Motor Oil Comparison

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Of this final project was commissioned by the racing and design performance-car engines and construction of specialized MW Steel Oy. This study examines motor oils, surface pressure resistance and tribological properties of the additives they contain.

Oil pintapaineenkestolla can be evaluated against two mutually acting between the movable part of the oil film strength. The oil film is broken in case of failure of the lubricant and wear is immediately multiple compared to the full lubrication.

Surface Pressure Duration says also very use of additives in motor oils, as well as their amount tribokeraamisista and -chemical properties. The thesis also introduces the lubricant distribution systems, mechanisms, not forgetting the oils used raw materials and the importance of the additives. Since numerous external variables make review of the phenomena of wear, friction and theoretically challenging, focus on the work of experimental research investigating the factors affecting engine wear.

Consumer sold on the market as well as to compare the performance of the engine oil as referred to-use, real use conditions simulating a repeatable and reliable test equipment, which is designed and constructed for research purposes. The results of the surface pressure resistance are tabulated separately performance- and consumer oils, which enables easy and accurate comparison between different engine oils.

Motor oils, surface pressure resistance have results suggest that significant differences.

Keywords	engine oil, oil, lubricant, surface pressure, oil test, the surface pressure resistance, load resistance, anti-wear, engine damage, long-life, SAE, ACEA, API, tribology, Mobil, Teboil, ExxonMobil, Shell, Redline, TriboDyn, Castrol, Kendall,

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The contractor of this research is MW Steel, a company specializing in the design and construction of racecar engines. This research examines the surface pressure resistance of engine oils and the tribological properties of the additives contained in them.

Resistance of surface oil pressure is well Depicted by the strength of oil film acting between two parts moving against each other. In case the oil film breaks, Resulting in the protective function of the lubricant no longer to be Effective, severe damage to the engine is often resulted.

The strength of the oil film alsó reflects not only the additives used in the oil but alsó Their amount and Their tribochemical and -ceramic properties. The research focuses is lubrication systems and -mechanisms and takes into account the Importance of the additives and raw materials used in engine oils. Because numerous external variables with fresh theoretical study of friction- and wear phenomenon challenging, the focus has been on experimental research in the study of engine wear factors.

For the comparison of engine oils used in factory-built cars as well as performance cars, a reliable test equipment simulating real operating conditions was designed and built. The results of the engine oil film strength are tabulated for two engine oil categories, adding providers easy and reliable comparison between different engine oil film Strengths.

The research results show That there are Significant differences in the film Strengths of engine oils.

Keywords	motor oil, oil, lubricant, surface pressure, oil test, resistance of oil surface pressure, load resistance, antiwear, engine damage, long-life, SAE, ACEA, API, Tribology, Mobil, Teboil, Exxon Mobil, Shell, Redline, TriboDyn, Castrol , Kendall,

Content

Attachments

The test results tabulated in Appendix 1. The surface pressure test raapaisujäljistä and load time

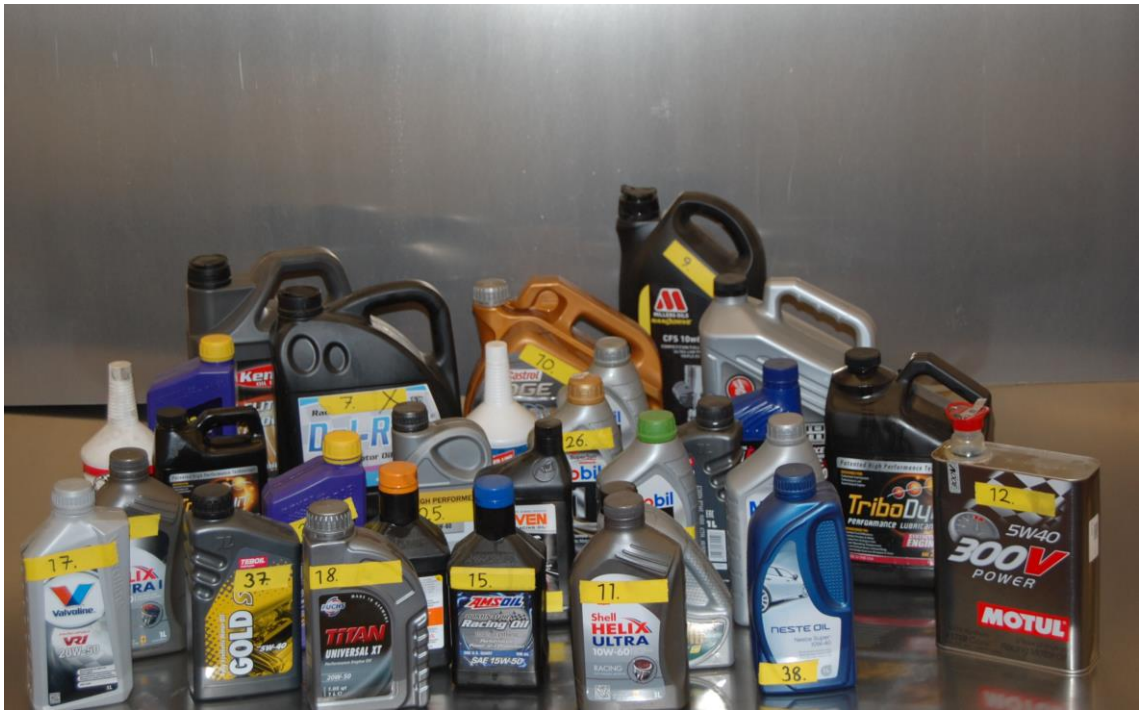
Appendix 2. The test results in tabular form the results of the dynamometer

abbreviations

PAO	Polyalphaolefine Oil
EP	Extreme pressure
AW	Anti-wear
PPM	Parts per Million
ACEA / API / ILSAC	Lubricant quality classification standards
LINE	Society Of Automotive Engineers standard classification of lubricant viscosity
Long Life	The long service interval engine lubricant
HTHS	High Temperature High Shear
VHVI	Very High Viscosity-Index
XHVI	Xtra-High Viscosity Index
EHVI	Extra-High Viscosity Index
HD	Hydrodynamic
EHL	Elastohydrodynamic

1 Introduction

MW Steel Oy is a Finnish racing and performance car repair and construction company specializing in the automotive sector. MW Steel Oy manufactures racing and performance car engines, where the duration of lubricants, surface pressure is the most important part of the engine lubricants tasks. The goal was to get a clear comparison in Finland, as well as motor oils sold on the world surface pressure duration, which would help to choose the most suitable lubricants for different uses. Part of the collected test oils is shown in Figure 1.



Kuva 1. Test oils.

The work is carried out automotive engineer students' thesis, and implemented in vehicle sales is from the perspective of technology. Work will focus on the most important motor lubricants feature a surface pressure resistance of lubricants. Interviews were consulted and a variety of lubricating oil companies in the field of professionals, as well as in engine technology and tribology professionals. Number interviews technician who participated in the conflict of interest, however, is examined with respect to the sharing of information and engine lubricants security features, many sensitive discussion When protecting

company secrets. For this reason, the source of information divided into multiple work are retained.

Major oil companies have focused on marketing and sales of high-volume products. Smaller manufacturers often seek to compete in product quality, and strive to produce other hand, the market volume of oils as a good lubricant. sold in Finland performance-limited supply of oil increased the interest in acquiring a variety of engine lubricants also abroad.

The goal was to create a reliable and concrete measurement system, as well as to prepare their own practical features simulating the measuring equipment. The aim was also to find out both in Finland and duration of engine lubricants worldwide sold in the surface pressure, and look for racing and the lubricant having the highest possible security features intended for performance use.

the duration of lubricants, surface pressure significance of an internal combustion engine is considerable. Standardized testing methods in the absence of most consumers and even automotive enthusiasts selection criteria on the image of the major oil companies and large marketing and advertising budgets created images that depict unfortunately rarely the actual characteristics of lubricating oils and contributes to the flagrant violations based on subjective perceptions of differences of opinion. This phenomenon is also reflected in service stations and car workshops.

the rapid development of internal combustion engines and consumers' requirements, long service intervals set for lubricants continually more difficult conditions. the number of unexplained engine failure is on the increase. In many cases, poor lubrication is either full or partly responsible for these damages. Car manufacturers are more precise in their respective analyzes of the damage with respect to oil quality classification review.

The most important task is to prevent the engine oil wear and lubricate the moving parts. In addition, the engine oil seals, cooled and binds to and transports the dirt. Service life and long-life oil being present day engines of passenger cars, trucks and debris is an important part of the functioning of the engine oil. The lubricant undertakes a lot of impurities palamisjäänteistä and fuels, and talking about long-life oils can reach up to 50 000 km replacement interval. Lubricant task is to carry these contaminants filtering

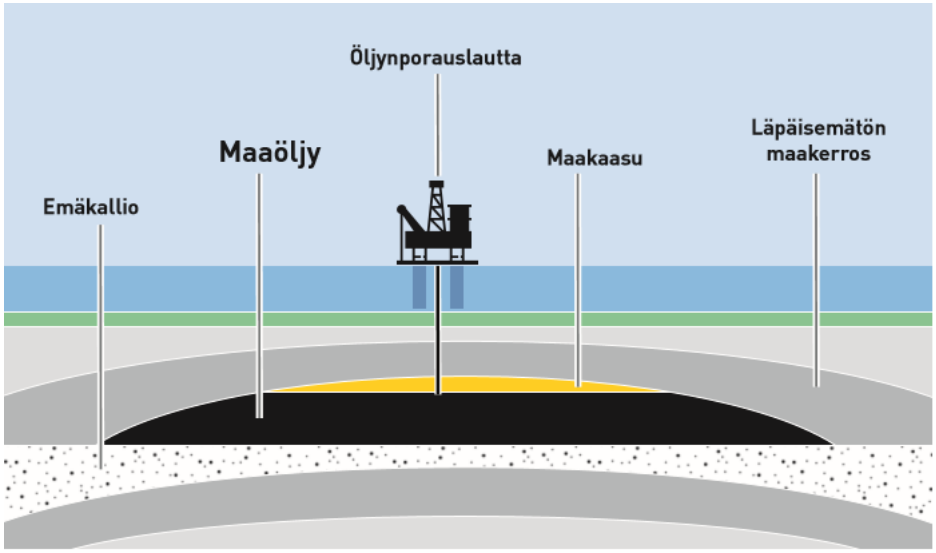
system. Long service interval brings significant challenges for the lubricant purity. (Http://www.oil.fi/fi/oljytuotteet/voiteluoljyt, & bio The fuel oil)

The motor racing dirt transportation properties and is promoting additives may be doing more harm than good. In practice, this does not exclude the long change intervals and oil advanced tribological good surface pressure resistance. It must be remembered, however, that in extreme circumstances, good and bad engine oil level difference may be either intact or broken engine. (Lehtimäki Timo, Til-Racing)

The work was purchased from a commercial measuring device which substantial changes were made in order to achieve the desired toistettavuustason. For the work was ordered from a complete range of engine lubricants. The instrumentation system worked up in front of operationally for several weeks prior to the performance of the actual measurements. Equipment inspection and internal measurement of the event was essential for the accurate reproducibility and reliable results in terms. The operational period of the study lasted for about 6 months. During this period, all lubricants included were measured. Of all the measured parameters were drawn up on the table. The studies continued dynamometer tests, which are discussed in Section 6.5. The remainder of the work consisted of interviews and reporting contributions.

2 Raw materials

Petroleum was born on the seabed swamped, dead plankton millions of years ago. is deposited on top of plankton, over time, the sand and stone, and a combination of dense layer, and oxygen-free condition, the pressure and the heat generated, these "organisms" changed petroleum. different lengths of petroleum based particles include hydrocarbon compound chains. The seabed and drilled from the mainland crude oil as such is unfit for use as a lubricant (Figure 2).
(Https://www.koivunen.fi/tuotteet/file/kemikaalit/liqui_moly_voitelu_abc.pdf, lubricants ABC)



Kuva 2. Crude oil drilling earth's crust. (Https://www.koivunen.fi/tuotteet/file/kemikaalit/liqui_moly_voitelu_abc.pdf, lubricants ABC)

2.1 Refining process

The crude oil requires multi-stage processing, in which the first of the crude oil is cleaned of impurities, is heated and passed kaasuuntumislämpötilaan jakotislaustorniin atmospheric pressure. Jakotislaustornissa oil gas is cooled in a controlled manner and the different fractions condensed distillation in accordance with each of the boiling point. the production of synthetic oil is a two way; the ethylene gas to the polymerization or multi-step conversion and refining process. The basic principle is that the lubricants are distilled fuels invalid distillation fractions. (Https://www.koivunen.fi/tuotteet/file/kemikaalit/liqui_moly_voitelu_abc.pdf, lubricants ABC)

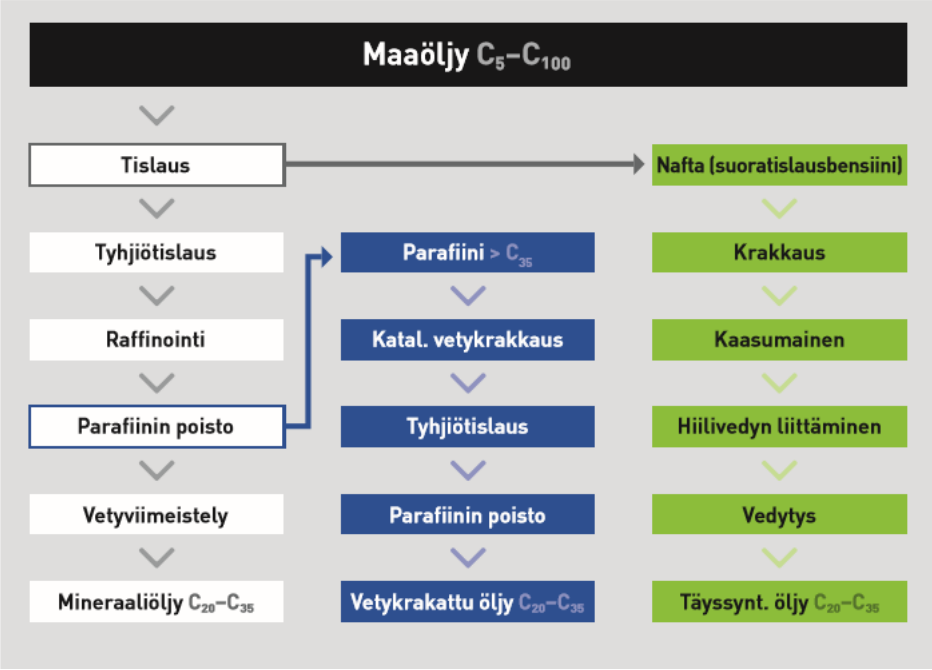
It should be noted that the synthetic base oil is not a guarantee of the quality of the oil, it is possible to produce quality mineral oil equivalent synthetic base oil. The market gives the impression of synthetic lubricants to be superior with respect to mineral oils, and in this way the manufacturing process are not told to quality classes and certainly not in the product information.

When using mineral-based oils, their composition is to be worthy purpose. This composition is a naphthenes, paraffins, aromatics, and the ratio of the oil. These high-

quality mineral oils are highly refined paraffinic oils containing optimally about 5-15% of the composition of the oil.

As we see the image 3, base oils, there are three main types: mineral oil, hydrocracked EHVI / VHVI fish oil, and synthetic oil. The lubricant product can be implemented and these are often carried out in various base oils in combination. By combining synthetic and mineral base oils obtained by the designation "osasynteettinen" and "semi-synthetic". (Https://www.koivunen.fi/tuotteet/file/kemikaalit/liqui_moly_voitelu_abc.pdf, lubricants ABC)

with the designations should be careful anyway, because the multi-brand oil may be called synthetic product, if it has been used for a modicum of synthetic base oil. The direct conclusion of oil in a jar of you reading data with respect to synteettisyyden is not possible, therefore, to do, but should know the precise chemical composition and properties of the oil.



Kuva 3. Base oil distillates.
(Https://www.koivunen.fi/tuotteet/file/kemikaalit/liqui_moly_voitelu_abc.pdf, lubricants ABC)

2.2 mineral oil

Mineral oil is a simple and direct oldest products maaöljytislauksen. Mineral oil is distilled by heating the oil in a blast furnace, where it breaks down the various components. Thereafter, the distillate is removed harmful constituents of refining or dewaxing process. At the final stages of the hydrogen is fed to the distillate suitably hydrogen, which closes the open molecular chains, thus improving the appearance of oil vanhenemisominaisuutta. This perusöljytyypillä is no longer the use of modern engines because its features are not enough modern engines requirement level. (Https://www.koivunen.fi/tuotteet/file/kemikaalit/liqui_moly_voitelu_abc.pdf, lubricants ABC)

2.3 Cracked base oils, EHVI, VHVI or XHVI

Catalytic cracking one krakkausmuodoista is hydrocracking. complex cracking of organic compounds chemically digested simpler, allowing the oil to cold and heat resistance are improved. The reaction is based on breaking the bonds between the carbon atoms. Cracked products are a lot of different kinds of quality may vary in mineral oil corresponding to the corresponding PAO oil. Of these abbreviations are used, inter alia, EHVI, VHVI and XHVI, the quality of the oil and, depending on the manufacturer. These cracked base oils, lubricants accounted for many there is still significant, as they help to create a blended lubricant additive and more homogeneous without fear of separation of the additives. These oils are in line with the latest developments in the industry and are widely used, inter alia, ultramodern petrol and diesel applications.

Hydrocracked base oils combine the best of mineral and fully synthetic base oils. Excellent Parties mentioned thermal stability and vanhenemisresistiivisyys. Hydrocracking base oil is used as a basis of the extracted production of mineral paraffin oil. These paraffins consist of very long chain molecular compounds(> C35). Molecular compounds is decomposed with the assistance of a high pressure (70-200bar) and temperature (500 ° C). They are then cut to the desired C20-C35-time, and the vacuum distillation is performed to prevent cracking of the molecular chains. The last possible paraffin distillate removed.

2.4 Ester-based base oils

The ester-oils are produced from vegetable oils and animal fats. Ester oils were originally used for aircraft turbojet engine lubrication, but little by little they have gained a foothold also in lighter traffic of vehicles in use. Most of the ester oils are mixed with PAO oils, as PAO oils, esters offer features that are not able to offer. Ester oils as the best party mentioned resistance and viscosity characteristics of temperature variations, as well as lack of combustion halo of carbon residue.

2.5 silicone oils

Silicone oil is not found in the vehicle the use of a number of these applications. The silicone oil is generally used as a heat transfer, a variety of plastics and rubbers, lubricants, greases and aerospace field. Passenger car use, silicone oil is used in gear differential locks visco-clutches because of their wide viskositeettivalikoiman.

2.6 Polyalphaolefin (PAO)

PAO is a widely used synthetic oils as a base oil feedstock. The use of PAO oils is also common in transmission and gear oil. PAO-based base oils prepared from petroleum raw materials by thermal cracking. Thus ethylene and natural gas can be completely desired type of raw material. The best lubricants, raw materials are formed by controlling the ethylene gases are complex, but the stable through a treatment process. manufacturers of these raw materials are just a few of the world. The actors are big globally operating oil companies whose production processes are carefully polished, and the products very similar to each other.

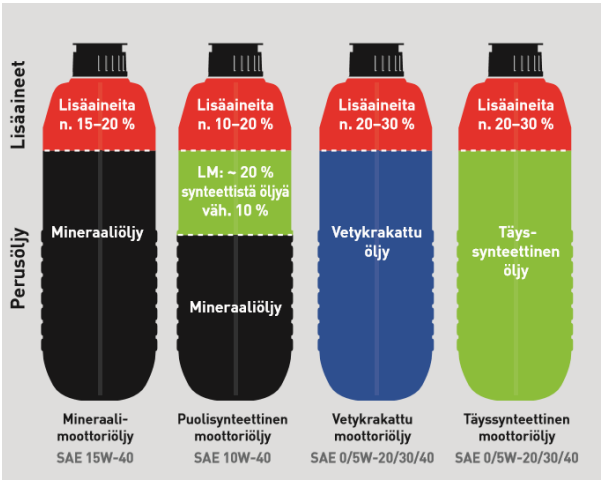
In the first stage, the naphtha cracking of crude oil and the molecular chains (C5-C12) is cut to the length of C2. Earlier liquid material is now an ethylene gas. The resulting short molecular chains (C 2) is continued along the molecular long (C20-C35). The molecular chains are closed by means of hydrogen, in the process, referred to hydrogenate. ethylene gas as a raw material is the same gas to the food industry matured bananas.

Also, the rest of the oil industry, including the confectionery industry, the end product is used polyalphaolefin. Additives PAO oils is a challenging task, and it requires a lot of experience and a high degree of precision. PAO oils tend to have additional material as a separate non-reacted motor with rubber gaskets undesirable way, causing leaks. to obtain a homogeneous mixture of additives and the PAO oil added to the mix with other synthetic lubricants such as alkylbenzenes, organic esters, polyglycols, phosphoric esters, and silicone oils. The alternative is to make a homogeneous mixture with the PAO oil and partial or full mineral oil.

the properties of the PAO oils include good mixing mineral oil, pumpability, low pour point, oxidation resistance, water resistance, high temperature resistance, low deposit formation and low volatility. Mixing PAO oils and mineral oils is safe and mixing engine lubricants with each other is provided for a law that allows this in all cases. Good pumpability to ensure removal of normal paraffins from among the PAO oils. PAO oils last on average about 50°C higher temperatures than mineral oils. The temperature upper limit of PAO oil is held at 160°it would be desirable C. measured in the oil sump to be at this temperature for at least 30°C less, for example, the crankshaft journal under high pressure oil temperatures are significantly higher than those of the oil pan. A natural high viscosity index allows for a narrow oil having a viscosity prepared without even having viscosity index improvers, which is in turn a positive effect on the engine fouling.

3 additives

Engine oil is composed of two components: base oil and additives. Almost all existing high-quality engine lubricants base oil is fully synthetic. Accordingly, lubricants are always mixtures thereof. The mixture ratio will vary by application and according to the manufacturer, the proportion of the base oil and additive of 70-90% 10-30% (Figure 4). (Lubricant Additives: Chemistry and Applications, Leslie R. Rudnick, CRC Press)



Kuva 4. Proportion of additives in oil. (Https://www.koivunen.fi/tuotteet/file/kemikaalit/liqui_moly_voitelu_abc.pdf, lubricants ABC)

Figure 5 shows clearly how the quality and characteristics of modern lubricants can be influenced by additives.

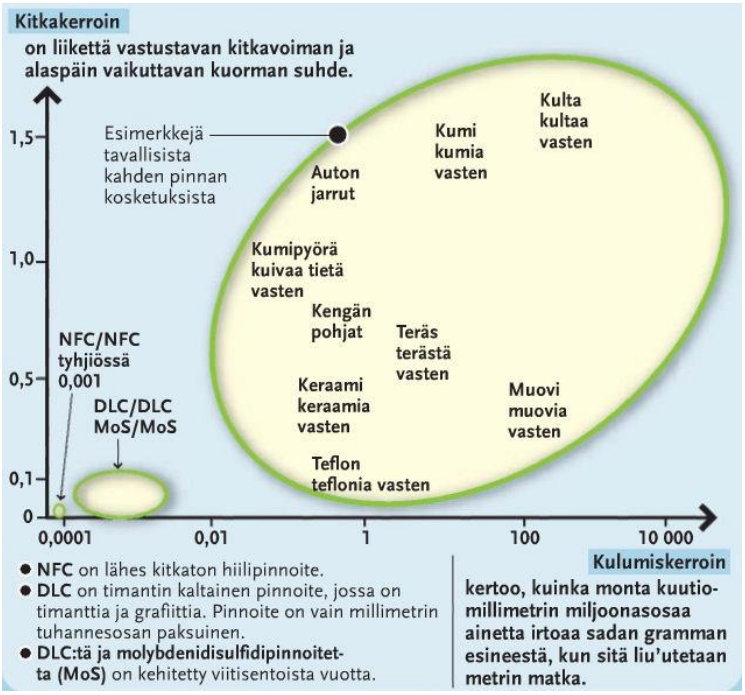
Ominaisuudet	Vaikutettavissa lisäaineiden avulla	Saavutettavissa vain lisäaineiden avulla	Ei vaikutettavissa lisäaineiden avulla
Kylmänkestävyys	●	○	○
Vanhenemisvakioisuus	●	○	○
Viskositeetti/ lämpötilakäyttäytyminen	●	○	○
Korroosiosuojaus	●	○	○
Lian irrotuskyky	●	●	○
Dispergoimiskyky	●	●	○
Suurpaineominaisuudet	●	●	○
Vaahtoutuminen	●	●	○
Ilmanpoistokyky	○	○	●
Veden erottuminen	○	○	●

Kuva 5. The effect of additives in oil areas. (Https://www.koivunen.fi/tuotteet/file/kemikaalit/liqui_moly_voitelu_abc.pdf, lubricants ABC)

Additives determine the final oil product price effectively, as raw material costs are only 5-10%. Some oil producers to purchase additional materials from major additive suppliers, which can be found on approvals according to the standards. Several small oil manufacturers do not settle for the big additives suppliers additive packages but to produce the greatest amount of additives themselves, and in this way guarantee the product quality, which is the only way to compete against the large suppliers. small

operators are developing this kind of additives the whole time in order to ensure the best possible tribological properties of the oil.

Boron, tungsten and diamond represent a new generation of additives. Nano-size particles is achieved by very pienikitkakertoimisiin compounds. However, they raise the cost of additives. WS-2 is the oil antiwear additive, which contains for example. tungsten and booria.WS-2 has been called "the most slippery substance in what science knows." In addition, these additives tend to be very active high pressures and temperatures under which brings a distinct advantage in the case of a racing engine with a lubricant system may not come to the slightest disturbance. Figure 6 shows the friction and wear factor, such additives designed to affect between two of the same material. (Lubricant Additives: Chemistry and Applications, Leslie R. Rudnick, CRC Press, 148-176)



Kuva 6. friction and wear factor of different materials. (Teaching materials, Kai Laitinen)

3.1 The anti-wear additives (EP / AW)

Anti-wear additives have been used for a long time for the different lubricant categories, these EP (Extreme Pressure) and AW (Anti-Wear) additive to have evolved considerably during the last decades. Zinc used to be the only effective way to protect the engine from wear. Zinc phosphate is used, however, also increases the amount of sulfur and

phosphorus, wherein the risk of corrosion damage to the engine, which is difficult to detect only by the engine side to the mechanical damage increases the risk. Zinc has been a popular additive because of its low cost and easy availability. (Lubricant Additives: Chemistry and Applications, Leslie R. Rudnick, CRC Press, 223-259)

Tribologiatieteen advances have been invented and patented many tribokemiallisia much more effective anti-wear additives, where the surface pressure resistance as compared to zinc can be up to a hundred times. the development of these additives in the zinc phosphate proportion of the oil additive is reduced due to the use of zinc phosphate is also limited by the accumulation of phosphorus pollution devices. Thanks to the additives Tribokemiallisten cylinder wall wear is reduced and the engine cylinder wall hoonausjälki is detectable even after several hundred thousand miles.

New types of additives are absorbed in an acceptable environment metallihuokosten surface to form an effective protection and prevent the metal parts pinnankarheushuippujen contact with each other. The properties of these additives affect the particular engine part-regions, where there is no hydrodynamic lubrication, and where high surface pressure resistance, such as a valve mechanism, a division chain and the cylinder wall. A test device used in this work effectively mimics this kind of event in the engine.

3.2 Wash additives (detergents and dispersants)

Pesevillä additives have two main functions, to dissolve the dirt and distribute particles. As a result of the current long-term engine oil change intervals, which leads to substantial amounts of dust and sludge, and the oil filter system alone can not cope with these impurities. In this case, the oil manufacturer designed, long oil change interval having lubricants containing additives plenty of detergent is required. (Lubricant Additives: Chemistry and Applications, Leslie R. Rudnick, CRC Press, 113-170)

Dispersants share the finely divided particles of dirt particles, facilitating the transport of oil supplied to the filter system, and to form a layer around the impurities, which prevents the particles from sticking together. The structure of dispersants are long chain polar compounds. Modern pollution devices, to higher cylinder pressures and smaller clearances due to dirt particles transfer ability is emphasized. This additive has been

taken to prevent the modern, long-life oils sludge accumulation of the motor and engine oil pump strainer. (Lubricant Additives: Chemistry and Applications, Leslie R. Rudnick, CRC Press, 113-170)

Detergents are surface active agents which are designed to improve the sylinteritiiveyttä, pollution equipment and extend the life of the oil change interval. The structure of the compounds of detergents consisting of sodium, calcium, and magnesium. (Lubricant Additives: Chemistry and Applications, Leslie R. Rudnick, CRC Press, 113-170) on the basis of the test, it was found that the abundance of detersive additives Oils with a negative impact on lubricant surface pressure resistance in most cases.

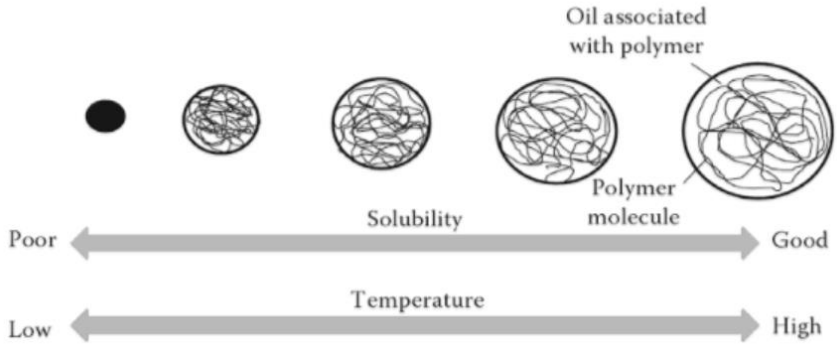
Lubricant and quality classification of the labeling of issuing car manufacturers could be observed that the abundance of classifications containing lubricants, surface pressure resistance was often at a lower level than the less classified lubricants. Modern engine technology and the lubricant industry is the cornerstone of the balance between long oil change intervals and engine durability. Requirements for long intervals between oil changes and pollution requirements are placed on oil manufacturers and car manufacturers in a challenging situation, with a sudden deterioration in the quality of the lubricant creates problems. (Lubricant Additives: Chemistry and Applications, Leslie R. Rudnick, CRC Press, 113-170)

3.3 Viscosity index improvers

Viscosity index improvers are polymeerisakeuttimia, whose task is to resist change in viscosity index. These polymeerisakeuttimia are widely used in lubricants, where the viscosity index is broad. Polymeerisakeuttimen drawback can be considered as a weak surface pressure resistance and temperature tolerance (Figure 7). It has a tendency to be cut at high temperatures and under high surface pressures effect. The polymer is microscopically small of the plastic, which tends to create the composition of the oil the internal network structure. (Kai Laitinen,Lubricant Additives: Chemistry and Applications, Leslie R. Rudnick, CRC Press, 329-354)

Polyolefins and methacrylates, viscosity index improvers, and they are soluble in the base oil. There is also a healer of materials with peseviä- and antioxidant properties.

These are aimed at overturning the overall viscosity-index additives tend to karstottaa engine.



Kuva 7. Temperature behavior of the polymer molecule according to the change. (ASTM D2782)

3.4 pour point improvers

Improving the pour point of the oil is changed kylmäjuoksevuusominaisuuksia and thus a better oil to remain fluid at low temperatures. The additive improving cold flow of oil and enhance the flow of lubricant to the lubrication point. This feature is highlighted widely varying climate countries. (Lubricant Additives: Chemistry and Applications, Leslie R. Rudnick, CRC Press, 355-362)

A considerable part of the passage of the internal combustion engine takes place when the oil temperature is below 50 ° C. It is very important that the load on the engine is cold moderate, and it is recommended to preheat the engine in cold conditions. Car manufacturers and esilämmitinvalmistajat have begun to favor the coolant heating instead of heating the engine oil. (Lubricant Additives: Chemistry and Applications, Leslie R. Rudnick, CRC Press, 355-362)

3.5 antioxidant additive

Oxidation is a chemical reaction that darkens the color of the oil and degrade the quality. Oil oxidation of the hydrocarbon transfer of electrons to oxygen. Upon receiving the electrons, oxygen is reduced. Oil oxidation is vernacular aging response. The reaction accelerate the high temperatures and contaminants contained in the oil. Copper and lead

are among the best act as catalysts for this reaction. Oil oxidation arises, inter alia, alcohols, which are further oxidized to aldehydes and ketones. Aldehydes continue to further oxidation to the carboxylic acids, ketones hapettumisreaktioketjun away. Carboxylic acids are effective to etch the engine components. formed by the condensation of the carboxylic acid and the solution was corrosive to the components above the oil surface. This phenomenon can be observed öljykorkkiin the forming of yellow powdery mildew. (Lubricant Additives: Chemistry and Applications, Leslie R. Rudnick, CRC Press)

hydrocarbon chains contained in the oil lengthening the oxidation reaction progresses. In this case, the lubricant system polymeerisakeuttimet form a slurry, which may cause clogging of pumps up oil strainer. Silty oil karstottaa hot engine components, leaving the surface of the hard harmful deposit. This phenomenon can best be seen in modern turbo chargers.

The oxidized oil is the first indication of the oil changed in color, although the current brought about by the EP additives can darken the color of oil in the new so small that oxidation of soot in the oil, and the oil must look very dark. color change due to oxidation of the examination is a color scale (ASTM D 1500). There are also instruments, on-line tests and laboratory tests to determine a total acid number (TAN, Total Acid Number ASTM D 664). The total acid number is indicative of additives increases, the color spectrum of oils. (Http://www.ekomobiili.fi/Tekstit/Oljytesti.pdf)

3.6 Anti-foam

There are two interdependent concept, which is easily mixed with each other: an air separation ability and foaming. Engine oil foaming reaction is undesirable. Engine oil mixes with air to small bubbles which impair lubrication. Air bubbles are created by the oil pump cavitates or crankshaft counterweights but hits the highlands of oil on the bottom of the oil. Foaming can also be generated in oil itself, varying flow rates abruptly, and this phenomenon seeks to prevent Anti-foam, which lowers the surface tension of the lubricant. Surface tension is lower resulting in lubricant small air bubbles to break more easily. In order to obtain the most efficient air separation oil, surface tension must be low, so that the air bubbles rising to the surface are broken and the separated oil. (Http://www03.edu.

3.7 Korroosionestolisäaineet

Namely the korroosionestolisäaineen main function is to protect the engine against corrosion of metal components caused by moisture and oxygen. As previously mentioned, with the zinc phosphate used in EP-dopant is added korroosiorasitus designed to neutralize these additives. Because of this new technology in oils the amount of zinc phosphate EP additive is limited. the amount of the zinc phosphate can also be reduced by reducing the korroosionestolisäainetta. Novel types of absorbable additives able to penetrate into the pores of the metal, leaving a critical touch point surface area for other additives.

The corrosion protection is of two main types: physical and chemical. Rust inhibitor is used as a physical long-chain hydrocarbons having polar molecules adhesion to the metal surface is good. Dry the corrosion inhibitor reacts with the engine components to change the electro-chemical potential. (Http://www03.edu.fi/oppimateriaalit/kunnossapito/mekaniikka_e04_voiteluaineet_lisa-aineet.html,Lubricant Additives: Chemistry and Applications, Leslie R. Rudnick, CRC Press)

Sulfur compounds, derivatives of carboxylic acids, nitrogen compounds and phosphorus derivatives are the engine lubricants most frequently used for corrosion additive chemicals. Many of these products are multi-effects and the compounds are used, inter alia, zinc dithiophosphate and benzotriazole. Metallipassivaattorit form their own group, which displace oxygen and moisture, and prevent dissolution of metals in the oil.

3.8 Friction Additives Converter

The friction additives Converter's main function is to absorb the metal surfaces and to create the microscopic thin, nearly frictionless surface. The effect of this additive is emphasized internal combustion engine lubrication applications where there is no hydrostatic, but hydrodynamic lubrication. In situations where the engine is started or is turned off, these additives are as a rule, they are substances that help protect the engine, even in situations where the engine lubrication system failure, these additives may save the engine lubricated friction surfaces. Friction converter additives are typically oil-soluble polar compounds such as alcohols, amides or salts, or alternatively, the oil and

additive company itself developed encrypted chemical compounds. (Lubricant Additives: Chemistry and Applications, Leslie R. Rudnick, CRC Press, 203-222)

3.9 The tag Additives

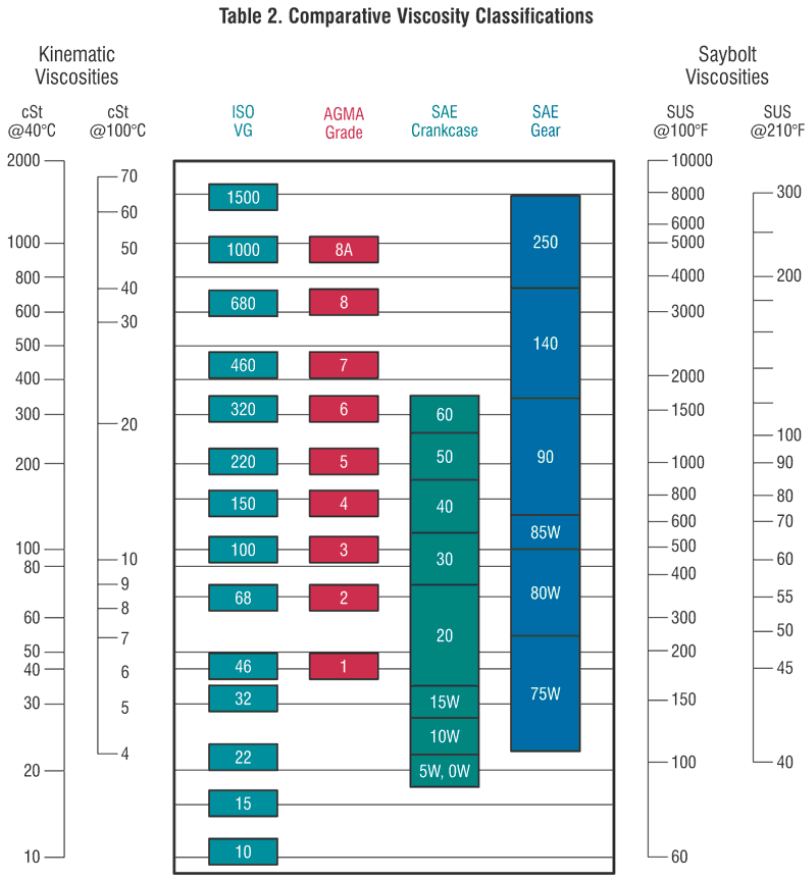
Zirconium (Zr) is commonly used in detection of oil additive. It has no other purpose lubricant, which means it does not participate in the lubrication oil and the behavior of the engine, and it can not be born as an impurity or the wear. The zirconium is about 20mg / kg, long-life -moottoriöljyjen Identification of the material. Zirconium allows car manufacturers and importers to ensure, if necessary, whether used motor oil as an approved long life. (Https://en.oelcheck.com/wiki/Zirco nium_% E 2% to 80% 93_why_does_this_element_pop_up_in_lab_reports% 3F)

4 Viscosity Index and the HTHS

The oil viscosity index reflects the change in the temperature of the oil viscosity changes. The higher the viscosity index, the less its viscosity changes with temperature fluctuations. Selection of a lubricant viscosity affects the bearing clearance and the entire engine operating temperature. Too wide viscosity index Selecting more lubricant suoriutumishaasteita. Is heard, the viscosity index decreases one slot index, the lubricant life cycle is considerably shortened.

The viscosity depends on the temperature and the pressure. The temperature rise of liquids, the viscosity decreases and the pressure increases, fluid viscosity increases.

SAE classified suppositories and transmission oil viscosity index is in line with the reading of SAE-rated engine oils, but in a different scale. For example, the viscosity index of one of SAE grade engine oil having a viscosity of 50 SAE 90 gear oil. A common misconception is directed to read the index and their comparison. The viscosity index is well illustrated Figure 9, which illustrates the viscosity index reading skaalauserot the gear, trailers and motor oils. (Http://www.upmpg.com/tech_articles/motoroil_viscosity/)



Kuva 8. The viscosity index (http://sovereign-omega.co.uk/what-is-viscosity/)

Racing engine crankshaft laakerivälysten general rule is one one-hundredth of a millimeter in diameter bearing clearance crankthrow per ten mils. In most engines of this clearance value is 0.03 mm-0.05mm, although the new engine technology designed to reduce the clearances objective of reduced pumping losses, and hence reduced exhaust emissions. Because of this, often for new passenger cars, the viscosity index is, for example, 0W-20 laakerivälysten of about 0,02mm.

The current SAE classifications may be necessary to reform the thinner lubricants, as many car manufacturers are already using the table to the lowest SAE viscosity index lubricant classes. Manual transmissions no longer sufficient classification table to determine the viscosity of the oil when it is so thin. Practical tests have shown that the oil with a higher viscosity will be able to carry a larger load and to maintain a higher oil pressure in the bearing and thus forming a better hydrostatic lubrication.

However, a high viscosity index can be detrimental to the engines, which are designed to a small viscosity index, and designed such that the oil must pass a remarkably small

holes, for example, chain tensioners and tappets. The high viscosity index also increases the internal friction of the lubricant, which in turn raises the temperature of the lubricant. Table 1 shows that the viscosity index is indicative reading. It is possible to have the two oil viscosity index differential is only 0.1cSt. Viscosity index provides the reference value, which must be accurate viscous oil to settle. (Http://www.upmpg.com/tech_articles/motoroil_viscosity/)

Taulukko 1. Viscosity Index and viscous. (Http://www.upmpg.com/tech_articles/motoroil_viscosity/)

SAE Viscosity Chart (High Temp) 100° C (210° F)		
SAE Viscosity	Kinematic (cSt) 100° C Min	Kinematic (cSt) 100° C Max
20	5.6	<9.3
30	9.3	<12.5
40	12.5	<16.3
50	16.3	<21.9
60	21.9	<26.1

Winter or "W" Grades			
SAE Viscosity	Low Temp (°C) Viscosity cP		Kinematic (cSt) 100° C Min
	Cranking Max	Pumping Max (NYS)	
0W	3,250 @ -30	60,000 @ -40	3.8
5W	3,500 @ -25	60,000 @ -35	3.8
10W	3,500 @ -20	60,000 @ -30	4.1
15W	3,500 @ -15	60,000 @ -25	5.6
20W	4,500 @ -10	60,000 @ -20	5.6
25W	6,000 @ -5	60,000 @ -15	9.3

HTHS measured by reading the oil at a temperature of 150 degrees to the specifically developed for the measuring device (Figure 9). The measuring device is a fast-rotating sliding bearing which shear strain-oil film. This type of measurement arrangements are intended to mimic the situation that arises at high speeds in a hot engine. This kind of test is intended to test the viscosity stability. However, the process of measurement does not simulate the surface pressure resistance of oils in the engine.

(Http://www.teboil.fi/tuotteet/voiteluaineet/yleista-voiteluaineista/suorituskykyluokitukset/)

Kuva 9. HTHS measuring device. (Https://www.crodalubricants.com/en-gb/discovery-zone/how-we-test-our-products/high-temperature-high-shear-viscometer)

5 Tribology and Lubrication mechanisms

Tribology-word stems from the Greek language tribos-word which means rubbing. Tribology is the study area, which looks at the contact surfaces, lubrication, friction and wear-related phenomena. In Sweden it is estimated that the cost of friction and wear are approximately 7% of GDP. Friction and examination of phenomena of wear, theoretically, is a challenge because of the many variables, so experimental research is often the only way to find out the actual effects of wear. Visual observations of lubricants are different from each other, but a direct conclusion on the basis of visual characteristics of different lubricants can not do. Figure 10 shows two visually different types of lubricant. (Kivioja, Stone Mountain, Salonen, 1997, Tribology-friction, wear and lubrication of instruction material Kai Laitinen)

Kuva 10. Motor oils visual perception differences.

Wear mechanisms are often divided into four main categories: abrasiiviseen-, adhesiiviseen-, tribokemialliseen- and fatigue wear. All of these degradation mechanisms found in internal combustion engine (Figure 11). Theoretical analysis often makes it difficult combination of the different wear mechanisms. In order to combat the degradation mechanisms, it is first identified. Effective means to combat the changing conditions, changing the structure and material selection. WEAR The most common internal combustion engine is abrasive wear. As a general starting point is that the harder the material is, the better it can withstand abrasive wear. This is true only if the hardness is changed by increasing substantially the current expenses and the ratio of hardness of the material. (Teaching materials, Kai Laitinen)

Kuva 11. the consequences of abrasive wear

The seemingly smooth surfaces are never perfectly flat, but they are more or less rough. When the actual surfaces are pressed against each other, pinnankarheushuiput carry the load. In this case, the actual contact area is often only a few percent of the apparent contact area. Surface peak temperatures can be momentarily thousands of degrees. Temperature shocks lasting only thousandths of seconds, but when repeated they affect the properties of the material. These temperature shocks soften and, at worst, can melt the counter surfaces. Those heat shock are also caused by thermal loads to the surface of which contributes to fatigue and cracking in brittle materials. (Teaching materials, Kai Laitinen)

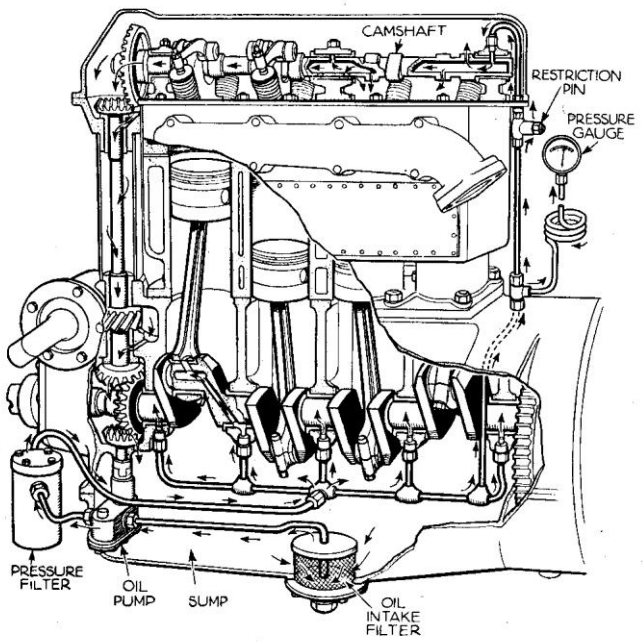
Very low loads the yield strength of the material is not exceeded, and the contact is completely elastic. When the surface roughness of top adapts plastically enough times, the deformation capacity runs out, and it breaks out as a result of fatigue. However, the majority of the contacts of the plastically deformable pinnankarheudenhuiput pinnankarheudenhuippujen and the formation of large dot thermal loads. (Teaching materials, Kai Laitinen)

Of lubricants through the wear can be reduced or even prevented completely. Sliding Speed affect the lubricated surfaces, the lubricant film thickness which affects both the wear of the friction coefficient. increase in load is directly proportional to the wear rate, but is not necessarily linear. against each other, sliding surfaces from the effects of stress load, or surface pressure, sliding speed. (Teaching materials, Kai Laitinen)

Through the tribological properties of the ages from internal combustion engines has been tried to improve a variety of coatings. Component Coating is not in itself a challenge of modern technology, but rather the wear resistance of coatings. The challenge for the coated components is often the adhesion between the coating and the base material, when a component subjected to high surface pressures and the base material takes place in the elastic deformation. Heat generated between the contact surfaces of the two bodies is dependent on imported energy between a surface speed, surface pressure and friction. (Teaching materials, Kai Laitinen)

5.1 The internal combustion engine lubrication system

The internal combustion engine lubrication system, the primary task is to lubricate the friction surfaces of the engine. Lubricant pump oil pressure is produced in the internal combustion engine oil ducts, which carry the lubricant to lubrication points (Figure 11). This provides lubrication points with a full hydrostatic lubrication, which is the most effective way to carry out the separation of the two friction surface. However, the internal combustion engine will remain a number of items which can not be used for hydrostatic lubrication. Most of these are located in the cylinder head, which is the engine lubricant challenging target, because it is located furthest away from the oil pump and the temperatures are high. (Teaching Material Heikki Parviainen)



Kuva 12. Cross-section of a typical gasoline engines lubrication system (https://www.hls.ie/what-is-a-lubrication-system-hls-explains/)

One of the problems of modern engines is sludge long-life oils accumulation of the oil pump strainer. With modern lubricant system also has other functions, the most important engine temperature management. One third of the heat energy generated by the motor is evaporated from the lubricant system. In today's petrol engines, the oil temperature can be 150 ° C, and the temperatures are significantly higher in high pressure in underground applications such as bearing journals. 30-40 ° C higher than the temperature kammenkaulan the oil sump the lubricant is measured. It is also measured at 150 ° C, the difference between the piston ring and the oil sump area. (Teaching Material Heikki Parviainen)

The internal combustion engine design as one of the starting point is to control the heat generated by friction, and to achieve the required heat transition lubrication technology. These planning assumptions are canceled when the engine performance will improve. Engine performance increase is often followed by increased thermal load, particularly in components where there is a limit and the principles of mixed lubrication. (Teaching Material Heikki Parviainen)

In general, internal combustion engine oil pressure is sufficient speed range 0.7-1bar 1000rpm, and 1000rpm of turns increases the pressure to rise up to 1 bar amount at 5000rpm. The lubricant system pressure lift to raise the temperature of the lubricant used in the internal combustion engine. The thinner viscosity of the engine oil is improved by cooling the larger the flowrate is, and therefore more oil flows through the system at the same time. the most important thing in terms of the anointing is to remain at moderate bearing and sliding surfaces sliding speeds, as excessive sliding speed causes the lubricating substance unnecessary challenges that the oil pressure in the lift would be able to compensate. Experience has shown the connecting rod necks over approx. The 25m / s sliding speed to cause challenges for lubricants.

The most cost effective way of improving the modern internal combustion engines, the lubricant system is used in tribological performance oil. This is also a positive filtering system because the current engines of particles must be small because of the hard materials karkaisutasojen and small clearances. Sliding surfaces simply does not fit in very large dirt particles, so as not to impact on the components that cause plastic deformation.

The textbook of pure liquid lubricating the surfaces completely separated from each other by means of an oil film. In this case, the wear is minimal and any level of wear and tear due to the lubricant of the entrained impurities. The particle size of the impurities will in this case be higher than that in the lubricant in the lubricant film thickness. This kind of liquid lubricant is an internal combustion engine lubricating wear protective mechanisms of the best. The liquid lubrication can be divided into three different groups, hydrodynamic (HD), elastohydrodynaamiseen (EHL), and the hydrostatic bearings. All of these lubricating mechanisms present in modern internal combustion engine.

In addition to the clean fluid lubrication of the internal combustion engine occurs in mixed and Boundary lubrication. These lubrication mechanism of the lubricating substance is pumped under pressure into the lubricated interest. Spots are lubricated with targeted ruiskukanavilla, the environment in which Splash, or the reciprocating movement of the lubricant is increased in, for example located into the hollow bucket tappets on the valve mechanism.

5.2 Hydrodynamic lubrication

Hydrodynamic lubrication prerequisite is that there is a relative speed difference between the lubrication lubricated surfaces. The speed difference and converging in favor of oil pocket is achieved by using a lubricant transportation be lubricated sliding surfaces. Another prerequisite is a sufficient oil supply tapered oil groove to pre-oil pocket. The converging öljyura be lubricated surfaces creates overpressure in the lubricant film. Overpressure lubricant is distributed to the bearing surfaces and the lubricant film is capable of bearing the load on the bearings. (Teaching Material Kai Laitinen)

The engine lubricant pump operates to transfer the oil pocket the bearing lubricant oil in the system along. In this case, the oil pump pressure is not critical lubrication mechanism, which has been in use hydrodynamic lubrication. What is important is the magnitude of the volume flow and the resulting oil film bearing shells design churn. Hydrodynamic lubrication is used in most modern engines, the crankshaft main bearings for lubrication, typically the greater the load bearing capacity of a runkopukkien. It is also bearing solutions, in which the oil pocket is machined from both main bearing half, when the principles of hydrodynamic lubrication will not be realized. 13 such as the frame bearings The hydrodynamic lubrication is fulfilled. The damage is similar to the typical lubricant system failure or damage due to a disturbance.

Kuva 13. Damaged crankshaft main bearings (left) and the intact main bearings (right).

5.3 Elastohydrodynamic lubrication

Elastohydrodynamic lubrication occurs most commonly in heavy-duty rolling bearings and highly loaded gears. Internal combustion engines for gears, consisting of the transfer of large forces through small surface areas, formed by the high contact pressures that may be in the order 0,3-3Gpa. under great pressure in the lubricant film thickness is only about 1 microns. Lubricant In the contact surfaces occurs elastic deformation. (Teaching Material Kai Laitinen)

The lubricant viscosity increases sharply at high pressure. Lubricant no longer behave as hydrodynamic lubrication and no longer be removed from the wedge-shaped gap. Such a large pressure generated by a point-like and linear contact. The pressure effect on the viscosity exponentially according to the following equation. (Airila et all. 1995 p. 425)

$$\eta = \eta_0 e^{\alpha p}$$

where η_0 The viscosity at normal pressure

α the viscosity of the pressure exponent (0.015 to 0.03 N 2mm)

Due to the high pressure lubricant compressed, its viscosity increases strain on the lubricant film. EP additives are of great value in such situations. due to the thin voiteluainekalvopaksuuksien advanced tribological surfaces and coatings help protect the elastohydrodynaamisesti anointed to wear effectively. (Teaching Material Kai Laitinen)

These items are also sensitive to contaminants because the thin voiteluainekalvopaksuudessa and a small contact surface area, even a small impurity acts as an effective abraded particles as the abrasive. Hard abraded particles are particularly harmful elastohydrodynaamisen lubrication properties, as early as a few microns in particle size causes under the pressure of great stress and heat concentration. The most typical elastohydrodynaamisesti loaded objects in modern internal combustion engines have a timing chain sprocket wheels and other components. (Teaching Material Kai Laitinen)

5.4 Hydrostatic lubrication

The main component of the hydrostatic lubrication oil pump for generating a pressure of the lubricant oil is transferred directly between the sliding surfaces to be lubricated. Thus, the oil formed a hydrostatic pressure capable of separating the sliding surfaces from each other, even if the relative motion between the surfaces is also possible. (Teaching Material Kai Laitinen)

advantages of hydrostatic bearings are small friction losses. It is noted, however, that the pumping losses caused by the oil pump cancel out the effects of friction loss. Therefore, both the flowrate-changing oil pumps and low viscosity oils have begun to favor the new engine technology. The hydrostatic bearing systems, the stiffness must be high, because the lubricant film is not able to bear the high forces created by hydrostatic pressure.

5.5 Border and mixed lubrication

An internal combustion engine has a number of border and mixed lubrication points. Mixed Lubrication In combined liquid and boundary lubrication. The situation is lubricating the mechanisms of the most challenging in terms of lubricant, since part of the load bears a thin film of lubricant and the remainder will be pinnankarkeushuippujen contact with each other. For this reason, manufacturers are forced to use and limit sekavoidelluissa components of advanced materials, and the tribological hard tempering. In such a situation the lubricating properties help the tribological performance oil, a surface-active additives EP-like metal pinnankarheushuiput separate from each other. (Teaching Material Kai Laitinen)

In these situations, the tribological properties of the lubricant and EP additives strength plays a major role and to effectively reduce the sliding friction, thereby reducing wear on engine components significantly. The oil viscosity is not capable of protecting the mixed lubrication conditions, the surface roughness of the peak will increase the contact between the contact surfaces between the temperatures significantly romahduttaen oil viscosity. As a result, a mixed lubrication situation is changing fast, boundary lubrication conditions. Advanced tribological and doped with surface-active additives lubricant is able to use this kind of situation to as additives, surface activity requires heat and pressure, and this environment acts as a catalyst absorbed from the surface of tribological additives for making better between pinnankarheushuippujen.

The lubrication effectiveness is based almost exclusively limit and mixed lubrication conditions the adhesion of surface films, ability to be absorbed in the pores, and the stability of formation of the contact point. response to the temperature of the surface-active additives can be controlled by the types of additives, and chemical combinations. Lubricant in case of failure of the film coefficient of friction can easily reach the level of a pair of dry friction material values or even stick to be cut. (Teaching Material Kai Laitinen)

An internal combustion engine starting and stopping moments are common frontier and mixed lubrication times when the components are under strain. Especially in these situations, the lubricant of EP additives reduce the abrasive and adhesive wear. Border and improve joint lubrication shall ensure the cooling of the lubricant, as well as providing transportation to lubrication. Typical limit and mixed lubrication to have almost all the

lubricating points of the valve mechanism, and the timing chain powered accessories and the cylinder walls.

All are difficult to be lubricated of interest is a racing engine applications developed for a variety of component coatings and solid lubricants such as DLC, cryo, Nicasil, Alusil, Black Carbon, MOS, NFC, PTFE and the like. Components of the coating or the solid lubricant may instead be similar tribological properties limit and mixed lubrication targets to achieve more cost-effective tribological-performance oil .

Figure tribological properties of Piston 13 of the engine racing is made to improve the hem attached to the PTFE pins, and the area of Piston coated with a solid lubricant (NFC / DLC). Despite the improvement of measures to be seen how the oil surface pressure resistance is betrayed, and a clear wear has occurred.

Kuva 14. Damage to the piston skirt

6 measurements

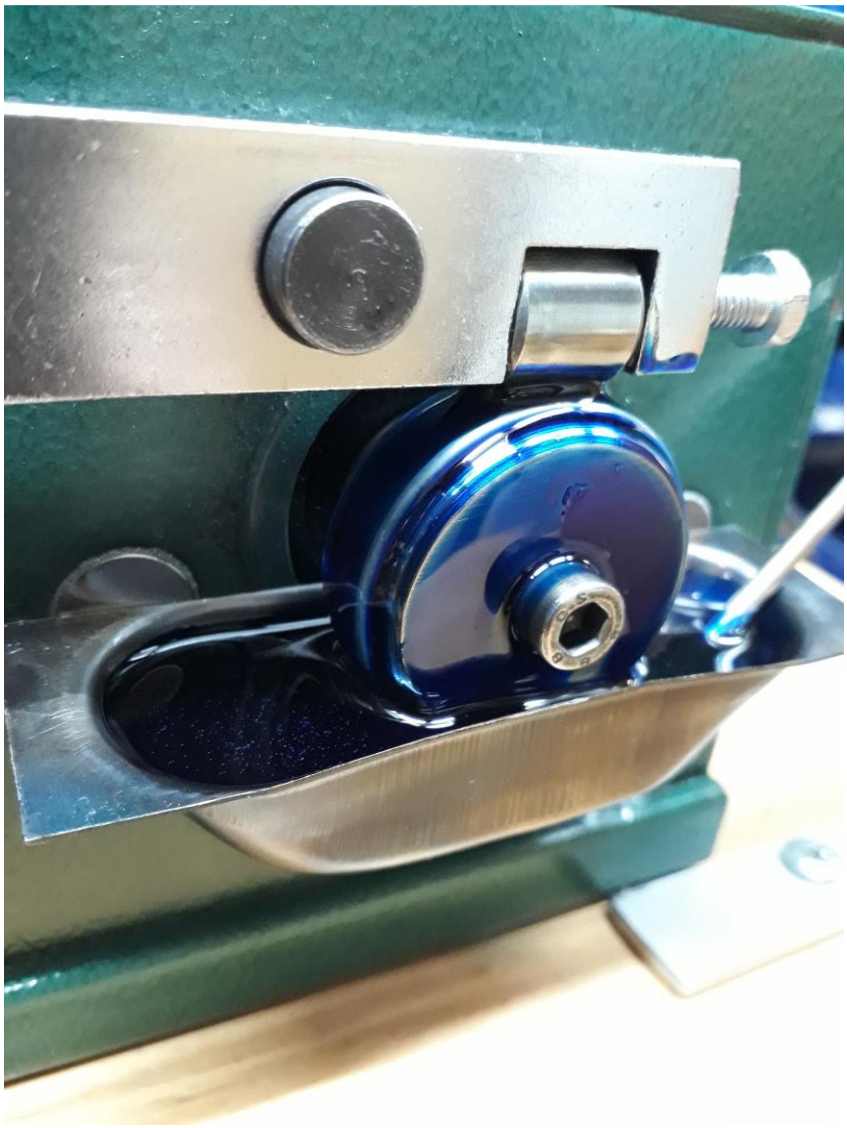
6.1 Measuring equipment

A test device used in this work is based on Timken -type surface pressure test equipment, by Henry Timken was developed as early as in 1935 (Figure 15). Unit loading method, either lihasvoimaperäisesti or weights has been questioned, since the results

so obtained are only indicative, the often unreliable and easily distort. As a result, the test apparatus was modified significantly improve the reliability and repeatability.

Kuva 15. The typical commercial Timken device. (Https://www.alibaba.com/product-detail/Lubricants-abrasion-test-machine-oil-abrasion_60737766389.html?spm=a2700.7724857.main07.1.5b285faaDa6ysP&s=p)

The test device includes an electric motor, a lever mechanism, the operating switch of the flow meter, an oil container, load-addition method and the biopsy and the koerullan (Figure 16). The electric motor rotates through a belt koerullaa. Koerulla rotation öljyastiasta captures the oil, which enters between the roller and the rotating test biopsy. A biopsy is attached to the first lever arm locking mechanism. The first lever arm has a second extension of the longer lever arm, which form the test device handle hardware. Increasing the mass of the load takes place by pouring liquid through a standard stopcock lever arm located away from the vessel.



Kuva 16. Measuring the focal point of the event.

6.2 Performing measurements

An elliptical surface area A is given by:

$$A = \pi \cdot ab$$

where a and b are the semi-ellipse. (Kivioja, Stone Mountain, Salonen, 1997, Tribology-friction, wear and lubrication, 88)

Raapaisujäljen measuring the width (L) and height (h) is given by:

$$A = \pi \cdot \left(\frac{l}{2}\right) \cdot \left(\frac{h}{2}\right)$$

After which, the surface pressure resistance P is given by:

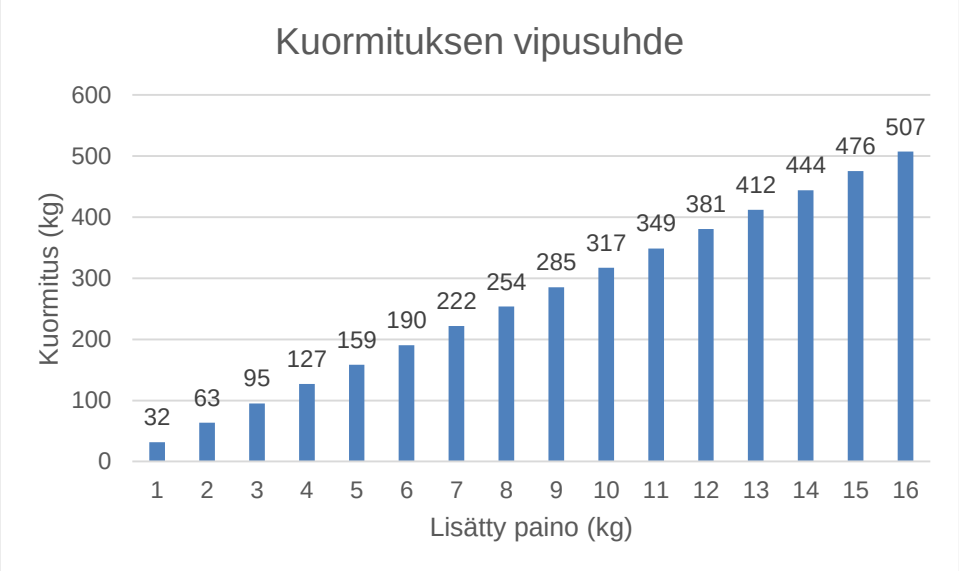
$$P = m/A$$

The calculation of the surface pressure resistance, in the formula of pulp is added to the initial weight of the lever mechanism and the leverage ratio is multiplied by x

$$P = \frac{(m+1) \cdot x}{A}$$

The below Table 2 shows the lever mechanism with respect to the linear rise in load. increase in the mass of the unit multiplies a ratio of 1: 31,71 the lever mechanism. Achieving a high load like this requires a radical leverage ratio, in order to test the best kiinnileikkautumispiste can withstand oils was achieved.

Taulukko 2. Load leverage ratio



A prerequisite for the measurements was to obtain measurement conditions remain constant throughout the measurement event. Lubricant measurements were divided into two main categories, Consumer Affairs and performance oils. The measurements, the focus was on lubricants, surface pressure duration. The starting point was to get the

maximum benefit of repeatability, and this succeeded by editing the increasing load event fluid flow. The load increase was identical of different oils in accordance with Table 3, the curve is descending parabola. With this change, the reproducibility give the desired level, and removal of human errors made by a human.

Taulukko 3. Load increase in function of time

All surface pressure tests were performed in the same current during the day. Each oil was numbered with the test and were listed in a table. Oils were tested in numerical order and oils reported kuormituspunnus, the final temperature, elapsed time and the load raapaisujäljen whole. Each test was started by installing the fixture clean the outer bearing ring, and clean the roller bearing roller (later "test piece"), which act as consumable test starring surfaces.

Before starting the engine oil heated to 110 ° C, and then allowed to cool to 100 ° C. When the temperature is equal to one hundred degrees, the test, the engine was started. After a further three seconds, was initiated load. audio visual observations of the behavior of different oils were carried out during the test friction and temperature. The surface pressure rises, and the oil film in case of failure of the electric motor load becomes too great, and the torque generated by the motor is not able to set aside the frictional force between the test piece and the roller. The load is switched off immediately when the friction force is the winner of the motor torque, and at the moment of each oil were recorded execution time and end temperature. At the end of the biopsy performed raapaisujäljen length and width were measured.

The measurement Mahr-brand digital vernier calipers were used and a microscope as a visual aid. Tabulation was facilitated by a wireless communication system between the measuring device and computer. In this way, each oil repeating the recorded measured values.

Kuva 17. Biopsies archived.

6.3 the reproducibility of the measurements,

The thesis discussed the design phase reproducibility, which was an absolute criterion to start the measurements. To achieve sufficient reproducibility of test equipment developed by modifying the method of load and improving the tribological properties of the lever device discharge valve. Testing orientation and systematic behavior during the actual measurement of the event were also the subject of development.

Method of load increase was completely changed stepwise, weights are added to digivaa'alla closely monitored but liquid water draining from the lever arm located on the vessel. The lever arms are modified using the general stress level in the place of hard-tempered counter surfaces of the original soft metal alloy.

The use of the test device was started by testing different oils prior to official measurements. The tests are repeated several hundreds of times. When making these

tests it was found that even small measurement variables of the event led to a deterioration of reproducibility. These control tests give a pitch repetition and experience of the test apparatus and the various oils. As the work progressed, it was found the importance of the use of the test device before the official measurements was to test the event of a number of small factors that contributed to the measuring process, and these could be eliminated before proceeding to the official measurements.

between two kinds of oil, the duration of which the surface pressure is adequate, but different from each other were selected reproducibility. This was achieved reproducibility even loading time. Raapaisujäljissä also appeared in two different dimension. Comparison Parilla ten from each other poikkeamatonta repeatability was made. Table 4 shows temperature, time and weight of the load and the dimensions of raapaisujäljen ellipsis. The measurement results were averaged, and the standard deviation of the error rate. Based on these repeatability of less than five per cent of the repeatability error was found.

Taulukko 4. The measurement repeatability.

Toistettavuustestin öljy 1.					
Lämpötila (Celsius)	**Paino(lb)**	**Jäljen pituus (mm)**	**Jäljen leveys (mm)**	**Pinta-ala (mm2)**	**Pintapaineen kesto (psi)**
186,00	22,09	2,65	2,03	4,23	179570,50
182,00	21,98	2,53	1,99	3,95	190953,52
185,00	22,31	2,55	2,01	4,03	190264,29
190,00	21,89	2,62	2,09	4,30	174883,75
188,00	21,93	2,51	1,97	3,88	194006,08
188,00	21,70	2,62	2,05	4,22	176816,16
197,00	21,81	2,69	2,09	4,42	169737,56
179,00	22,22	2,68	2,14	4,50	169381,08
180,00	21,45	2,48	2,04	3,97	185646,06
179,00	22,54	2,65	2,11	4,39	176128,39
			Keskiarvo (psi)		180738,74
			Keskihajonta (psi)		8928,68
			Virheprosentti (%)		4,94
Toistettavuustestin öljy 2.					
88,00	3,02	6,69	4,37	22,96	5752,67
86,00	2,86	6,62	4,30	22,36	5672,99
89,00	3,01	6,81	4,42	23,64	5573,48
93,00	2,89	6,78	4,34	23,11	5530,72
98,00	2,99	6,66	4,14	21,66	6054,10
99,00	3,04	6,64	4,25	22,16	5989,29
90,00	3,19	6,73	4,38	23,15	5946,70
87,00	2,87	6,78	4,41	23,48	5414,94
84,00	3,08	6,84	4,52	24,28	5520,99
86,00	2,95	6,75	4,36	23,11	5615,11
			Keskiarvo (psi)		5707,10
			Keskihajonta (psi)		220,63
			Virheprosentti (%)		3,87

Figure 16 is a biopsy, which is more raapaisujälki of the same oil. These raapaisujälkien and the weight of the load was done reproducibility calculations.

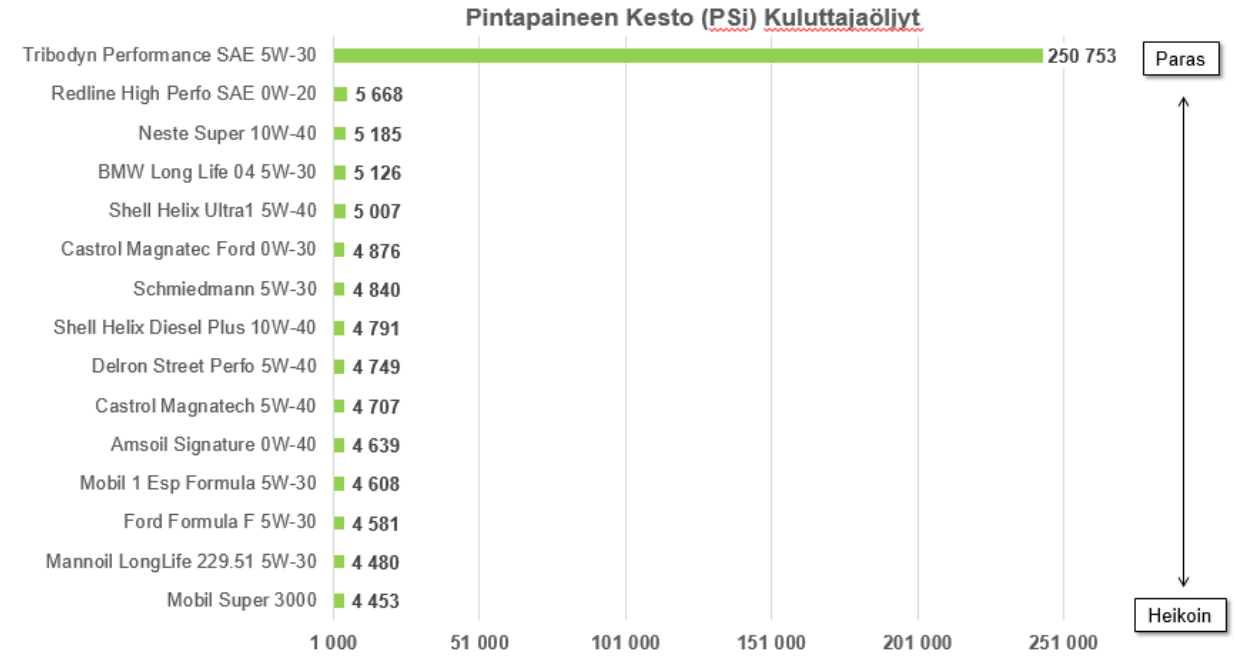
Kuva 18. Raapaisujäljet biopsy.

6.4 Measurement results

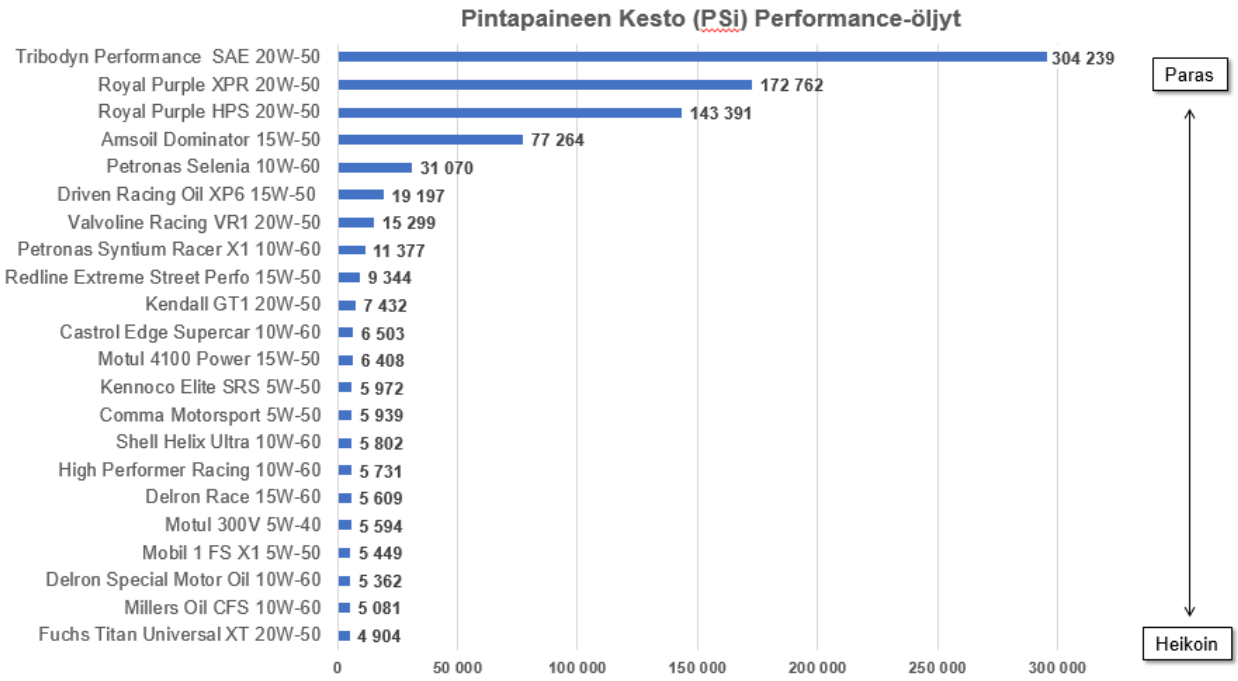
The research results are presented in Tables 5 and 6. Table 5 pintapaineenkestot consumer oils tabulated in the ranking order, and the values of the corresponding performance of oils in Table 6. It can be observed that the consumer the best in the category of consumer oils peittoavat the worst oil performance category pintapaineenkestossa. From the results we can see that the oil manufacturer The categorization of the product does not tell the oil film surface pressure duration.

documented work parameters raapaisujälkien-soluble, as well as the load time can be found in Annex 1.

Taulukko 5. surface pressure resistance of the Consumer oils



Taulukko 6. surface pressure resistance performance oils



6.5 The dynamometer measurements

on the basis of observations made at the surface pressure of the test was to obtain support for dynamometer test. It can be assumed that a weak pintapaineenkestolla oil becomes more marginal and mixed lubrication conditions pinnankarheushuippujen contact with each other. These pinnankarheushuippujen contact to increase the friction, increase local temperature, and reduce the torque produced by the motor. The goal was to determine how much of the border and a mixed lubrication situations friction losses actually affect the efficiency of the engine, as these modern tribological lubricants are able to reduce the test, according to pinnankarheushuippujen contact with each other.

Many oil manufacturers market their products by telling how the effects of the oil is changed are shown engine power and torque in the. It is common for manufacturers of praise for oil products "slipperiness" without a clear test results. As a result, the surface pressure test seven oil was elected dynamometer test. Test were chosen as the top end of the same viscosity of the oils, so that pumping losses do not affect the efficiency measured. Was chosen as Car of Toyota Celica ST 205 34mm coupler. Coupler was useful because the objective was to determine exactly what kind of differences in oil provides the engine efficiency, and limits the engine coupler was used without always constant to the largest one of the variables was eliminated.

Preparations for the test vehicle on a chassis dynamometer (TAT Chassis Dyno Rolling Road Dyno Inertial Systems) was started by measuring the engine's compression pressures, as well as ohivuodot. The car performed a four-wheel alignment and direction of the wheels was to the country as neutrally as possible, so that transmission losses or the measurement results are not distorted. Measurements jäykkäkylkisiä new tires used in order not to distort the measurement of deformation caused by the temperature of the tire. Auto tied on top of each corner of the chassis dynamometer, as well as further confirmation cloth through the middle of the car. In this context, the measured distance from the standard body measurement points dynamometer at constant measuring points, and this distance is monitored and corrected, if necessary, between measurements. The car was connected to the chassis dynamometer controller devices so,

The measurements were started by first making a number of control measurements. During these motor vehicle and give a stable temperature. The measurement was started

by adding oil to the engine and changing the new oil filter. The engine was operated until the oil reached a stable temperature of 85 degrees Celsius. Engine power measurement carried out, and then, the motor control for data collection were recorded oil pressure and temperature data to a predefined set of round areas. This measurement was carried out by repeating systematically into the oil. Figure 19 is seen as a chassis dynamometer results are listed, and Annex 2 is the torque curves of different dynamometer results of the oils.

Kendall GT1 20W-50	**310,3HP / 559,5NM**
Amsoil Dominator 15W-50	**309,8HP / 559,6NM**
Redline Extreme Streetperformance 15W-50	**309,3HP / 558,4NM**
Castrol Edge Supercar 10W-60	**309,4HP / 559,0NM**
Delron Race 15W-60	**311,2HP / 560,7NM**
Royal Purple XPR 20W-50	**310,2HP / 557,3NM**
Tribodyn Performance Lubricants 20W-50	**312,3HP / 559,3NM**

Kuva 19. The results of the dynamometer.

The results indicate that the engine of major losses due to heat losses. the effects of the lubricant efficiency were observed. Significant differences such as the surface pressure resistance results were observed. From various sources have been receiving reports several percent of motor power increases the effect of the oil, but such results have not occurred.

7 Summary and Review

Several of the world's largest companies, with a turnover of up to € 200 billion, operates in the field of lubricant. advertising budgets for these companies are hundreds of millions of Euro, and brand values even higher. For people to create ads using images and illusions of security capabilities and characteristics of their products. The company's brand can effectively influence consumers' perceptions and choices through the oil, so it is hardly surprising that the protection, marketing and maintenance of corporate image and brand is investing hundreds of millions of euros annually.

It is consulted by the early 2000's oil to a manufacturer's product accounted for 80% by the Finnish oil packaged. A major factor was the huge advertising campaign, rally, as well as the addition of a formula-car image side of the can and an active workshop and store sector, ways to improve cooperation. This proves how great a proportion of sales of oils is based on the perceptions and relationships.

The major oil companies reserve the secondary market for fraternizing with car manufacturers, namely the sale of first-time setup oils even without margins, brands, logos in order to get onto the filler caps as well as a car manufacturer's quality ratings of their öljyihinsä. This is an effective way of ensuring a secondary market for the sale of packaged oil, in other words, by creating powerful images of oil, which would be the best option for the consumer.

One of the world's largest oil company responsible for the North-European product support engineer told me that it is not unusual to launch the same product in two product categories with different labels and different prices. This reflects very well how difficult it is to compare consumer products, if the same oil can be sold at a different price in different jars.

Theoretical calculations indicate a case where the engine components are designed well and the plan succeeded and the engine is not tuned in, the anointing would be expected to be perfect nor wear occur, but this rarely come true. The car itself is designed vehicle spare parts market with a calculated and controlled wear is the core of the design. Against this wear can fight better anti-wear properties equipped with oil.

When the engine power, torque, or maximum revs are components after the original engine manufacturer's plans changed, there is a complete fluid lubrication safety margin decreased. This means that the lubricant is required in the increased surface pressure resistance limit and mixed lubrication conditions. As a result of modern automotive manufacturing methods and the spare parts market ideology engine damage often incurred high costs. There are plenty of large components and large applications that are after the breakdown of the correction is unusable. In particular, the minimization of injuries caused by these sorts of applications, lubrication is the most reasonable cost reasons, to solve a preventive measure, by selecting the characteristics of the security-performance lubricant.

Best oil tribological developed, often patented, heat and pressure are activated by a surface-active EP-additives create a coating on the metal surfaces. Tribo This coating protects the bearings and the valve mechanism when the principles of the ideal lubrication is exceeded or lost, and proceed to the boundary lubrication conditions.

The aim of this thesis was to create a comprehensive, mutually comparable listing of engine oils, surface pressure resistance. The aim was to gather as broad as possible a sample of consumer and performance of oils of different viscosity indices. The tests progresses, motor oils were found some clear border surface pressure resistance average, which inspires a deeper study the performance of the oil.

A new objective was to search and find the lubricant pair of world-class motor racing. Nearly the final stage of operational research was commissioned an in-flight American Motor Sport online store designed to compete item for use in motor oils. become a lot is accompanied by TriboDyn from the brand motor oil turned out to be the most successful oil so our research Racing, as the consumer category, too. The research outcome and quality of the product reported TriboDynin mill, which eventually led to the North European import agreement. The end it can be said that the objectives of the work was achieved and even exceeded.

sources

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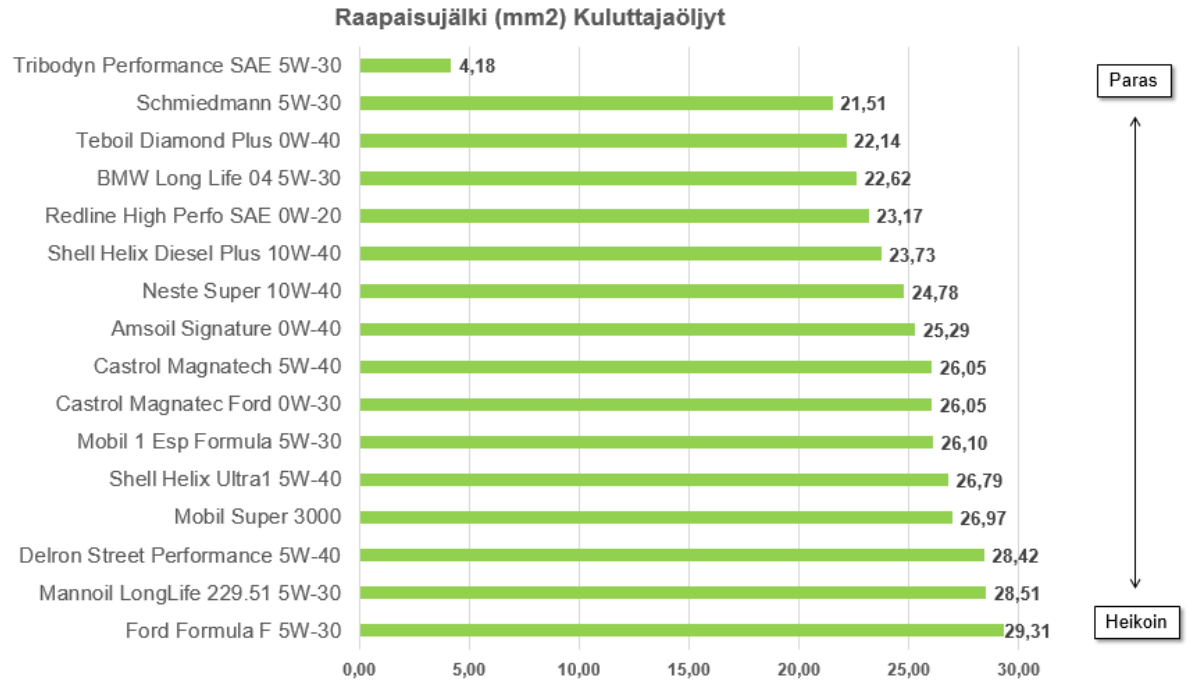
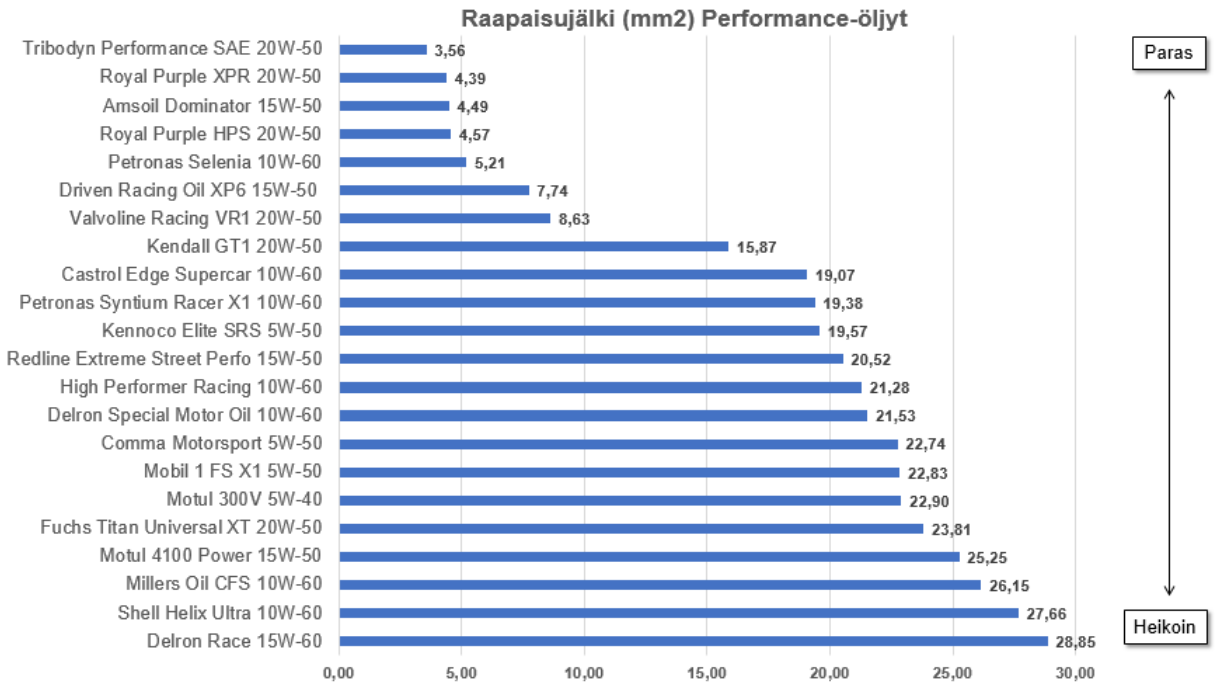
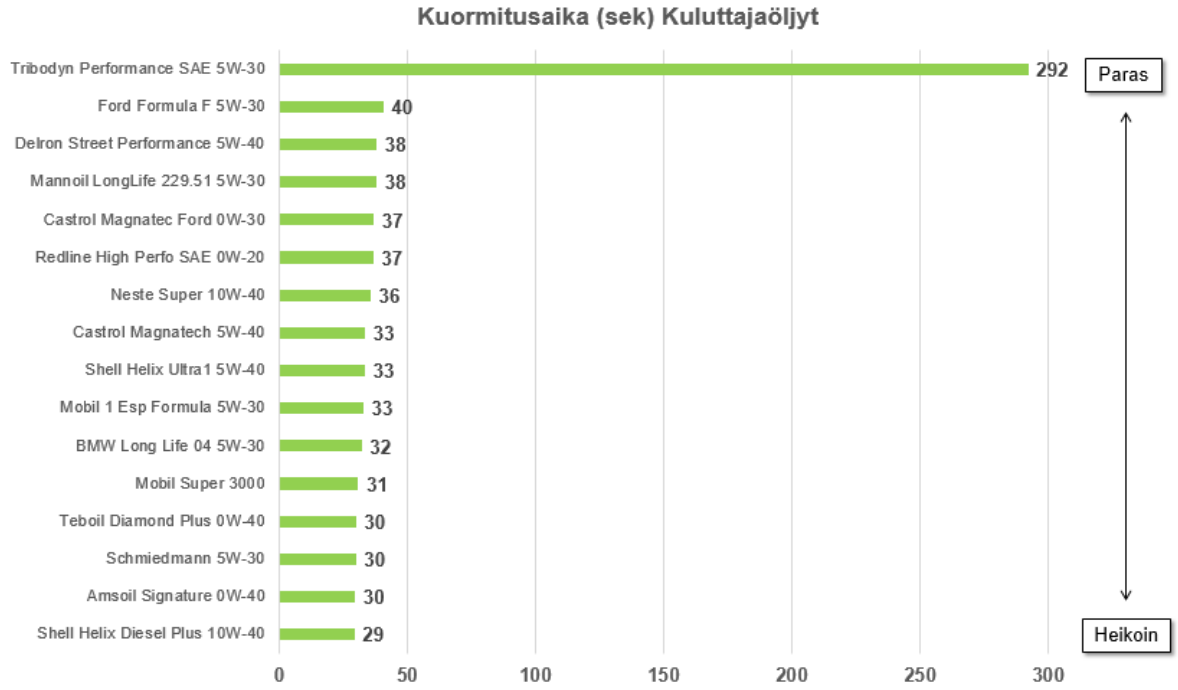
Taulukko 7. Consumer oils raapaisujäljen size



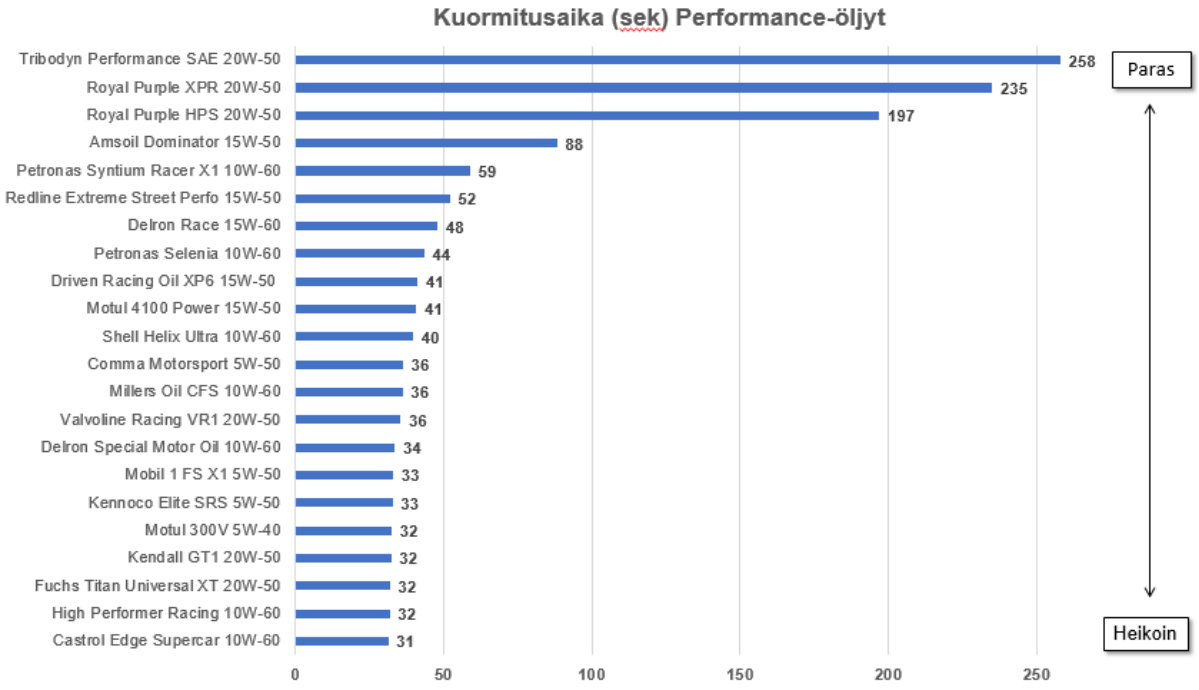
Taulukko 8. Performance-oils raapaisujäljen size



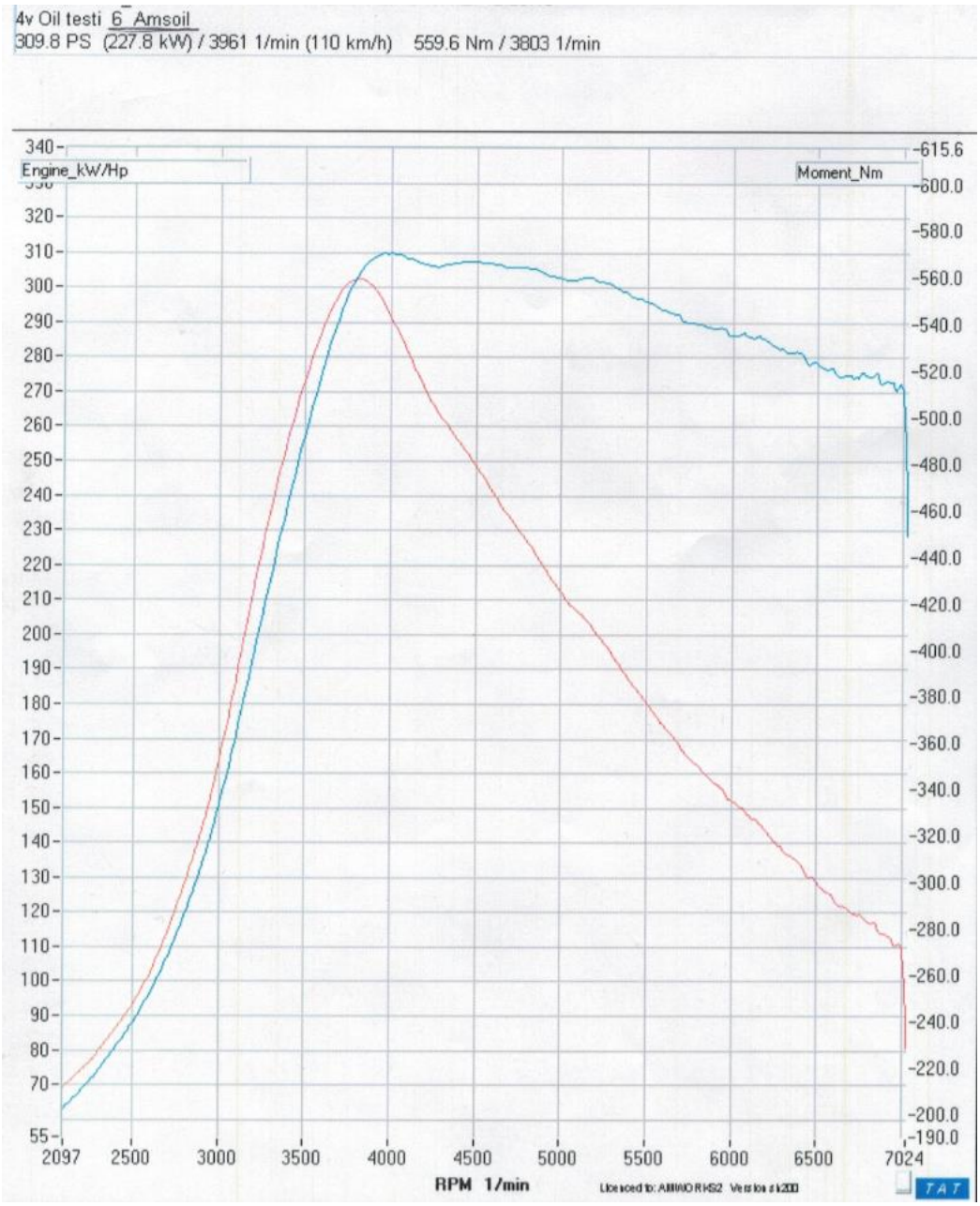
Taulukko 9. load time Consumer oils

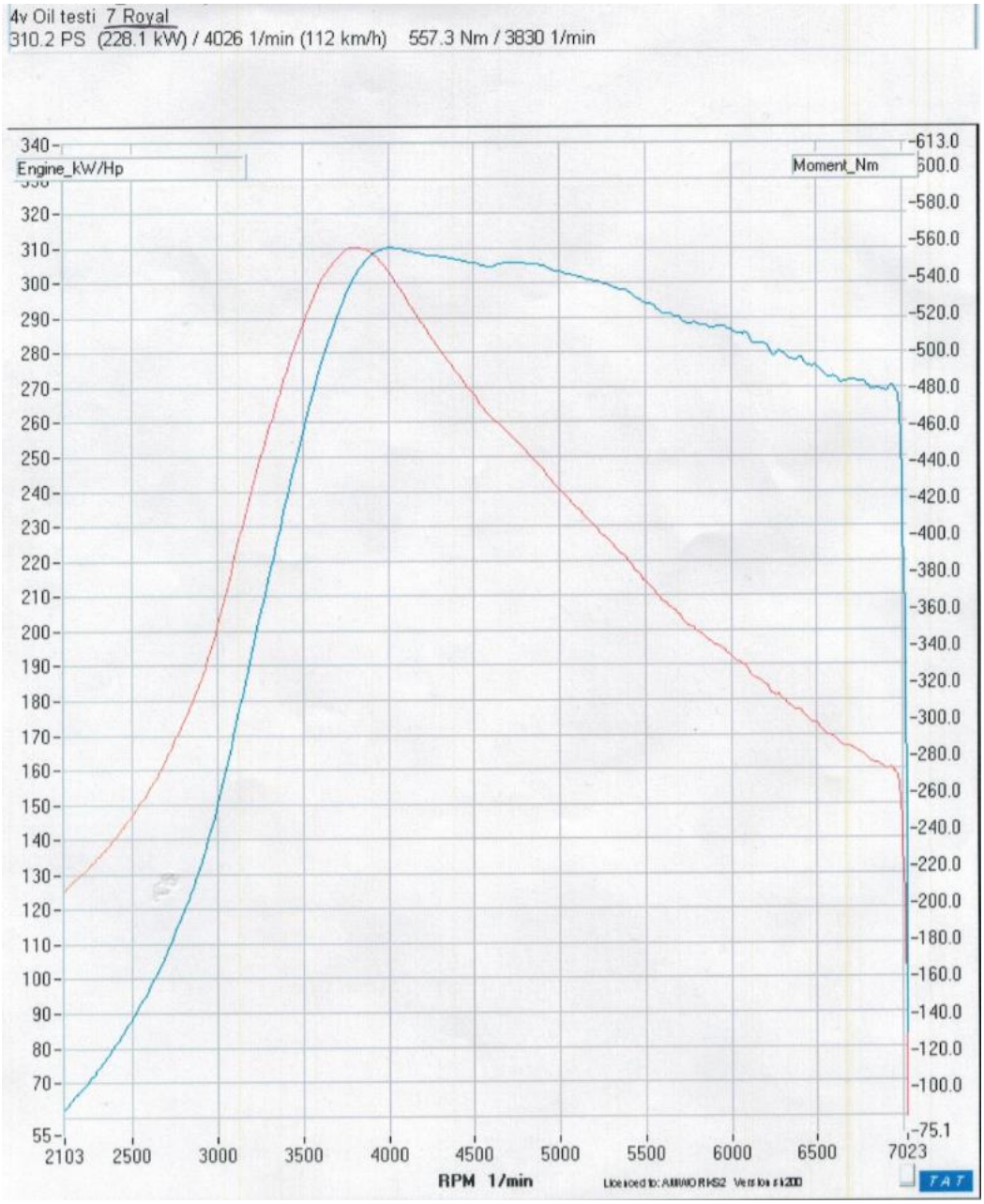


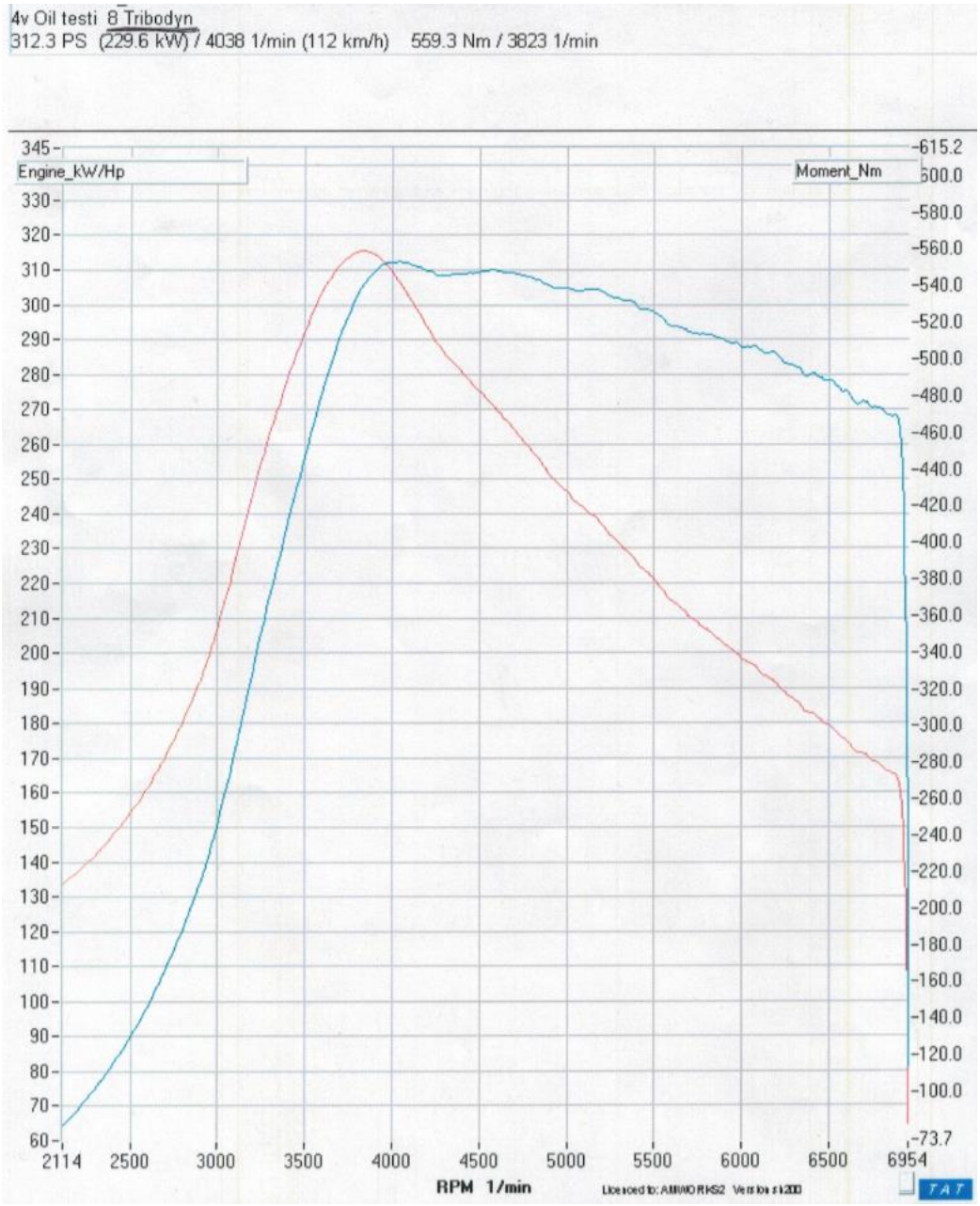
Taulukko 10. load-time performance oils



Chassis dynamometer Results




4v Oil testi 7 Royal
310.2 PS (228.1 kW) / 4026 1/min (112 km/h) 557.3 Nm / 3830 1/min
Engine_kW/Hp
Moment_Nm
340
320
310
300
290
280
270
260
250
240
230
220
210
200
190
180
170
160
150
140
130
120
110
100
90
80
70
55
613.0
580.0
560.0
540.0
520.0
500.0
480.0
460.0
440.0
420.0
400.0
380.0
360.0
340.0
320.0
300.0
280.0
260.0
240.0
220.0
200.0
180.0
160.0
140.0
120.0
100.0
75.1
2103
2500
3000
3500
4000
4500
5000
5500
6000
6500
7023
RPM 1/min
TAT


4v Oil testi 8 Tribodyn
312.3 PS (229.6 kW) / 4038 1/min (112 km/h) 559.3 Nm / 3823 1/min
Engine_kW/Hp
Moment_Nm
345
330
320
310
300
290
280
270
260
250
240
230
220
210
200
190
180
170
160
150
140
130
120
110
100
90
80
70
60
615.2
580.0
560.0
540.0
520.0
500.0
480.0
460.0
440.0
420.0
400.0
380.0
360.0
340.0
320.0
300.0
280.0
260.0
240.0
220.0
200.0
180.0
160.0
140.0
120.0
100.0
73.7
2114
2500
3000
3500
4000
4500
5000
5500
6000
6500
6954
RPM 1/min
TAT