Winchester Global Pty Ltd

COURSE SUBJECT

FINER FILTRATION FOR OIL & FUEL

INTRODUCTION

During this course we will supply basic information on the following;

- **The background of oil**
- **Properties of oil**
- **Oil additives**
- **Reasons for oil changes & Oil analysis**
- **Standard spin-on filters v ProtxL bypass oil filtration**
- **Other filter products in the marketplace**
- **Bypass filtration for plant and equipment**
- **Fuels for diesel engines**
- **Properties of diesel fuels**
- **Standard spin-on filters v ProtxL full flow fuel filter**
- **Service procedures for ProtxL oil and fuel filters**

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AIMS OF THE COURSE

With your participation, it is our aim by the end of this course that you will have a basic understanding of the following;

- **About oil and its properties**
- **The additives in oil and their functions**
- **The information about Bypass Filtration**
- **The difference between standard full flow spin-on filters and controlled bypass filters on fixed and mobile mining equipment**
- **Some of the other types of filters in the market place.**
- **You will be informed about diesel fuel and its properties**
- **The correct servicing procedure for the bypass oil filter and the full flow fuel filter.**

The background of oil

Oil is perhaps one of the oldest natural non-renewable resources believed to come from the decomposing bodies of marine life and vegetation with dead carcasses of dinosaurs mixed in it. These deposits, millions of years ago, were subjected to intense concentrations of heat and pressure, and were formed into crude oil.

Lubricants have been around for many centuries, In Roman times they used animal fats and pig lard to grease their chariot axles while the Egyptians used tallow and lime on their axles and to move large objects. The Eskimos used whale oil to grease the rails on their sleds to improve the movement over the ice.

Colonel Edwin. L. Drake on the 27th of August 1859 in a small town in Pennsylvania demonstrated that oil could be released from the earth by drilling, and that has had a lasting effect on the living standards of all developed Countries in the World.

The crude oil can be coloured from yellow through to green and black. Some have a high sulphur content this is called “sour crude” while others have a low sulphur content and that is called “sweet crude”. Both are pumped from under the ground or seabed and transferred through pipes into tankers that move the crude in large quantities to a refinery.

The early refinery was a simple process. The oil was boiled and from distilling the vapors they were able to get kerosene and gasoline. There was no commercial use for the gasoline at the time so it was dumped.

The modern refinery refines the crude that undergoes a number of processes to produce a number of different products. The crude oil is placed in a large tall hollow cylinder and is heated. The cooling off of the vapour at different stages up the tower gives us the various products. The first is furnace fuel followed by diesel oils, jet fuel and kerosene,

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then we have motor spirit and aviation gasoline and at the top are the gases that are used in the manufacture of synthetic oil. At the bottom of the cylinder under the intake bitumen is formed.

Chemists use advanced technology to enable them to change the structure of the crude oil molecule, thereby obtaining more products such as petrol, oils, fuels, bitumen, asphalt, soaps, LPG, solvents used in paints and chemicals, motor spirit, power kerosene and lighting kerosene. These products today are called Petrochemicals.

Environmental damage caused by the dumping of waste oil was costing Australia millions of dollars. One of the real threats was to our drinking water. **As little as five litres of waste engine oil will contaminate a water surface of four square kilometers.**

Properties of oil

The make up of a satisfactory oil must have the correct viscosity and must resist oxidation, carbon formation, corrosion, rust, extreme pressure and foaming. It also must have good cleaning agents and be able to pour at low temperatures and have good viscosity at extremes of high and low temperature. A number of additives are put into mineral oil, during the manufacturing process because, by itself, it does not have all these properties.

As stated by May E (1991) Diesel Mechanics McGraw-Hill Roseville NSW
"Viscosity is a most important characteristic of lubricating oil. Viscosity refers to the tendency of oil to resist flowing. Viscosity may be divided for the purpose of discussion into two parts, "body" and "fluidity".

Body refers to the resistance to oil-film puncture, or penetration, during the application of large loads. When the power stroke begins, for example, bearing loads sharply increase. Oil body prevents the load from squeezing out the film of oil between the journal and the bearing. This property cushions shock loads, helps maintain a good seal between piston rings and cylinder walls, and maintains an adequate oil film on all bearing surfaces under load.

Fluidity has to do with the ease with which the oil flows through oil lines and spreads over bearing surfaces. In some respects, fluidity and body have opposing characteristics, since the more fluid the oil is, the less body it has. The oil used in any particular engine must have sufficient body to perform as explained in the previous paragraph and yet, must have sufficient fluidity to flow freely through all oil lines and spread effectively over all bearing surfaces.

Temperature influences viscosity. Increasing temperature reduces viscosity and decreasing temperature causes oil viscosity to increase. Since engine temperatures range considerably, from cold-weather starting to operating temperature, lubricating oil must have adequate fluidity at low temperatures so that it will flow. At the same time, it must have sufficient body for high-temperature operation

Oil additives

Although there has been a shift in attitude towards additives in oils in recent years there is still a lot misinformation in the work place. Many think of additives as chemical tonics used to treat an ailing engine, and few realize that additives play the major role in virtually every lubricant used today.

There are many different types of additives and each one of them has a different function. We will look at each one in turn.

- **Viscosity index improvers**
- **Anti wear agents**
- **Rust inhibitors**
- **Demulsifiers & emulsifiers**
- **Anti oxidants**
- **Anti foam agents**
- **Metal de-activators**
- **Pour point depressants**

Viscosity index improvers

When oil is cold it is thicker and runs more slowly than when it is hot. Some oils change viscosity a great deal with temperature change. In order to have an accurate measure of how much any particular oil will change in viscosity with temperature change, the viscosity index scale was adopted.
Special additives have been developed which improve viscosity indexes. Oil with these additives show relatively little change in viscosity from very low to relatively high temperature.

Anti wear agents

The combustion processes leave deposits of carbon on pistons, rings, valves and other parts. Also, some oil oxidation may take place, resulting in still other deposits. As a result of these conditions, deposits tend to build up on engine parts. The deposits gradually reduce the performance of the engine and speed up wear. To prevent the formation of these deposits, engine oil contains a **detergent** and **dispersant** additive.

The **detergent** in the oil loosens and detaches the deposits of carbon, gum and dirt, the oil then carries the loosened material away.

The **dispersant** prevents the particles from clotting and greatly increases the amount of contamination the oil can carry and so keeps them in a finely divided state. Without the dispersant the particles would tend to collect and form sludge and varnishes in the bottom of the sump or inside the rocker cover, which might block the oil filter and reduce its effectiveness.

Rust inhibitors

At high temperatures acids may form in the oil, which can corrode engine parts, especially bearings. The rust inhibitors displace water from metal surfaces so that oil coats them, also, they have an alkaline reaction to neutralize combustion acids.

Demulsifiers & Emulsifiers

When it is imperative to keep oil and water in separate phases, Demulsifiers & Emulsifiers are used. These additives are found in automatic transmission fluids and in petrol and diesel fuel conditioners.

Anti oxidants

When oil is heated to fairly high temperatures and then agitated so that considerable air is mixed with it, the oxygen in the air tends to combine with oil, oxidizing it. As oil is oxidized, it breaks down to form various harmful substances. Some of the products of oil that have been affected by oxidation can coat engine parts with an extremely sticky, tar like material. This material may clog oil channels and tend to restrict the action of piston rings and valves.

Anti foam agents

The churning action in the engine crankcase also tends to cause the engine oil to foam. As the oil foams up it can overflow, or be lost, through the crankcase ventilator. The foaming oil is not able to provide normal lubrication of bearings and other moving parts. To prevent foaming anti-foaming additives are mixed with the oil.

Metal de-activators

Their purpose is to protect non-ferrous metals from other additives in the oil, which would otherwise cause corrosive attack on these metals. They do so by either forming a protective film on these sensitive metals, or by “deactivating” the corrosive tendency of the other additives.

Pour point depressants

At low temperatures, some oils become so thick they will not pour at all. Certain additives can be put into oil, which will depress, or lower, the temperature point at which the oil will become too thick to flow. Such additives keep the fluid at low temperature for adequate engine lubrication during cold weather starting and initial operation.

Reasons for oil changes & Oil analysis

Normal engine operation generates a variety of contamination ranging from microscopic metals and dirt to corrosive chemicals and sludge. If the oil is not kept clean through filtration this contamination is carried through the engine causing irrepairable damage. From the time that fresh oil is put into the engine crankcase it begins to lose its effectiveness as an engine lubricant. This gradual loss is largely due to the accumulation of various contaminating substances and to the reducing effectiveness of the additives. As the engine operates the oil accumulates more and more contaminants. Even though the engine has an oil filter, some of these contaminants still remain in the system. After many hours of operation the oil is so loaded with contamination that it has to be replaced.

The environmental condition under which the engine is working or loads that are applied in operation could govern the oil change intervals, or maybe a set number of hours or kilometers before the oil is changed. Oil analysis is another method that will govern the time when oil is removed from an engine.

Oil analysis is carried out in a Laboratory where a sample of oil is tested to determine the following: -

- Whether the viscosity is too low due to dilution from fuel.
- Whether the viscosity is too high due to sludge and contamination
- The sediment content
- The acidity
- The water content
- The extent of additive reduction
- Whether metal or other foreign material is present.

Preventative maintenance through oil analysis is used by machinery owners and operators who understand the necessity to protect valuable machinery from the ravages of fuel dilution, water invasion, dirt, fuel sulphur and wear metal contamination. Oil analysis normally involves two types of tests on the lubricant.

The first offers “spectrographic” analysis that tests for the presence of metals in the oil and this metal is calculated in “parts per million”. The contaminates that are found during the test are **Aluminum, Chromium, Copper, Magnesium, Silver, Nickel, Calcium, Iron, Phosphorus, Zinc, Lead, Silicon, Tin, Molybdenum, Lead, Boron, Sodium.**

The second test conducted is a “physical chemical water and fuel ingress test.” This tests the level of sulphurous acids present in the lubricant. TBN is also tested during this test.

Oil analyses have to be conducted over a long period of time to be able to determine the history on a piece of machinery. One test will not do.

Standard spin-on filters v ProtxL *bypass oil filtration*

The primary cause of engine component wear is contaminated lubrication oil.

Taken from SAE Technical Paper Series 930996

As the demands for longer engine life increase, engine oil cleanliness becomes more important. The requirement to minimize vehicle-operating costs has led to extended oil drain intervals. To maximize oil drain intervals, oil additive packages are being designed with more emphasis on their ability to contain contaminant in suspension to prevent sludge formation. Environmental demands require exhaust emissions to be minimized, and to achieve this, oil consumption needs to be minimized. Oil consumption serves as a means for removing contamination from engine oil by burning contaminated oil, which would then be replaced by clean oil. Reducing oil consumption and extending oil drain intervals puts an increased burden on lubricating oils. Clean oil lessens this burden, minimizes component wear and extends engine life.

The above Document examines the effect of different bypass cleaning systems have on engine component wear and oil condition.

Three filtering systems were tested on identical six cylinder, 10 litre, turbocharger, intercooled, direct injection, automotive diesel engines. Each engine had an oil capacity of 35 litres and ran on a low sulphur content fuel containing less than 0.05% sulphur. The results of these systems will be compared to the Winchester Filtration Bypass Oil Filter.

- Engine one was a standard engine and had **full-flow** filtration only.
- The second engine had full-flow filtration and had a **pleated** paper bypass filter.
- The third engine had full-flow filtration and a bypass oil-cleaning centrifuge.

The engines were run for 400 hours over controlled duty cycles of which each lasted 120 minutes. To ensure measurable engine component wear during the engine tests, a carefully controlled amount of test dust was added into the engines oil to accelerate component wear. The test dust was Air Cleaner Fine Test Dust (A.C.F.T.D) in suspension in engine oil. The dust was cut to remove particles less than 30microns, which would not normally be present in an engine lubricating system.

During the test, the standard engine experienced an oil pressure loss of 28%, the engine with the pleated paper skirt experienced an 8%pressure loss and the engine with the centrifuge experienced no loss. The loss in oil pressure from the engine without a bypass-cleaning device would detrimentally affect engine durability. The reducing oil pressures is attributable to component wear, especially wear in the main and big end bearings, and wear in the oil pump.

The bypass centrifuge showed an 87% reduction in wear to the top piston rings, an 89% reduction in bearing wear by weight, and the increase in valve clearance experienced by the engine was on an average 0.2mm.

Particle levels in the standard engine started to accelerate after 300 hours but the pleated bypass filter is similar to the level of particles in the oil from the engine with the centrifuge.

From the engine tests, it was concluded:

1. An oil cleaning centrifuge is more effective in reducing engine component wear than a pleated paper bypass filter, even though the latter offers significantly reduced wear rates over standard full-flow filtration. The lower component wear is due to the centrifuge’s ability to separate and isolate from the oil system wear causing particles.
2. Although the number of particles less than 5 microns in the lube system were not measured, it was the Author's (of SAE Technical Paper Series 930996) informed opinion, that the significant decreases in component wear experienced by the engine fitted with the centrifuge, were a result of the reduction of small abrasive particles, less than five micron, circulating in the lubricating oil.
3. The ability of the centrifuge to maintain oil cleanliness will extend engine life and allow longer oil drain intervals to be considered which will minimize the overall cost of running a machine.

Comparison between the Centrifuge and the ProtxL Bypass Oil Filter

As seen by the results in SAE Technical Paper Series 930996, the centrifuge is a system that would be hard to beat. Taken from a product sheet headed 'Glacier Centrifugal Oil Filters' dated 15 January 1979 and approved by Shell International Petroleum Co Ltd., Castrol Ltd., ESSO Petroleum, and Mobil Oil Co Ltd is the following statement.

“When the additive has performed its designed function, it becomes spent and consequently serves no useful purpose. The additive consumed in this manner is either replaced by "make-up oil" or by the new charge. Spent additives are also present in sludge removed by the Glacier centrifugal filters but no **significant quantities** of **additive** are removed from the lubrication oil by these filters”.

A ProtxL Bypass Oil Filter System will not remove additives from oil. It is only possible to remove particulate as small as sub- micron on multiple passes. As stated, oil additives chemically become part of the oil and have their various functions to perform. The system increases the effectiveness of the additives in the oil by the continual removal of contamination smaller than 1 to 5 micron particles while in operation.

Glacier CENTRIKLEEN Portable Centrifugal Filter Unit brochure states:
“A centrifugal filter will not remove water from oil”

A ProtxL Bypass Oil Filter System will remove moisture from oil and will also control fuel dilution. The removal of moisture in the oil and fuel eliminates the formation of acids and sludge.

Glacier Centrifugal filters do reduce wear rates, maintain oil cleanliness, and allow extended oil drains.

A ProtxL Oil Bypass Filter System will:

- **Reduce** the amount of wear inside equipment by removing the fine contamination.
- **Reduce** the need for routine oil drains because the oil is kept chemically clean and dry.
- **Reduce** the amount of spin-on filters that are used.
- **Reduce** the down time of equipment due to the reduction of worn parts.
- **Reduce** the maintenance costs and, in some cases, cut the outlay on oil and spin-on filters by half.
- **Reduce** the amount of money having to be spent on waste oil holding facilities on mine sites.
- **Reduce** the amount of sludge and fine dirt build up in engines and stationary equipment so the cleaning additives in the oil can keep all internals clean.

Other filter products in the marketplace

Other products in the market use a variety of filtering mediums such as wool, cotton cellulose, paper, cardboard, mesh, and centrifugal.

But, none have the same surface area of filter medium as an element from a **ProtxL** Filter. The replacement element is manufactured from long fibre cellulose virgin paper, which is embossed and wound to its correct diameter. The filtering process using this type of filter medium is called "Edge Filtering". The surface area of a 28CM element would cover a football field. The element is cut to its correct length, blown with air to remove any dust or fluff particles, packaged individually in plastic bags, and put into marked, sealed cardboard boxes.

Bypass filtration for plant and equipment

The **ProtxL** Bypass Oil Filter Systems are fitted to both fixed and mobile plant and equipment. Sizing of the filter or filter system depends on HP for engines, and reservoir size or system capacity for hydraulics, gearboxes and lubricating systems. Supply to the filter must come from a pressure source and the return line returns to the reservoir (low pressure). The **ProtxL** Oil Filter is manufactured from a high tensile hydraulic tube with a plate steel lid and base. The filter element is supported inside the filter housing by an element support assembly.

The filter has its own orifice built in which limits the amount of oil going through the system. This previously was on the outlet of the filter but is now fitted to the inlet side of the filter. This small amount of oil will not appreciably affect the oil pressure or lubrication of a normal engine.

Engines. Supply to the filter system is connected to one of the following:

- the oil pressure gallery along the side of the engine block
- Tee-off at the oil sender unit.
- check for pressure points at the oil full-flow filters
- Check accessories such as coolers, air compressor, etc (use a tee where pressure goes in).

Return from the filter is connected to one of the following:

- free return plugs on side of engine block
- spare dipstick holes in block
- accessory returns (use tee)
- crankcase - if light steel, use self tapping hollow bolt
- if heavy, drill and tap 1/8"
- inspection plates - drill and tap or use self tapping hollow bolt

Hydraulics

Supply to the filter system comes from the pump pressure side of the hydraulic system. As this pressure is above the working pressure limit of the bypass filter, a pressure-reducing valve must be installed. This valve must reduce the pressure to below 100 psi to the inlet side of the filter/s.
The return line from the filter/s returns to the reservoir. Connection may be a tee being fitted to another low-pressure return line or a fitting drilled and tapped into the reservoir.

Lubrication Systems

Supply to the filter comes from a pressure source. If this source is over 100 psi, connect a pressure-reducing valve. Many of these systems are very low pressure (some as low as 5 psi), so the supply line to the filter/s should be as large as 3/4 or 1 inch. Return directly back to the reservoir as per the hydraulics and increase line size if necessary. With a low-pressure system, the orifice in the inlet of the filter can be increased in size.

Gearboxes

Supply to the filter/s comes from the pressure side of the circulation pump. If this pressure is very low, increase the line sizes as per the lubrication system. If there is no circulation pump or pressure source to connect to, a separate pump system can be connected. Return line can be connected to the drain (use a tee if necessary) or to a tapped hole put into an inspection plate or similar.

Winchester Global can also supply mobile 'Cleaning Units'. These are manufactured from robust materials and sized to the application required. Please contact for further details.

Fuels for diesel engines

Microbial contamination of distillate has, for many years, caused intermittent problems. These problems are now prevalent in petrol; ULP, PULP, and Super, due to the drastic decrease in lead-based octane enhancers.

Avoiding water contact with the fuel can eliminate microbial contamination, as water must be present for growth to occur.

Airborne soil spores are attracted to hydrocarbon fuels where they remain dormant until contact with water and ambient temperature of 22 degrees C results in germination. Spores derive oxygen from the water and feed from the mineral content within the fuel, thus becoming a living, breathing, multiplying bio-mass; excreting acidic elements and prematurely degrading the host fuel.

These fungi, especially cladisporium resinae, form dense mats at the fuel/water interface. Growth and volume of mats are directly attributable to volume of water and ambient temperature.

Fuel storage tanks, where cladisporium resinae has been present in excess of twelve months, will also experience fuel emulsification immediately after bunkering or refilling due to the emulsifying nature of cladisporium resinae excreta.

To solve this problem, it is important that frequent drainage of tanks takes place to remove the oxygen source, thus preventing germination. However, very often it is found that satisfactory draining of the storage system is nearly impossible for environmental reasons and/or due to the construction of the storage tanks, e.g. on board ships, pleasure craft, and modern motor vehicles.

Atmospheric humidity promotes condensation formation within fuel tanks. Fuel motion washes condensation to the tank's bottom due to water being denser than fuels. Modern diesel and injected petrol engine operation contributes to the condensation formation due to the high volume (up to 80%) of hot fuel returned to the storage tank.

When water is present in storage systems, problems of microbial contamination arise in the following applications.

- Automotive diesel and petrol storage tanks at, for example, service stations and transportation depots
- Automotive diesel and petrol fuel storage tanks for commercial vessels and pleasure craft
- Stored fuel for emergency power generation

In the absence of oxygen, sulphate-reducing bacteria thrive in water under a layer of fuel. They reduce sulphate in the water to sulphides, which **accelerate tank corrosion, increase the sulphur content of the fuel and contribute to sludge formation.**

Winchester Global has a fuel conditioner product that it uses in conjunction with the fuel filter range. It has a package specially formulated to disperse and prevent the accumulation of condensation, fungi, sulphate-reducing bacteria, gums and varnish from the entire fuel system; promoting optimum engine performance via increased injector efficiency, maximum economy and extended filter life.

Properties of diesel fuels

These fuels have certain properties that make them suitable for use in diesel engines.

Viscosity

Viscosity, as indicated, must be low enough to atomise readily when sprayed into the combustion chamber.

Flash Point

Is the temperature at which the fuel commences to give off a vapour, which would ignite immediately if lit by a spark or flame. The flash point of diesel fuels is approximately 55 degrees C, which makes them much safer for handling and storage than petrol, which vaporises at all normal atmospheric temperatures.

Self-Ignition Temperature

Is the temperature at which the atomised fuel will ignite and burn without the aid of a spark. A low self-ignition temperature means that the engine will start easily and run with less diesel knock. This temperature is around 250 degrees C for diesel fuel.

Suitable Ignition Qualities – Cetane Number

The cetane number of a diesel fuel is a measure of it's ignition qualities, or it's readiness to burn in the combustion chamber. Fuels with a low cetane number will take longer to ignite after being injected, and so cause a longer delay period, and when ignition does take place, there will tend to be greater diesel knock as the accumulated diesel fuel suddenly burns and builds up pressure. On the other hand, if the cetane number is significantly high (correct cetane number) the fuel will ignite and commence burning almost as soon as the injection spray commences. Thus there will be an even rise in combustion pressure and no knock.

Sulphur Content

All diesel fuels contain a certain amount of sulphur. Too high a sulphur content, results in excessive cylinder wear due to acid building up in the lubricating oil. Fuel should contain no more than 0.5% sulphur.

Standard spin-on filters v **ProtxL** *full flow fuel filter*

A standard spin-on fuel filter element usually filters to around 12 micron and on the inside is a screen material with a pleated cardboard skirt. These filters are limited to the amount of moisture and fungi that they are able to filter from the fuel. This results in machinery losing power and eventually stopping.

The **ProtxL** Full Flow Fuel Filter uses the same element as the oil filter systems. This dense long fibre element is capable of completely drying even the emulsified moisture in the fuel. The most desirable location to install the **ProtxL** fuel filter would be prior to any other filter and in the circuit that returns unused fuel back to the fuel tank.

The fuel enters the inlet located at the base of the **ProtxL** fuel filter and proceeds through a device that enables contamination, such as long strands of fungi, to break up and disperse into the base area of the filter. The fuel then travels through a division plate with many holes (except Model WF4LPM filter) to a quiet zone, which also allows some additional moisture to fall from the fuel before the fuel proceeds through the cellulose element (Edge Filtering).

Because of the filtering medium used, this type of filter far exceeds the expectations placed on any standard full-flow fuel filter. The fuel returning back to the fuel tank will mix with the contents of the tank so that eventually, a dirty tank becomes clean. If the fuel tank is very dirty or contaminated with fungi, the filter element/s may require constant changing until the situation is overcome and element changes are extended out to the correct service interval.

A severely contaminated tank should also be dosed with a suitable fuel-cleaning chemical (as listed in Fuels for Diesel engines section) to aid the filters in the tank cleaning process. Contact Winchester Global for information for Fuel tank cleaning of fuel conditioner.

References

Ashwell D.M. (1992) The Good Oil

May E. (1991) Diesel Mechanics McGraw-Hill NSW

SAE Technical Paper Series 930996

Glacier CENTRIKLEEN Portable Centrifugal Filter Unit brochure

Please note because of the nature of the information sought, some parts of this paper are direct extracts from the reference material.

ProtxL home page