

EXTENDED DRAIN INTERVALS FOR CRANKCASE LUBRICANTS

INTRODUCTION

Recent advances in lubricant and engine technology have enabled significant increases in the potential for extension of service intervals, particularly in the Commercial Vehicle market where off-road time for servicing is required to be at an absolute minimum. In Europe, current drain intervals of 100,000 km. are now the benchmark for such vehicles. Several key Truck Manufacturers have introduced exacting new specifications for engine and transmission lubricants, the use of which are required in order to achieve new extended service intervals and are in some cases mandatory in certain extended warranty situations.

Passenger car manufacturers are also realising the marketing benefits associated with extended service intervals in today's highly competitive market, and most manufacturers are designing-in the potential for less frequent servicing. However, increasingly stringent emission regulations are an additional complicating factor. The resultant increased contaminant load upon the lubricant acts against the extension of drain intervals. Lubricant formulators and vehicle manufacturers are therefore endeavouring to achieve longer lubricant life by re-formulating the lubricant and by modifying the design of engine lubrication systems respectively. With regard to the latter approach, the most viable option appears to be the incorporation of some form of by-pass filtration system supplementing the normal full-flow filtration.

LUBRICANT CONTAMINATION

The primary contaminant of diesel engine crankcase lubricants is soot, the accumulation of which leads to thickening of the oil and an increase in the abrasive wear in critical areas such as valve cross-heads, rockers and cam followers. The need to meet increasingly stringent exhaust emission regulations has required modifications to engine design and operating conditions, such as the use of articulated pistons with steel crowns and high top rings, increased injection pressures, retarded injection timing and the use of exhaust gas recirculation. The last two items in particular directly contribute to higher contamination levels in the lubricant, particularly soot content. The size of primary soot particles is in the order of 20-30 nm, but these primary particles rapidly fuse together to form larger particles in the order of 0.2-0.3 µm. General opinion seems to indicate that the smaller particles are primarily responsible for oil thickening, whereas the larger agglomerates are responsible for wear. Earlier investigators reported that the presence of a certain concentration of fine sub-micron particles was in fact beneficial as they aided polishing of bearing surfaces over an extended period thereby reducing friction. Removal of particles down to 5 micron did not significantly reduce wear, whereas when the oil passed through a 1 micron filter there was a significant reduction in wear. Wear rates arising from the presence of particulate contaminants increase rapidly when the size of the particles exceeds running clearances between sliding surfaces.

Other contaminants include unburnt fuel, metallic particles, together with acidic by-products of fuel and lubricant combustion, etc. In general, it can be seen that the more stringent controls on emissions are leading to an increase in the contamination level in the lubricant.

The presence of even small quantities of metallic debris, such as iron, copper, lead, etc., can act as an oxidation catalysts which will degrade the lubricant. In the presence of oxygen at elevated temperatures, organic peroxides are formed by the removal of hydrogen atoms from the lubricant hydrocarbon chain, which results in the formation of free radicals, which then react with the oxygen

to form peroxy radicals. These act as precursors for further oxidation, which ultimately result in the formation of a variety of organic compounds, including aldehydes, acids, ketones, which may then further oxidise and react with each other to form high-molecular weight polymers, such as varnish or sludge.

Water is another potential source of serious engine problems which conventional full flow oil filters are not designed to handle. A normal by-product of combustion, water enters the crankcase with piston ring blow-by gases and condenses when the engine is shutdown and cools. Water, oil and soot then mix to form sludge which insulates the crankcase and oil pan to reduce the engine's cooling capacity. Water in oil also promotes formation of corrosive acids. Sulphur and nitrogen compounds, when combined with water in a hot engine, can form sulphuric and nitric acids.

DEVELOPMENT OF LONGER-LIFE ENGINE CRANKCASE LUBRICANTS.

Most lubricant marketers have responded to the requirements for extended drain intervals by introducing new or upgraded product lines. A typical diesel engine product range would include, for example:-

1. Standard Engine Oil suitable for On and Off Road applications - Would meet basic industry requirements for diesel engines only. Little opportunity for extension of normal drain intervals, however. Suitable for the majority of the current on/off Road vehicle parc but not recommended for new design low emissions engines
2. Mixed Fleet product suitable for On and Off Road applications - diesel and gasoline engines. Meets "second tier" industry specifications for diesel engines, and "suitable for use" in gasoline engines. Suitable for mixed Van/Car fleets where there are some gasoline-engined vehicles. These products, however, would not usually meet the latest performance requirements for low viscosity fuel economy oils for gasoline engines. Meets some manufacturer specifications for moderate extension of drain interval in commercial diesel engines e.g. up to 30,000 kms.
3. Super High Performance Diesel Engine Oil suitable for On Road applications - may have some gasoline engine performance. Meets several OEM and Industry "Long Drain" specifications typically used for long haul applications. Oil life can be between 45,000 and 60,000 kms depending on application. Also needed for some European Off Road engine designs.
4. Ultra High Performance Diesel Engine Oil "very long life" oils using new technology, synthetic base fluids, etc. Needed for latest engine designs where manufacturers are offering 100,000 kms + oil life and service interval.

Experience by some manufacturers who have evaluated synthetic oils to their limits show that engine oil life of 500,000 kms can be accomplished in the right type of operation. It is argued that if the total cost of lubrication of a vehicle is considered, rather than just the cost of the lubricant, it will be found that elements such as filters/labour/oil disposal can contribute far more to the cost of lubrication than the lubricant itself. By using a higher quality of oil the cost of lubrication can fall. However these exceptional results are not possible for many of today's vehicle parc - mainly due to a limited degree of sophistication of engine management systems and to the type of operating conditions experienced in practice.

ENGINE DESIGN

The simplest and most obvious way of extending oil change intervals by reducing the concentration of contaminants in the sump is to

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