

**THE USE OF RE-REFINED OILS
IN
HEAVY DUTY DIESEL CRANKCASE
LUBRICANTS**

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NZ

Presented to the
Institute of Road Transport Engineers of New Zealand

FOURTH INTERNATIONAL HEAVY VEHICLE SEMINAR

AUCKLAND

3 - 5 March 1992

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The use of Re-refined Oils in Heavy Duty Diesel Crankcase Lubricants.

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Subject theme: Recycled lubricants - all round winners.

For the Fourth International Heavy Vehicle Seminar the conference theme is Efficiency, Safety and the Environment. Usually when one thinks of the environment it is often the negative aspects, of environmental pollution, that spring to mind.

When it comes to matters of pollution, the transport industry is under public pressure, that affects all members of society, to reduce its impact on the environment.

Although a great deal of work in the transport industry is going into areas such as air and noise pollution, an area that is of particular concern to my company is pollution caused by waste oil. We all know of oil pollution overseas - the oil spill in Alaska from the Exxon Valdez is a dramatic example - but how relevant is that in New Zealand?

Well, to put things into perspective, in New Zealand this year, the total consumption of lubricating oil will be more than 70 million litres.

About 30 million litres of that is not recoverable. It is burnt off in vehicles or lost as leaks or is used as process oils in various manufacturing operations.

That leaves 40 million litres able to be captured for re-use. So what is happening to it now?

Some of it is collected and recycled.

The oil re-refining industry in New Zealand consists of Dominion Oil Refining in Onehunga, Auckland and two other very much smaller plants in Thames and Dunedin. There are a further two non-operational plants in Wellington and Christchurch. All together, the three working plants process about 10 million litres of waste oil.

That leaves 30 million litres of waste oil unaccounted for - almost as much as that lost from the Exxon Valdez!

Although this oil is unaccounted for we do know where it is going. It is being poured down drains and dumped in landfills. It is also burnt off causing air pollution. It is being sprayed on some country and private roads to control dust. And finally it is just being left on the ground.

All of this points to an environmental time bomb that may impact on the quality of our water supplies, for example, and this could affect everyone in this country.

Over dramatising - I think not! If a major used oil pollution incident occurs someone will have to pay to clean it up, be it central government, local authority or private industry with the prospect of increased regulation, administration, cost overheads, rates and taxes.

So what are the options?

Many studies have been done both here and overseas and the conclusions are simple - recycling offers the best alternative. Burning waste oil in other than specially controlled high temperature incinerators leads to air and residue pollution problems. Burning also wastes a

non-renewable resource and is not considered an environmentally sound long term solution. Small stand-alone heaters, burners and pot belly stoves are unacceptable and are banned in more enlightened countries.

Generally everyone supports recycling - I've yet to hear anyone argue against recycling per se - but when it comes to re-refined and recycled oils many operators prefer virgin grades in the mistaken belief that re-refined equates to second best.

But how good are re-refined oils?

They can be very good - or not so good - it depends on how they are processed.

Modern lubricants are able to provide outstanding protection against wear and significantly extended drain intervals, compared to their counter parts of even 10 years ago, by a combination of hydrodynamic (oil film) lubrication and specialised chemical additive technology. So the oil has two functions - a liquid lubricant and carrier of additive systems.

Yet most oil molecules are very stable. They don't change as the oil is used. When a lubricant reaches the end of its service life it is because the oil is contaminated with water, sludge, dirt, oxidation by-products and the additives are used up. Obviously all one has to do is separate the good oil molecules from the contaminants, blend in a new additive system and start again. The following table shows the typical composition of waste oil collected in New Zealand. See Attachment I (Used Oil Sample analysis ex Dominion Oil Waste Holding tanks).

Obviously, used oil is a rich source of base oil provided it is suitably processed. Over the years processing techniques have varied from simple centrifuging (of 30 years ago) to sophisticated multistage wiped-film high vacuum distillation systems.

The questions of quality and performance standards can be understood in terms of processing techniques and modern oil requirements.

With older processing techniques such as centrifugation, and acid-clay leaching and filtering the used oil is treated in a batch. No two batches are ever the same. Consequently the physical parameters of the re-refining base oil produced are determined by the components in the used oil. This leads to variations in basic characteristics such as viscosity, volatility, pour point and viscosity index of the re-refined base oil, i.e. centrifuging or acid-clay leaching removes contaminants and leaves a single grade of oil which is a mixture of all the virgin oil components that went into the original virgin grades. The re-refiner's ability to blend 'new' lubricants based on the above re-refined base stock will be limited by the viscosity of the oil produced in each batch.

Organisations such as Mercedes-Benz and bodies such as the U.S. Military - Lubricants Review Board - will accept and register lubricants blended from re-refined base oils if they meet their quality and performance criteria. The key concerns of most organisations are:

1. Consistency of product quality and parameters.
2. Assessment of any health risks associated with the re-refined oil.
3. Demonstration of technical lubricant performance.

1. In New Zealand BP has been able to demonstrate consistency of quality, of re-refined oils, with such measures as Telarc Registration and Accreditation to ISO 9002 international quality standard. These are registered standards that ensure the quality and consistency of product. Both of these standards have been gained with product portfolios that incorporate the use and production of re-refined lubricants.
2. The oil industry worldwide have set very high standards for the health and environmental effects of their products and have an extensive and on going commitment to research in these areas.

Crude petroleum contains a wide variety of components some of which can be harmful on prolonged exposure. Modern refining processes such as the severe solvent refining of virgin oils are capable of reducing these components to levels representing very low levels of risk.

Used oils like wise contain some trace components, notably lead, chromium, fuel residues and additive breakdown products all of which can be totally removed in the re-refining process. A class of compound which is only partially removed by re-refining are the polynuclear aromatic hydrocarbons (PAH), sometimes referred to PCA's. These compounds exist in low (ppm) levels in virgin oil and diesel but are chemically altered during the combustion process to give rise to components that are more readily detected than their original form.

DOR base oils have not only been analysed chemically for total PCA content and composition by individual PAH's but have also been tested to and passed stringent biological screening tests as a further check on their safe use.

Interestingly, it has been found that used diesel engine oils have much lower levels of the more active PAH components than do used petrol engine oils.

As a final note on health risks associated with skin contact there are no proven cases of skin cancer arising from prolonged skin contact with modern virgin or re-refined engine oils. There is a finite risk but this is very low. It is in fact much higher for contact with used oil from all sources than with either unused virgin or re-refined oil.

3. The demonstration of technical lubricant performance for DOR Base oils has been through a variety of testing and accreditation procedures. DOR base oils are accepted by Daimler Benz of Germany, one heavy duty diesel grade made from DOR base oil is listed in their international service blue book.

During the development of a high performance engine oil grade, recently released in New Zealand, samples of DOR grades were tested and assessed by a leading lubricant development company. Their results, below, show that in all respects the re-refined grade is comparable to its virgin counter part. See Attachment II (Comparison of Base Oils) and Attachment III (Comparison of fully formulated motor oils).

With regard to lubrication performance and reliability our experience has shown that lubricant failure, for either virgin or re-refined oils, is most likely to occur when the engine builders' oil change period recommendations are exceeded.

BP and Dominion have ongoing test programmes for their re-refined base grades. In today's quality conscious commercial market place it is only by manufacturing quality products from re-refined base oils and using them that we will succeed in providing New Zealand with a viable recycling system to protect the environment against used oil.

So to conclude, what does a re-refined lubricant offer the oil user, the transport operator who requires a competitively priced, quality product meeting the necessary performance levels?

Two things.

Because of negative purchasing attitudes towards re-refined oils, equivalent performance grades tend to be discounted in relation to their virgin counterparts to overcome unfounded buyer resistance. Put simply, re-refined oils offer cost competitive performance advantages.

Purchasing re-refined lubricants means closing the recycling loop - If we can't sell it then we can't collect it and then real problems will arise. In Victoria, Australia, an advisory committee to the state government has proposed a significant surcharge on all oil products, that would be refunded on return of the used oil for recycling or some other approved disposal. Although it may be an accountant's dream it sounds like an administration nightmare. Fortunately this is still being debated but the message is clear; in todays society the attitude is that the polluter

must pay. The oil industry is aware that, under the concept of cradle to grave responsibility, we must be pro-active in putting in place systems that do not cause pollution or control it at the source. That is why we believe the recycling initiatives, promoted by BP and Dominion Oil, deserve to be given active support.

Today's environmentally conscious consumer is influenced and motivated by actions that support and improve the environment. The success of unleaded fuel and non-ozone depleting aerosols are but two examples of how being environmentally responsive is also good business. Use of re-refined lubricants should become a sales tool and a part of any business manager's marketing package.

BP and Dominion Oil have many years' experience with both virgin and re-refined lubricants. Although there will always be a need for virgin oils it is undeniable that re-refined lubricants will grow in use. The smart operators are the ones using them today.

So using re-refined recycled quality lubricants is a win - win situation, it's good for business and it's good for the environment.

ATTACHMENT I

ANALYSIS OF TYPICAL USED OIL SAMPLE EX - DOR WASTE OIL HOLDING TANKS.

Density	0.899	Kg/l
Viscosity 40 °C	77.8	cSt
Fuel, Volatiles	9.3	%
Water Content	8.2	%
Lead	4800	ppm
Particulate Metals	2320	ppm
Insolubles (Dirt)	4.13	%
Oil component	78.37	%

It should be noted from the above figures that:

1. The water content is usually quite high. This water is most often bound up in sludge and highlights how water condensation in an engine is a potential trigger for rust.
2. Lead levels typically found in New Zealand used oil are often very high (can be up to 2%). This is one of the reasons that BP does not support burning of used oil in small heaters and light commercial burners. The insolubles or dirt will also contain fuel combustion by-products which can only be destroyed by specialist high temperature furnaces. Improper combustion of these materials can generate very toxic substances and pose severe health risks, ie dioxins.
3. Particulate metals and insolubles measures the amount of buildup of wear residues, spent additives and dirt in the oil.
4. The oil component gives an indication of the potential amount of base oil that could be extracted under ideal conditions. Oil soluble components are also included in this figure. Acid-clay re-refining typically yields 60 - 65% oil. DOR typically achieve yields of 70% plus with their modern wiped film vacuum distillation plant.

The composition of crudes from different sources varies tremendously, but a typical make-up may be as follows:-

FRACTIONS

Gases	5 %
Gasoline	35 %
Kerosine	10 %
Diesel	20 %
Lube oil	2 %
Wax	5 %
Tar, Bitumen	23 %

ATTACHMENT II

COMPARATIVE ANALYSIS:- Dominion Oil Refinery DOR BG 180 re-refined base oil compared with a matching BP virgin grade.

	DOR BG 180 Re-refined	BP 150N/500N Virgin
Specific Gravity	0.89	0.89
Kinematic Viscosity 100 °C	6.51	6.53
Kinematic Viscosity 40 °C	44.15	44.52
% Paraffinics & Naphthenics	77.4	76.7
% Aromatics	17.9	18.0
% Olefins & Polars	4.9	2.3
Volatility by ASTM D2887 (°C at 15%)	371	415
% Sulphur	0.66	0.8
Thermal stability screen test *	7.5	6.3
Oxidation screen test	Good	Good

* Ranking:- 0 = poorest, 7.5 = Best possible.

The key points to note are that:

1. The DOR base grade manufactured to the 180 specification is comparable in all key physical characteristics to its virgin counterpart. Specific gravities are identical. The rate of change in viscosity with temperature is also nearly identical (this is a critical control parameter when making an engine oil - ie the performance of an oil when it is hot)
2. The chemical composition compares the relative proportion of each chemical family of oil molecule in the two mixes. There are no significant differences between the two oils.
3. Volatility rates the potential of an oil to evaporate which is one of the mechanisms relating to oil burning. Again the two base oils are similar although the DOR BG does have a very slightly higher potential to evaporate.
4. The sulphur content gives a rough indication of refining purity. The less stable sulphur containing molecules can break down in engines and release sulphuric acid which can cause corrosion. Not only does the DOR BG have marginally lower sulphur than the virgin BG but, more importantly, only very stable sulphur containing molecules remain in re-refined oils.
5. The thermal stability and oxidation screen tests determine how resistant the oil is to high temperature break-down typical of conditions found in highly stressed diesel engines. The DOR BG scored the maximum possible rating and exceeds the virgin BG which confirms the statement on stability of sulphur compounds in 4. above.

ATTACHMENT III

COMPARATIVE ANALYSIS:- Re-refined motor oil compared with the equivalent virgin motor oil.

	DOR BG 180 Motor Oil	Virgin motor oil
Cold cranking simulator (CCS) @ -15 °C (1)	3310 cP	3300 cP
Viscosity @ 100 °C (2)	17.26 cSt	17.38 cSt
Volatility, loss % @ 700 °C ASTM D2887	6.7	1.0
Volatility loss % NOACK (3)	10.2	Not available

- (1) The SAE current engine oil standard (J-300 June 1987) defines a SAE 15W engine oil as having a viscosity maximum of 3500 cP at -15 °C. This means that both the re-refined and virgin oils are true SAE 15W and of comparable performance.
- (2) The SAE(J-300 June 1987) defines a SAE 50 engine oil as having a viscosity of between 16.3 and 21.9 cSt at 100 °C. This means that both the re-refined and virgin engine oils are true SAE 50 grades.
- (3) Evaporative loss maximum percent limits for 15W/ engine oils as defined by the following specifications:-

CCMC G4	NOACK	13%
VW 501.01	NOACK	15%
VW 500.00	NOACK	13%
MIL-L-46152 E	NOACK	15%
	or D2887	15%
FORD	NOACK	15%
	or D2887	15%

Even though the DOR BG 180 has poorer volatility performance figures than its virgin equivalent, the finished blended oil comfortably exceeds all major engine builders volatility limits, ie this re-refined base oil will **NOT** cause excessive oil burning.

LOCAL ISSUES - ENVIRONMENTAL (D.O.R.)

