practice is to fill the equipment tanks or engine fuel tanks the evening before use. Any air whipped into the oil during filling will escape overnight.

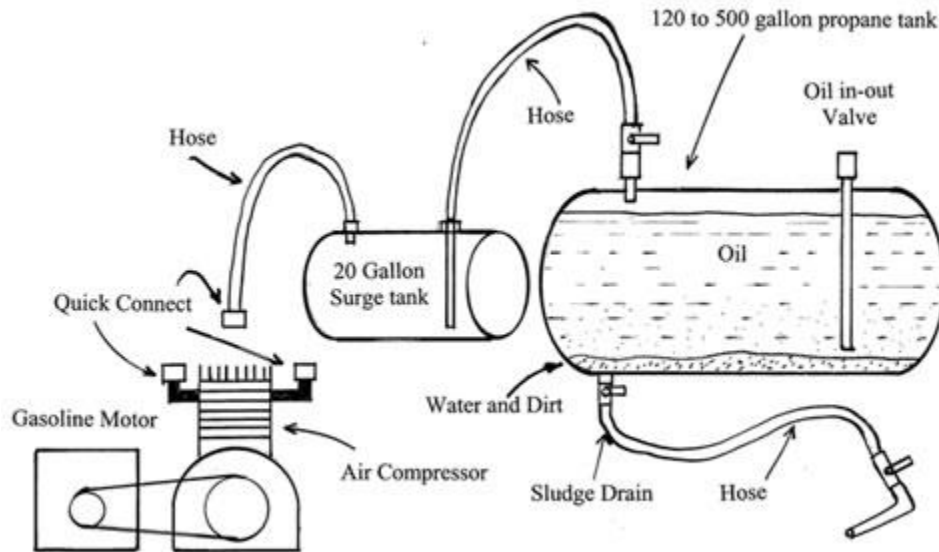
## **Filter after Storage**

So you have cleaned and blended your oil and put it into the final clean tank for storage. "Clean tank" is relative and no matter how much you clean out your tank, there will still be rust, dust and dirt that gets into it. Oil is like a dust magnet so it will have to be filtered once more before it goes into your engine's tank. Because oil is such a dust magnet, we make a final pass between a 10 and a 2 micron filter right before the filler hose. At this point, the oil going into the tank is super clean and dry. A typical filling station uses a 30 micron filter before the filler hose. You can expect excellent results from your cleaned oil. Generally, we see 2 years and 30,000+ miles between engine fuel filter changes with this oil fuel.

# COLLECTING WASTE OIL

## Avoid Oil Spillage

The first rule of oil collecting is “Spill No Oil.” A half a pint of water on the ground isn't even noticeable but a half a pint of oil is a huge mess. Oil spills have a magical property of being exponentially messier than almost anything else. You should avoid spilling even the smallest amount. Be stocked with towels or rags to catch any hose dribbles.



Vacuum oil collection system

## Vacuum Collection is the Best

Because everything is sucked into a tank, waste oil is best collected with a vacuum system similar to the type used in a septic tank truck. This doesn't mean you need a sewage truck to collect oil. Small systems are easy to build and will fit in the back of a truck or on a small trailer. Plans and a complete description of vacuum systems may be found in our book *Alternative Energy Secrets*, and a short vacuum oil collection video may be seen on [YouTube](#).

## Gear Pumps are Second

Gear Pumps are the next option for moving oil. They have the advantage of being small and portable, with the disadvantages of being more prone to dribble oil and may require priming after they have been used a while. The other disadvantage of gear pumps is that they form oil water emulsions (mayonnaise) when they run into water in an oil tank. These emulsions can be difficult to break. Blend the mayonnaise with 15% gasoline and allow it to settle for 10 days to break the emulsion. Gear Pumps may be found at: [USFiltermaxx.com](http://USFiltermaxx.com)

## **Avoid Centrifugal Pumps**

Centrifugal Pumps are instant losers and burn up within minutes when pumping oil, so don't even think about it.

## **Collection Hoses**

The typical braided PVC hose will work for pumping oil on the “pressure” side of the pump or tank but this hose will quickly collapse if used for “vacuum” or on the suction side of a pump. Only spiral wound suction hose should be used here. PVC suction hose is inexpensive and good for light use. Cam-Lok connectors quickly attach and remove pump hoses and are highly recommended.

# TIPS ON USING BLACK DIESEL

## Cold Weather Running

Heated fuel is best for colder weather. Unlike vegetable oil, the fuel does not have to be hot and 70 to 85 F is good. A heater filter, fuel line or tank should suffice. An unused cooler line in the radiator will also work in very cold weather.

## Best Engines for Waste Oil

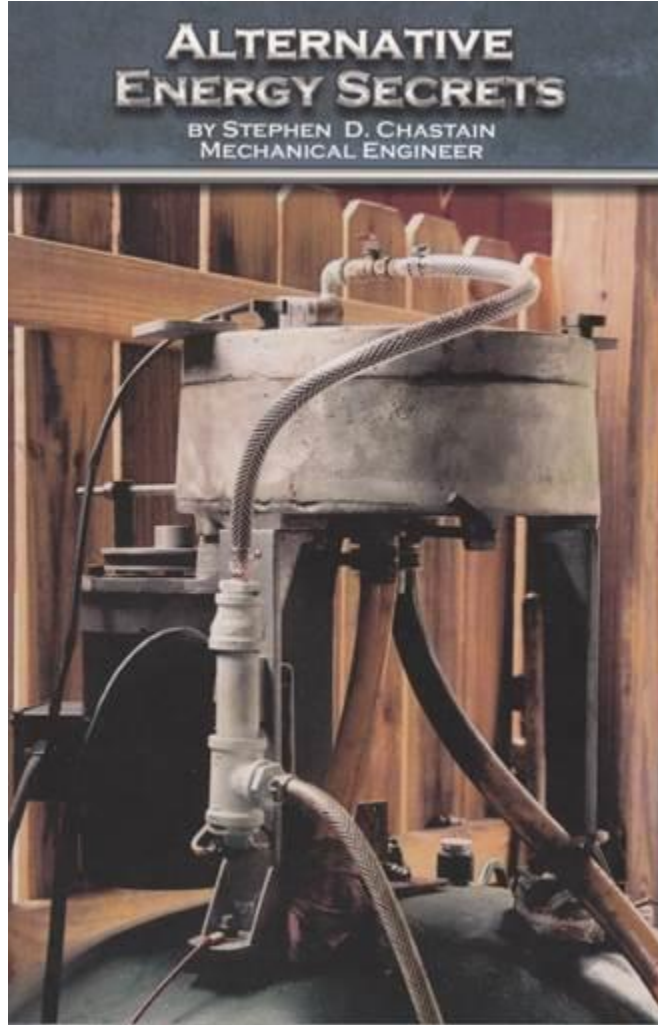
There are a range of engines that work well with waste oil fuel. Anything with mechanical injection is an instant winner; however, gravity feed fuel systems may require adding a fuel pump. Cummins engines are notoriously good at running on this fuel along with 6.9 and 7.3 Fords. Chevy 6.2 diesels work well, Some 6.5 diesel owners report trouble because of an optical sensor, however other 6.5 owners run by adding a “performance chip” and using even the lowest economy setting produces dramatic results. This will be vehicle specific and will require investigation regarding your specific model. Some do an EGR bypass to improve performance and clean up smoke. However, I do not endorse changing any pollution control device. Any IDI engine is a very good candidate. Volkswagon, Mercedes and Jeep diesels also work well on waste oil fuel. Late model diesels with advanced computerized emissions control have no history with this fuel that I am aware of and cannot be recommended from a “tested and confirmed” point of view. Depending upon cleanliness of the final oil, catalytic converters may or may not experience shorter life if the engine is equipped with such a converter.

Adding a turbo to any naturally aspirated engine makes a huge difference and is one modification I strongly recommend. Others add a performance chip and this gives them a dramatic increase in performance.

## ADDITIONAL INFORMATION

### Energy and Manufacturing How-to Books

Find the perfect books to learn about [Alternative Energy](#), [Generators and Inverters](#), [Small Foundry Furnaces](#), [Metal Casting](#) and more at [StephenChastain.com](http://StephenChastain.com).



Book Cover of Alternative Energy Secrets

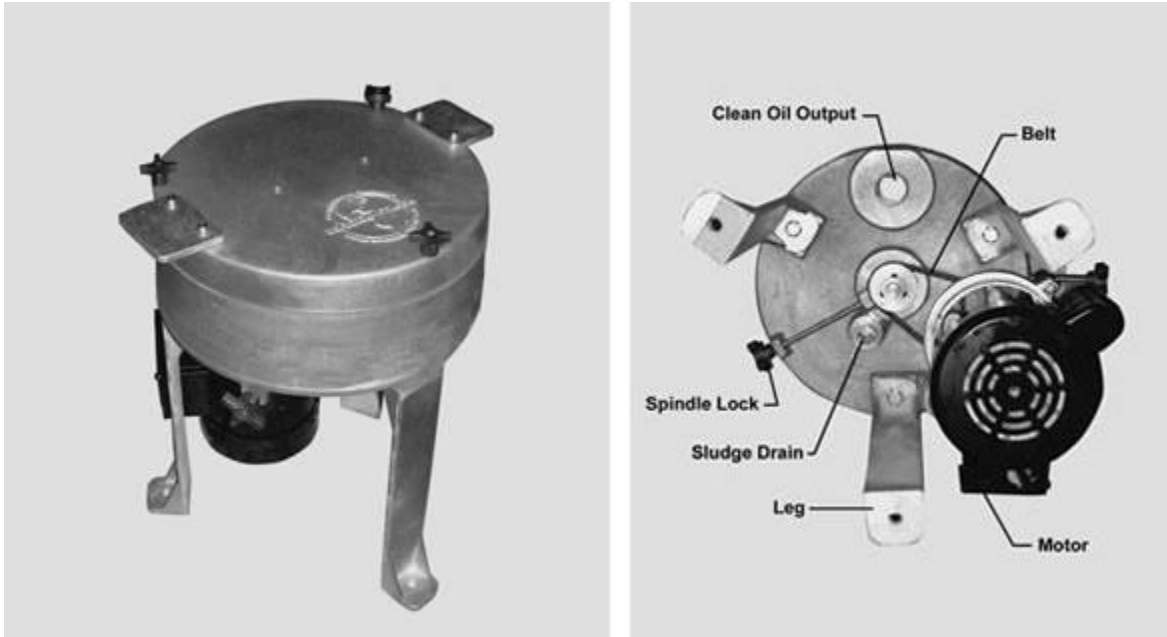
### Black Diesel Report Rebate

If you purchased this report on eBay, the purchase price will be refunded if you purchase the Alternative Energy Secrets book. To receive your rebate, email the purchase date and PayPal transaction number to: [rebates@usfiltermaxx.com](mailto:rebates@usfiltermaxx.com).



## Centrifuge and Pump Equipment

US Filtermaxx runs a store on the World Wide Web at [USFiltermaxx.com](http://USFiltermaxx.com) where you can purchase our high quality centrifuge models along with automatic centrifuge controllers, oil heaters, oil pump equipment, and more.



Top and bottom views of US Filtermaxx centrifuge

[USFiltermaxx.com](http://USFiltermaxx.com)

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### **WARNING – DISCLAIMER**

This report is to provide information on the methods used to blend waste oil fuels. No attempt has been made to point out all of the dangers or even a majority of them. Local codes may preclude blending of any fuel. Taxes may be due on blended fuel and proper taxing authorities should be consulted. Although this information has been researched and believed to be accurate, no liability is assumed for the use of the information contained in this report.