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# Straight vegetable oil as diesel fuel

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There's a choice to make for running diesels on biofuels:

- make biodiesel and just use it, no need to modify the engine, or
- buy a ready-made conversion system for your vehicle or build your own so you can run it on straight vegetable oil (SVO) -- no need to process the fuel, just put it in and go.



[Elsbett, Germany](#)

Does the SVO option work? Yes -- IF you go about it the right way. It's not quite that simple a choice. For one thing, if you want to use waste vegetable oil, which is often free, you're going to have to process it anyway, though less so than to make biodiesel. And it still might not be a very good fuel.

But read on -- you CAN run your diesel motor safely on straight vegetable oil, just put it in and go. There are pitfalls and provisos, but we'll help you to steer your way through them.

One of the great advantages of biodiesel is that it will work in any diesel motor -- see [Biodiesel and your vehicle](#). ([More](#) on the choice between biodiesel and SVO.)

The same claim is often made for straight vegetable oil fuel systems, such as this: "Ready-to-install kit that will allow you to run any diesel on waste vegetable oil."

Is it true? Yes, BUT... and it's an important "but".

Diesel motors last a long time, half a million miles or more is not unusual, and there are very few thorough, long-term studies of the effects of using straight vegetable oil in diesel motors. What is clear, however, is that "any diesel" is an exaggeration.

- Some vegetable oils are better than others.
- Some diesels are more suitable than others.
- Some injection pumps work better than others.
- Some computerized fuel systems don't like vegetable oil at all.
- There are doubts about using vegetable oil in DI (Direct Injection) diesels.
- There are also doubts about using waste vegetable oil.

The main problem is that vegetable oil is much more viscous (thicker) than conventional



[Spanish-language sister-site for DIY biodieselers](#)

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diesel fuel (DERV, petro-diesel). It must be heated (thinned) so that it can be properly atomised by the fuel injectors. If it's not properly atomised, it won't burn properly, forming deposits on the injectors and in the cylinder head, leading to poor performance, higher emissions, and reduced engine life.

This can also happen with unsuitable oils, for instance those with a high iodine value, such as linseed oil (see [Iodine Values](#)), which can form tough epoxy deposits, not good for engines. It's argued that a good SVO system will prevent this, but solid proof is lacking.

"In the high temperatures commonly found in internal combustion engines, the process is accelerated and the engine can quickly become gummed-up with the polymerised oil." -- From "Waste Vegetable Oil As A Diesel Replacement Fuel":

<http://www.shortcircuit.com.au/warfa/paper/paper.htm>

Waxes can clog up the fuel system, especially in [cold weather](#). Waste oils can contain acids that cause corrosion in the injector pump, and impurities that can cause coking and further corrosion.

"In autumn 2001 an injection pump was damaged for the first time ... so that an exchange was necessary. The vehicle had previously been driven without problems for two years. An examination of the defective sections found substantial surface erosion of the hardened steel high pressure parts, which are not acid-proof." The problem was traced to a supply of soy oil which was not the usual food-grade oil and had a high acid-content. BioCar (German page):

<http://biocar.de/info/warnung1.htm>

Here's some more:

"Rapeseed oil ... can only be used as a diesel fuel extender, with inclusion rates of up to 25%." -- From "Results of engine and vehicle testing of semi-refined rapeseed oil":

<http://www.regional.org.au/au/gc/6/214.htm>

And yet more:

"Deacidified rapeseed oil can be used as fuel for a diesel engine. Degummed oil and crude rapeseed oil were found to be unsuitable for use as fuel due to the high level of incombustible materials in oil." -- From "Operation of a Diesel Engine Using Unrefined Rapeseed Oil as Fuel":

<http://ss.jircas.affrc.go.jp/engpage/jarq/33-2/Togashi/togashi.html>

Nonetheless, experience is showing that SVO systems are a practical proposition with a lot of advantages to offer, not least of all that using SVO is cheaper than turning it into biodiesel and uses less energy than making biodiesel does.

It's critical to pay close attention to the properties, quality and condition of the oil -- much more critical with an SVO system than if you're going to convert the oil into biodiesel. Study the resources below carefully, as well as the information on oil and fuel qualities and properties on our [Oil yields and characteristics](#) page.

That done, get a good system matched to the right kind of engine with the right kind of



Cutaway view of an injector pump -- complex, expensive

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## Contact us

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Homepage

<http://journeytoforever.org/>

Handmade Projects

Osaka

Japan

injection pump, as well as to your climate, and you'll be just fine, like thousands of others.

The following chart is a guide to safe, long-term use of vegetable oil as diesel fuel.

# Guide to using vegetable oil as diesel fuel

## Key

+ favored

- less favored

SVO = straight vegetable oil (virgin oil, fresh, uncooked)

WVO = waste vegetable oil (used cooking oil, "grease", fryer oil, including tallow, fats)

-- With information provided by Ed Beggs of Neoteric Biofuels, Inc.

<http://www.biofuels.ca/>

## Engine type

IDI (Indirect Injection) +

DI (Direct Injection) -

Newer engines are generally less tolerant of SVO.

## Injection type

Mechanical injection +

Computerized injection -

## Injection pump

Inline +

Rotary -

Lucas/CAV injection pumps have had high failure rates running on SVO.

## Oil type

New SVO +

WVO -

Brassicas (mustard, rapeseed, canola -- all high-lubricity oils) seem to be among the best, or at least there are more results available on using them in SVO applications.

## Pre-treatment

Raw SVO pressed on-site from seed should be degummed and deacidified.

Oil must be free of water (especially WVO).

Deacidification of WVO recommended.

WVO must be pre-filtered.

## Filtering (engine fuel system)

To 10 microns, preferably 5 microns or even lower.

Oil should be filtered to the specifications for the injection pump. Additional coarser, upstream filters recommended, final filter should be the same rating as original equipment.

## Injection temperature of SVO

For IDI engines, the oil should be pre-heated to 70-80 deg C (160-180 deg F).

Research indicates that DI engines require much higher injection temperatures for efficient fuel atomization, but higher temperatures cause other problems. DI engines are being run with SVO systems, but it's a less favored option than IDI engines.

### **Maintenance**

Injector inspection and cleaning if indicated.

Head removal, combustion chamber cleaning if indicated.

Lube oil sampling.

Check/change fuel filters often, especially in cold weather -- vacuum gauges can warn when filters are plugging.

### **Start-stop fuel**

Biodiesel or petro-diesel (high-quality). The solvent properties of biodiesel and of premium petro-diesel fuels help to remove any deposits that may form. See: Fuel Quality

<http://www.dieselpage.com/art0599fq.htm>

Lubricity benefits

[http://www.biodiesel.org/pdf\\_files/Lubricity.PDF](http://www.biodiesel.org/pdf_files/Lubricity.PDF)

### **Frequency of start-stop cycle**

Fewer is probably better, especially in cold weather, eg.:

Genset +

Taxi -

### **Load**

Full load operation +

Idling -

### **Method**

Two-tank system, start-stop on petro-diesel or biodiesel, with pre-heating of SVO + +

Single tank with SVO heating +

(for IDI genset, this may be okay, since very low number of start-stop cycles and high loads)

Unheated SVO -

## **SVO systems**

Apart from the Elsbett system (below), the best systems use **two tanks**, one for SVO and one for diesel or biodiesel. Start up the engine on biodiesel/diesel from one tank while the SVO in the other tank is heated to at least 70 deg C (160 deg F) using the engine coolant and/or electric heating. Once it's warm enough, switch the fuel supply to the SVO tank -- and then back to biodiesel/diesel several minutes before shutting down. This flushes out the fuel system and prevents cooling SVO from clogging the injectors and filters. Extra upstream filters should be included.

**Elsbett**, Germany -- Full conversion to running a diesel car on pure vegetable oil -- includes new injectors, glowplugs, heat exchangers, everything required. This is the truly professional system, but it's not cheap. Warranty limited to SVO, excludes WVO, but not limited to rapeseed oil.

<http://www.elsbett.de/>

Also exports do-it-yourself "tuning kits", on application:

submit a form online for feasibility, prices, etc.

<http://elsbett.com/emotanfr.htm>



**BioCar** -- "The mother of all D-I-Y kits for vegetable oil and fat in unmodified diesel

engines." Advanced dual-tank straight vegetable oil system from G. Lohmann in Munich, Germany. The patented "BioCar" computerized controller monitors and controls fuel flows and temperatures, allows use of veg-oil with the newest injection pumps, adding petro- or biodiesel before the injection pump to adjust the viscosity. Can be installed by any handiman who "can solder and read". See "List of the motor vehicle types already converted". German-language site with on-site Babelfish/Systrans translation to English and other languages. Not a cheap system.

<http://www.biocar.de/home.htm>



The BioCar computer



**Neoteric Biofuels Inc.** in British Columbia, Canada -- Neoteric's G3 SVO Systems are complete two-tank systems with a range of options, starting at US\$299, or \$199 without the plastic tank, which you can easily supply yourself. Also, inline G3 VEG-Therm vegoil heaters (12-volt, self-regulating), tank heaters, vegoil pumps, canola-based lubricants, KOMET oil presses, workshop filters and transfer pumps, and more.

<http://www.biofuels.ca/>

**Greasel** conversion kit --

"Ready-to-install kit that will allow you to run any diesel on waste vegetable oil. The key to running a diesel on vegetable oil is heat. This is done by a special tank and fuel line, heated with the hot coolant your engine is already producing." From \$365, popular system.

<http://www.greasel.com/>

Also from China Depot:

<http://www.chinadepot.com/>

[greasel1.html](http://greasel1.html)



**Diesel-Therm** (German pages with English version) -- ATG, Innovative Products and Solutions for Diesel Vehicles and Motors, Vegetable Oil-Kit, Converting Diesel-Operating Vehicles to Vegetable Oil. (SVO heating only. Lines and tank are not heated.)

<http://www.diesel-therm.com/veggie-kit.htm>

From **TäbyPressen** in Sweden: "Drive your diesel-engine with warm raw straight vegetable rape-oil" -- Skeppsta Maskin AB veg-conversion, veg-tuning -- dual-tank system with thermostat-controlled electric valve to switch to veg-oil after start-up and back to diesel on shut-down. Electric SVO heating, extra fuel

filters, etc. Also small-scale oil-presses, information on using SVO, online forum and links to other forums and resources (some in English).

[http://www.oilpress.com/drive\\_your\\_diesel.htm](http://www.oilpress.com/drive_your_diesel.htm)

The book "**From the Fryer to the Fuel Tank**" by Joshua Tickell has how-to details on a basic SVO system. No need for a custom-made stainless steel tank though. Coolant-heating only.

<http://www.veggievan.org/book/>

**Grease Car** -- Dual-tank system with coolant heating, no electric heating, claims suitable for WVO use in any climate.

<http://www.greasecar.com/>

<http://www.greasecar.com/products.cfm>

### [Fuel heaters, filters](#)

**Vegoil-diesel** mailing list discussion group:

Subscribe: [vegoil-diesel-subscribe@yahoo.com](mailto:vegoil-diesel-subscribe@yahoo.com)

Unsubscribe: [vegoil-diesel-unsubscribe@yahoo.com](mailto:vegoil-diesel-unsubscribe@yahoo.com)

Post message: [vegoil-diesel@yahoo.com](mailto:vegoil-diesel@yahoo.com)

List URL: <http://groups.yahoo.com/group/vegoil-diesel>

**Veg-Oil-Car.com** web forum for discussion of the advantages and disadvantages of running your car on vegetable oil.

<http://pub41.bravenet.com/forum/show.php?>

[usernum=3470269378&cpv=1](http://pub41.bravenet.com/forum/show.php?usernum=3470269378&cpv=1)

## References

Report of the **European Advanced Combustion Research for Energy from Vegetable Oils** (ACREVO) study of the use of straight vegetable oil as diesel fuel.

Investigates the burning characteristics of vegetable oil droplets from experiments conducted under high pressure and high temperature conditions. Very interesting study, worth a thorough read (4,400 words).

<http://www.nf-2000.org/secure/Fair/F484.htm>

**"Renewable Oil Fuels and Diesel Engines As Components of Sustainable System Design"** by Ed Beggs of Neoteric Biofuels -- "Are renewable oils, as fuels in unmodified compression ignition engines, a technically and economically feasible component of sustainable system design, in both developing and developed countries?" --

196-page Master's degree thesis, 1Mb Acrobat file:

<http://members.shaw.ca/biofuels/ebeggsthesis.pdf>

**"Technical Overview of Vegetable Oil as a Transportation Fuel"**, 1991, Charles L. Peterson and Dick L. Auld, Department of Agricultural Engineering, University of Idaho -- see section concerning Fuels, South Africa, indirect injection engines: Fuels, J., Hawkins, C.S. and Hugo, F.J.C., 1984, "Tractor Engine Performance on Sunflower Oil Fuel," Journal of Agricultural Engineering Research 30:29-35. Download (Acrobat file, 2152kb):

<http://www.biodiesel.org/resources/>

[reportsdatabase/reports/gen/gen-292.pdf](http://www.biodiesel.org/resources/reportsdatabase/reports/gen/gen-292.pdf)

**"Waste Vegetable Oil as a Diesel Replacement Fuel"** -- Informative 6,500 article by Phillip Calais, Environmental Science, Murdoch University, Perth, Australia,

[pcalais@ieee.org](mailto:pcalais@ieee.org), and AR (Tony) Clark, Western Australian Renewable Fuels Association

Inc, [ar.clark@bigpond.com](mailto:ar.clark@bigpond.com):

<http://www.shortcircuit.com.au/warfa/paper/paper.htm>

**"Waste Vegetable Oil Conversion of Mazda 1990 2.0L diesel station wagon"**, by Tony Clark:

<http://www.shortcircuit.com.au/warfa/WVOMazdaDiesel.htm>

Pictures of the Mazda conversion:

<http://www.shortcircuit.com.au/warfa/warfaPictures.htm>

**"Biodiesel: The Use of Vegetable Oils and Their Derivatives as Alternative Diesel Fuels"**, G. Knothe, R.O. Dunn, and M.O. Bagby, in *Fuels and Chemicals from Biomass*. Washington, D.C.: American Chemical Society.

<http://www.oup-usa.org/j778/isbn/0841235082.html>

Download full-text article (Acrobat file, 901kb):

<http://www.biodiesel.org/resources/reportsdatabase/reports/gen/gen-162.pdf>

**"Operation of a Diesel Engine Using Unrefined Rapeseed Oil as Fuel"**, Chiyuki Togashi, Department of Agricultural Engineering, Miyagi Agricultural College, and Jun-ichi Kamide, Faculty of Agriculture, Yamagata University, Japan. Report of tests with unrefined rapeseed oil in a small diesel engine on short-term performance, long-term operation and no-load continuous operation using deacidified oil, degummed oil and crude oil.

<http://ss.jircas.affrc.go.jp/engpage/jarq/33-2/Togashi/togashi.html>

**"Results of engine and vehicle testing of semi-refined rapeseed oil"**, Kevin P. McDonnell, Shane M. Ward & Paul B. McNulty, University College Dublin, Dept of Agricultural & Food Engineering, Dublin, Ireland.

<http://www.regional.org.au/au/gcirc/6/214.htm>

General information: **"Vegetable oil instead of diesel -- an alternative fuel?"**

<http://people.freenet.de/sthl/poel/vegoil.htm>

Using vegetable oil as a substitute for diesel fuel -- extensive **FAQ**

<http://people.freenet.de/sthl/poel/VegFAQ.htm>

There's a helpful **FAQ** at the **Neoteric Biofuels Inc** website:

<http://members.shaw.ca/biofuels/faq.html>

John Nicholson's **Bio-power UK** in North Wales -- good information on SVO use, informative, cautious but encouraging. "The fact is that this is an unknown territory. We need to test the use of SVO in all kinds of vehicles, but to do so cautiously, and not fool-hardily... We need to know which diesel engines work well on straight fat." Can I burn straight vegetable fat in my diesel engine? How can I know if my engine will run on Straight Vegetable Oil? If my engine runs on SVO, then can I burn WVO? How to make your own heat exchanger.

<http://www.northwales.org.uk/bio-power/svo.htm>

Using jatropha oil as fuel -- a selection of interesting papers at the **Jatropha Website**, along with lots of other material on the uses and benefits of the wonderful *Jatropha curcas* tree. See "Literature":

<http://www.jatropha.org/>

**Honge Oil** as diesel fuel in India

<http://www.goodnewsindia.com/Pages/content/discovery/honge.html>

## **SVO vs biodiesel in Europe**

Much of the work with SVO as a fuel has been done in Northern Europe, and there's much valuable information to be found there. But (again!) -- in a word, beware. A lot of Northern

Europeans simply chuck it in and go -- no dual-tank systems, no modifications at all, and they claim high mileages with no trouble.

Maybe so, but note the provisos listed above. And also be aware that they generally don't use waste vegetable oil, it's usually new, virgin oil, most often rapeseed oil, one of the best oils for fuel use.

Also, there's quite a lot of mis- or disinformation, especially about SVO vs biodiesel.

A Northern European gent sent a message to the [Biofuels mailing list](#) which caused widespread derision and amusement, and some anger. He was pushing the use of "pure plant oils", but ignored all the caveats on using SVO, and added some serious nonsense about biodiesel to strengthen his case for pure plant oils:

"Biodiesel is a chemically altered plant oil. However the process to chemically change the structure of Pure Plant Oil is a very costly operation and requires a lot of energy, as it removes the glycerine substituting it by methanol as well as adding other chemicals, making the end-product poisonous and equally hazardous as fossil diesel fuel."

He was referred to the comprehensive, much corroborated tests in the US that found that biodiesel is "less toxic than table salt, more biodegradable than sugar", to the U.S. Department of Energy study at the University of California at Davis, which found a 93.6% lower risk of cancer from biodiesel emissions than from petro-diesel, to life-cycle and economic studies of biodiesel production that found the opposite of his cost and energy claims, and to [this picture](#) at our website.

Asked to support his claims, he descended into accusation and denial, and then unsubscribed from the list.

Such stories of the alleged horrors of biodiesel are not uncommon in Northern Europe, especially on websites promoting SVO. It seems partly to stem from an apparent misclassification of water pollution standards in Germany, where the risk from rapeseed oil is not even classified, whereas biodiesel is a class 1 hazard, and fossil diesel is in class 2 (worse). It only refers to water pollution and no other aspects of toxicity or hazard.

Some would argue that a biodiesel spill would be less of a problem than a spill of vegetable oil, which coats everything, like fossil oil does. In fact biodiesel is used to clean up marine oil spills. In North America it is not classed as hazardous goods.

You'll encounter a few such yarns being spun at the European sites listed below. Here's another one:

"Biodiesel is chemically produced and substantially more expensive than vegetable oil. Except for a few new vehicles, most are not suited for using biodiesel. The majority of diesel vehicles must first be converted, in order to guarantee they will operate on biodiesel. The problem is the durability of the plastic and rubber components, which come into contact with the fuel. If biodiesel is used in a system that has not been adapted, the fuel can leak from places where it frequently backs up, which weakens and dissolves the fuel system's components. When using pure, untreated vegetable oil, these problems will not occur." -- From Diesel-Therm.

<http://www.diesel-therm.com/>

The introduction of low-sulphur diesel fuel in Europe about 10 years ago caused severe problems for fuel systems and all manufacturers hastened to correct it, which also made the



vehicles safe for biodiesel. In effect, no European cars made in the last 10 years have fuel-system parts that are susceptible to rot from biodiesel use. Also, all French diesel fuel now contains 2-5% biodiesel (partly to make up for the lack of lubricity in low-sulphur diesel fuel), and European diesel cars can and do use it safely, as with Japanese diesels. See: **Stanadyne White Paper on diesel fuel** -- "Low-Sulfur Diesel Fuel Requires Additives to Preserve Fuel Lubricity":

<http://fiss.com/rm/firm0015.htm>

If you're in any doubt, check the resources linked from our [Biodiesel resources on the Web](#) page, and make up your own mind.

## European SVO resources

Some of these sites are also listed above under "SVO systems" or "References". Many European sites have English versions. Or use these translation sites:

**AltaVista** -- World / Translate

<http://babel.altavista.com/>

**Google** Language Tools

[http://www.google.com/language\\_tools](http://www.google.com/language_tools)



Report of the **European Advanced Combustion Research for Energy from Vegetable Oils** (ACREVO) study of the use of straight vegetable oil as diesel fuel.

Investigates the burning characteristics of vegetable oil droplets from experiments conducted under high pressure and high temperature conditions. Excellent study, worth a thorough read (4,400 words).

<http://www.nf-2000.org/secure/Fair/F484.htm>

**Elsbett**, Germany -- Full conversion to running a diesel car on pure vegetable oil, dedicated system -- includes new injectors, glowplugs, heat exchangers, everything required. Not at all cheap. Warranty limited to SVO, excludes WVO, but not limited to rapeseed oil.

<http://www.elsbett.de/>

Also exports do-it-yourself "tuning kits", on application: submit a form online for feasibility, prices, etc.

<http://elsbett.com/emotanfr.htm>

**BioCar** -- "The mother of all D-I-Y kits for vegetable oil and fat in unmodified diesel engines." Advanced dual-tank straight vegetable oil system from G. Lohmann in Munich, Germany. The patented "BioCar" computerized controller monitors and controls fuel flows and temperatures, allows use of veg-oil with the newest injection pumps, adding petro- or biodiesel before the injection pump to adjust the viscosity. Can be installed by any handiman who "can solder and read". See "List of the motor vehicle types already converted". German-language site with on-site Babelfish/Systrans translation to English and other languages. Not a cheap system.

<http://www.biocar.de/home.htm>

**TäbyPressen**, a Swedish company making small-scale oil-presses, has much information on SVO, online forum and links to other forums and resources (some in English). Also supplies Skeppsta Maskin AB veg-conversion kits.

<http://www.oilpress.com/index.html>

General information: "**Vegetable oil instead of diesel -- an alternative fuel?**"

<http://people.freenet.de/sthl/poel/vegoil.htm>

Using vegetable oil as a substitute for diesel fuel -- extensive **FAQ**

<http://people.freenet.de/sthl/poel/VegFAQ.htm>

Finland: 1,800 hours and seven years on mustard oil in a farm tractor:

<http://personal.inet.fi/yritys/ekolaiho/mustarddiesel.html>

**Diesel-Therm** (German pages with English version) -- ATG -- Innovative Products and Solutions for Diesel Vehicles and Motors -- also supplies Vegetable Oil-Kit SVO system:

<http://www.diesel-therm.com/>

Datenbank des Forums '**Fahren mit Salatöl**' (Database of the forum 'driving with salad oil') -- This German database has information on more than 300 cars using veg-oil.

<http://www.poeltech.de/database/>

**Folkecenter for Renewable Energy**, Denmark -- Plant oil technology -- modification of standard diesel engines: Running cars on pure plant oil

[http://www.folkecenter.dk/plant-oil/plant-oil\\_en.htm](http://www.folkecenter.dk/plant-oil/plant-oil_en.htm)

**Ökologisch ohne Ökosteuer** (German page with English version) -- "I drove with pure salad oil for the next 12,000km... I didn't make any changes on my car at all. I'm driving, driving and driving... for already 146,000km."

<http://www.rerorust.de/>

<http://valenergol.free.fr/>

<http://www.pro-ev.de/>

<http://www.fnr.de/>

<http://www.pflanzenoelinitiative.de/>

<http://www.bioenergie.inaro.de/>

## **Diesel information**

**How Diesel Engines Work**

<http://www.howstuffworks.com/diesel.htm>

**Diesel Engines** (Chevron)

[http://www.chevron.com/prodserv/fuels/bulletin/diesel/L2\\_6\\_fs.htm](http://www.chevron.com/prodserv/fuels/bulletin/diesel/L2_6_fs.htm)

**Diesel Fuels -- Technical Review** (Chevron)

[http://www.chevron.com/prodserv/fuels/bulletin/diesel/L1\\_toc\\_fs.htm](http://www.chevron.com/prodserv/fuels/bulletin/diesel/L1_toc_fs.htm)

**All About Diesel Fuels** -- Lubrizol Corporation

<http://www.lubrizol.com/ReadyReference/GasolineDieselFuels/default.htm>

**So, This is Your First Diesel**

<http://www.dieselpage.com/art1110fd.htm>

**Breaking in a Diesel Engine**

<http://www.ford-diesel.com/contents/getitems.php3?Breaking>

[%20in%20a%20Diesel%20Engine](#)

### **Diesel Injection Systems**

<http://www.dieselpage.com/art1110ds.htm>

### **Bosch -- Past, Present and the Future**

<http://www.dieselpage.com/art0898pf.htm>

### **20 Questions with Racor**

<http://www.dieselpage.com/art1021ra.htm>

### **20 Questions with Stanadyne**

<http://www.dieselpage.com/art0898sg.htm>

### **Robert Bosch** type VE Diesel injection pump -- how it works, illustrations

<http://www.cs.rochester.edu/u/jag/vw/engine/fi/injpump.html>

## **Fats and oils**

[The Fats and Oils: a General View](#), by Carl L. Alsberg and Alonzo E. Taylor, 1928, Food Research Institute, Stanford University, California

First in a series of five Fats and Oils Studies published in the 1920s by the Food Research Institute. Good overview of the subject written in layman's terms, covers nature and sources of fats and oils, properties, technology, production, international trade and more. Not very much has changed since then, it's just grown more complex. A clear and informative guide -- useful information for anyone making biodiesel or working with SVO. Full text online at the Biofuels Library.

**Oils -- King's American Dispensatory**, by Harvey Wickes Felton, M.D., and John Uri Lloyd, Phr. M., Ph. D., 1898

<http://www.ibiblio.org/herbmed/eclectic/kings/olea.html>

### **Chemical Reactions of Oil, Fat and Fat Based Products**

<http://alfa.ist.utl.pt/~fidel/creac/reac.html>

**Food Fats and Oils** (1994) -- online book (Acrobat file):

<http://www.iseo.org/foodfatsoils.pdf>

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