Automotive Oil Drain Frequencies

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Do you recall the expression,
“Clean Dry Cool Well-Oiled
- Right Oil
- Right Place
- Right Amount
- Right Time?”

It is used to describe good lubrication practices.

Or the one, “Choosing the right oil, taking proper care of it and changing it on time?”

They both contain a word or phrase that includes the importance of properly timed oil changes. Although this article is oriented toward automotive applications, much of what is discussed here also applies to industrial applications.

The main reasons for draining the oil are usually
1) Contamination,
2) Additive Depletion and
3) Base Oil Deterioration (Oxidation).

Contamination of the oil from soot, silica (dirt), water, glycol and wear debris is possibly the most common reason for changing the oil. The next most common reason is additive depletion, primarily due to the antioxidant and detergent depletion spurred on by temperature, wear debris and water, and resulting in acid build-up. Probably the least common of these major reasons is direct attack on the base oil. Most of the time, the oil is changed before significant damage has occurred to the base oil.

The factors which influence oil drain intervals include:
• Sump Capacity
• Oil Quality
• Filtration (oil by-pass and air)
• Temperature, and
• Soot Load (diesel engines)

Other factors which have a lesser affect are:
• Fuel Consumption (Fuel Economy and Load)
• Fuel Sulfur Content
• Excessive Idling Time of Diesels and,
• Oil Consumption.

In regard to these factors, if the sump capacity, oil quality, filtration, fuel economy or oil consumption increase, then the drain interval will be positively affected and will increase. But, if the temperature, soot loading, load or duty cycle, sulfur content of the fuel or idle time increase, then the drain interval will be negatively affected and will decrease.

The bottom line effect that the oil drain interval selection has on operations and maintenance is basically dollars. Oil changes create out-of-service periods which affect equipment availability and productivity. Manpower requirements that are needed to perform the oil change plus the cost of the new oil and disposal of the used oil contribute to the cost. The actual cost of an oil change can be as much as 40 times more than the cost of the oil itself. In addition, the oil drain frequency can impact the equipment reliability and life (rebuild frequency). Therefore, it is in our best interest to try to OPTIMIZE the drain interval to match our individual situations.

Our goal is to maximize the oil life without compromising the equipment.

Generally, three basic options exist: “Interval-based,” “Condition-based,” and a combination of these in which the condition of the oil is used to set an interval-based oil drain interval. Purely “interval-based” oil changes are performed on a repetitive time basis based on hours or miles or fuel consumed or the calendar or production schedules. These may be the best option for some operating situations, but they do have an element of guesswork associated with them and can result in over or under-extended drain intervals. Where possible, it is beneficial to apply a more scientific approach and use oil analysis to help us select the optimum drain interval based on the condition of the oil (and the machine). “Condition-based” drain intervals monitor the oil while it is in service; then the results are used to select the time for an oil drain based on the most recent results and the trend. This works well for large industrial equipment. For mobile equipment, it is often best to use a combination of these methods and select an oil drain interval (time or mileage) based on past condition monitoring data for the equipment and load (duty cycle) of the specific application.

Some of the factors which may influence which option to use include:
• The volume of the oil in the system
• The amount of make-up oil added to the system
• The cost of the lubricant
• The cost of performing the oil change
is generated on these oils will that answer be readily known.

Time whether this change in additive chemistry will have a negative effect means a lower initial base number (less detergent) and less zinc-reduced Sulphated Ash, Phosphorous and Sulfur (SAPS) content. These are superior oils to the previous CI-4 Plus oils but they have consistent. Some common automotive oil drain intervals include:

The opinions regarding heavy duty diesel engines are more drain interval should be for passenger vehicle gasoline engine oils. The new CJ-4 heavy-duty diesel engine oils introduced in 2006, available in the market in 2007, were specifically designed to accommodate the new 2007 engine exhaust after-treatment devices. These are superior oils to the previous CI-4 Plus oils but they have reduced Sulphated Ash, Phosphorous and Sulfur (SAPS) content. This means a lower initial base number (less detergent) and less zinc-phosphorous antioxidant (and antioxidant) additive. It is uncertain at this time whether this change in additive chemistry will have a negative effect on diesel oil drain intervals. Not until sufficient field experience (mileage) is generated on these oils will that answer be readily known.

Extending Oil Drain Intervals

One of the most significant factors in determining oil drain frequencies is the oil operating temperature. It is well-known that operating at higher temperatures reduces oil life due to oxidation, thermal degradation and general additive depletion. Oil oxidation will result in both an increase in acids formed (acid number increase, base number decrease) and the joining together of oil molecules to form sludge and varnish. A 10°C or 18°F increase in oil temperature reduces the life of the oil by one-half (50%). Operating at too low a temperature can also cause some issues related to air release, foaming, water separation and evaporation, and particle settling.

Oil quality is a major factor in oil drain frequency. Using lubricants formulated with superior base oils, such as Group II and Group III and traditional synthetics can extend oil life and thus oil drain intervals. If the oil drain interval is being dictated by contamination, such as soot or silica, then superior base oils may not provide any benefit. Premium additive packages with better antioxidants and detergents can have a huge effect on drain intervals. One major company feels that this is the key to extending drain intervals. Another major oil company is promoting gasoline passenger vehicle oil drain of 15,000 miles (25,000 km) by using premium base oils and additives.

Sump capacity is another major factor. A larger volume of oil in the sump, very simply, provides a larger quantity of oil additives to deal with the oxidation or soot created in the oil. In some cases, additional filtration devices are added to a piece of equipment (an engine) more for the purpose of increasing the oil volume than for improving the actual filtration capabilities.

But many experts believe that improved filtration itself is a major factor in extending drain intervals. This includes both oil and air filtration. Removing wear debris, such as iron and copper, which act as oxidation catalysts, will extend oil life and oil drain frequencies. Fine, low flow rate, side stream by-pass oil filtration with high Beta ratios for 1 to 20 micron particles is often needed to remove these small critical materials. These by-pass oil filters may be either depth type or centrifugal type filters. Normal full-flow oil filters which are only capable of removing larger (40 micron) particles will not have a significant effect. It is worth noting that some of the benefits of improved oil filtration are debated by some major companies.

“Bleed and Feed” and “partial drain” strategies can also be used to extend oil drain intervals. What is meant by a “partial drain” is a situation whereby part of the oil (10% of the volume) is drained off, either while the equipment is operating or during a brief shutdown, and is immediately replaced by new, fresh clean oil. This could be repeated several times to obtain a higher proportion of new oil in the sump. This practice could be used to extend an oil drain until a complete oil change could be scheduled. In a variation of this, some engine manufacturers employ a “Bleed and Feed” system whereby some of the used oil from the crankcase is filtered and then sent to the fuel system where it is burnt with the diesel fuel. New fresh oil is introduced into the crankcase sump to replace the oil that was removed. This could be likened to a type of intravenous oil system. This, reportedly, has had great success at extending oil drains and engine life. Future engine exhaust emission requirements, to be introduced in 2010, will spell the end to this practice as it is anticipated that engines burning these larger amounts of oil will not be able to meet the tighter upcoming emission requirements.

One oil drain affects the next. It is important to remove as much of the used, contaminated oil during an oil drain as
possible. Some equipment designs leave as much as 20% of the old used oil behind in the sump and circulation system. All of the oxidation contaminants and wear metals left behind have a significant impact on the life of the new oil, reducing the length of time until the next oil drain is necessary.

One major automobile manufacturer is talking in terms of the potential for 30,000 mile (50,000 km) oil drains using some combination of these factors.

**Role of Oil Analysis**

Oil analysis can play a significant role in determining oil change frequencies. The technology exists for online monitoring of dielectric strength (conductivity or the buildup of polar oxidation byproducts), water content, particles and viscosity. Most of these sensors are currently too expensive for use on passenger car engines and only find application in larger, critical industrial oil circulation systems.

The onboard monitors that are being factory installed on some recent passenger car engines do not directly monitor the condition of the engine oil. Most of these units calculate an oil drain frequency based on engine rpm, operating temperature, speed, stop-and-go driving patterns and the average length of a driving trip. They do not have any ability to take into account the type or quality of the oil being used. Generally, these monitors are indicating longer oil drains (8,000 miles, 13,000 km for highway use) than have been historically recommended.

When on-site or laboratory oil analysis is used to determine or set drain intervals, some of the tests that can be used to monitor oil contamination include FTIR soot, spectrographic silica (Si), wear metals, and potassium (K) and sodium (Na) for glycol. Some of the tests that can be used to monitor oxidation (acid buildup and/or additive depletion) include Acid Number, Base Number, FTIR oxidation, Viscosity, RPVOT, and Scanning Voltammetry. Although some of these are expensive or impractical for routine testing and some are used primarily on larger industrial systems, they each provide information that can influence oil drain intervals.

Base numbers of engine oils are often allowed to drop to 50% of the new oil value before an oil change is considered. In an extreme case this could be allowed to drop to only 20% of the new oil value. The exact percentage used is often dependent on the consequences of failure from over-extending the oil drain and the availability of the equipment for an oil change; at 20%, the margin for error is very small. A comment is needed on the topic of “base number retention.” Several years ago, some oil suppliers were promoting that their oils had better “base number retention” than their competitors’. This could be interpreted in two different ways. If an oil has superior base number retention this could be interpreted as a superior oil which has a higher dosage and better additive system which provides longer oil life. But, it could also indicate an oil that has an inferior detergent additive in which the detergent is not neutralizing the acids forming in the oil and thus the base number does not decline. Monitoring the Acid Number in addition to the Base Number could clarify this situation.

A final cautionary comment needs to be made on oil drain intervals and their influence on engine rebuild frequency. One major manufacturer of on-road truck engines has correlated extended drain intervals with reduced mileage to the first engine rebuild. Therefore, some caution and discretion needs to be applied to extending drain intervals.

Remember - maximize the oil life without compromising the equipment.