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AUTOMOBILE ENGINE OIL FILTERS

The quality of commercial oils for lubricating automobile engines has been improving rapidly in the past few years, due largely as the result of new and improved methods of refining. Thus, notwithstanding the higher engine horsepower, higher engine speed, and more severe engine operating conditions of recent models of cars, lubricating oils are now obtainable which deteriorate much less in 500 miles of operation than did the oils available a few years ago. Offsetting this, the customary period between oil changes has been gradually increasing, so that in general the condition of the crankcase drainings is about the same as that with the older oils run for shorter periods of time. In order to extend still further the mileage between oil changes, many motorists are now installing efficient oil filters. In many cases, an oil filter will keep the oil clean for thousands of miles of operation and it has been reported that use of oil filters may result in a considerable reduction in wear of piston rings and cylinder walls.

The National Bureau of Standards is not in a position to give detailed information regarding the efficiency of any particular make of oil filter, but the following discussion may be of assistance in the choice of a suitable oil filter for any particular purpose.

In order to understand the function of an oil filter, it is desirable to consider what changes take place in an oil during use. These changes are mainly (a) contamination with road dust, (b) contamination with metal particles from wear or abrasion of engine parts, (c) formation of asphaltenes as the result of partial oxidation of the oil, (d) increase in oil acidity, (e) dilution with the less volatile portions of the gasoline not burned in the combustion chamber, and (f) contamination with water formed by combustion of the fuel.

I. Road Dust and Metal Particles

Road dust invariably gets into the oil during use, either through the intake manifold or directly into the crankcase through the breather pipe or other openings. In extensive driving over unpaved roads or in localities where dust storms are prevalent, large amounts of dust may get into the oil in this way. The use of an efficient air filter will remove a large percentage of the dust entering the intake manifold, but even so, the finer particles tend to work past the filter. It is true that some of these particles are so small that they probably cause little wear directly. However, these fine particles may tend to form larger agglomerates with the carbonaceous material resulting from decomposition of the oil, in which case, they may cause appreciable wear of cylinder walls and piston rings.

With new cars, there is always the possibility that all the core sand used in the casting has not been removed and this may get into the oil. Also there may be metal particles from the machining operations which were not entirely removed before the engine was put in operation.

Wear and abrasion of the various moving parts of the engine may result in the accumulation of a considerable amount of metal particles in the oil. These particles are ordinarily so small that they do not cause abrasion directly, but they may do so if they form agglomerates with the asphaltenes or carbonaceous material in the oil.

Practically all oil filters efficiently remove dust and metal particles until they become clogged. Since a considerable part of engine wear can be attributed to abrasion by these foreign particles, the use of an oil filter to remove them should result in a decrease in engine wear. Futhermore, any reduction in engine wear which is effected in this way will tend to increase the mileage before excessive clearances are formed between the piston rings and cylinder walls and will therefore tend to minimize oil consumption.

II. Asphaltenes and Carbonaceous Material

During use, the crankcase oil is continually being exposed in the presence of air to heated surfaces at high temperatures, and under these conditions there is a gradual decomposition of the oil due to cracking and partial oxidation. No definite names have been given to these decomposition products, but those resulting from partial oxidation are frequently called asphaltenes. If the cracking process on the hot cylinder walls is continued far enough, carbonaceous material similar to the 'carbon' in the combustion chamber may be formed.

Some oils decompose more readily than others and form larger amounts of decomposition products during any given mileage. However, all oils if used sufficiently long will form considerable amounts of these decomposition products.

When formed in excessive amounts, the products of decomposition increase the viscosity of the oil. Also, they frequently tend to combine with water to form sludges which, in extreme cases, may clog oil passages and coat exposed metal surfaces with a semisolid deposit. Further as pointed out in section I, the decomposition products tend to form agglomerates with road dust and metal particles, which may cause increased wear.

Oil filters containing cloth, felt, cotton fiber, cellulose fiber, absorbent clays and similar materials, if properly designed, will remove the asphaltenes and carbonaceous materials as they form in the oil, and in many cases will keep the oil clean for several thousands of miles of operation. They also have the advantage of removing road dust and metal particles from the oil. There is one other possible advantage. If the asphaltenes come in contact with the piston rings and become gummy, there may be a partial sticking of the rings with a consequent marked increase in oil consumption. Further, this condition may cause the engine to lose compression and thereby increase the gasoline consumption. Some cases have been reported where the installation of a filter has appreciably reduced both oil and fuel consumption in engines previously run without a filter, presumably as the result of freeing partially stuck rings.

III. Oil Acidity

Practically all oils are essentially free from acid when new. However, during use, acidity may develop as the result (a) of a high sulfur content in the fuel, or (b) of oxidation of the oil.

When a fuel containing sulfur is burned in the engine, a small percentage of the oxides of sulfur formed in the combustion chamber gets past the piston rings into the crankcase. If water is present in the oil, the oxides of sulfur will combine with the water to form highly corrosive acids. Fortunately most gasolines contain only small amounts of sulfur, and ordinarily water is not present in the oil except during intermittent operation in the winter time under conditions where the engine does not warm up and the water does not get an opportunity to evaporate. Thus, there is ordinarily little

increase in acidity due to sulfurous or sulfuric acid, but in the comparatively rare cases where those acids are present very serious corrosion may occur.

On the other hand, the acidity of all oils increases during service as the result of oxidation of the oil. These acids are soluble in the oil and are so weak that they will not corrode steel or most of the metals with which they come in contact. If the acidity becomes high, however, these weak acids may gradually attack some of the newer bearing materials, sometimes so seriously as to require replacement of the bearings. No trouble from this cause appears to have been observed with the older babbitt-type bearing materials.

As far as available information goes, oil filters containing an absorbent clay or similar materials are the most effective in maintaining the acidity at low values. Some of the other types of oil filters mentioned in Section II may, however, maintain the acidity at a considerably lower value than if no filter is used. The explanation for this reduction in acidity in the case of oil filters not containing absorbent clay or similar materials appears to be that the carbonaceous material adsorbs some of the acid, which is incidentally removed from the oil when the carbonaceous material is retained by the filter.

IV. Crankcase Oil Dilution

Whereas a few years ago, dilution of the crankcase oil with unburned residues of fuel from the combustion chamber was a serious problem, at present, as the result of the more extensive use of crankcase breathers and ventilators, crankcase oil dilution is rarely very high. As far as available information goes, oil filters have very little tendency to reduce the dilution of the oil. However, with modern automotive equipment, crankcase oil dilution is a comparatively unimportant matter.

V. Water

During intermittent operation of the engine in cold weather, where the engine does not get an opportunity to warm up, considerable water from combustion of the fuel may work past the piston rings and accumulate in the oil. If no oil filter is used, the water may combine with the asphaltenes to form sludge which, in some cases, may become so thick as to interfere seriously with proper lubrication of

the engine. Where a filter is used to remove asphaltenes and carbonaceous material, the presence of water in the oil is ordinarily of little consequence, except when a high-sulfur fuel is being used. Some oil filters have a fairly large capacity for absorbing water and removing it from the oil, while many of them have traps for separating the water from the oil.

VI. Changing of Oil Filters

Oil filters are of two general types, one type being constructed as a unit so that the entire filter has to be replaced when clogged, and the other type containing replaceable filtering elements. Some filters of this latter type are so constructed that the motorist can readily replace the filtering element in a few minutes without any special equipment. With such filters, the case can be used for many years, for it can be cleaned out easily when desired and new filtering elements introduced from time to time as required.

The mileage which can be run before a filter becomes clogged or inefficient depends upon its design, the type and quantity of filtering material, the quality of the oil being used, the type of automotive equipment on which the filter is installed, and the nature of the operating conditions. In general, the useful life of an oil filter is longer in warm weather than in cold weather. When the filter becomes clogged, it has no further effect in keeping the oil clean, but if not replaced immediately, there is no reduction in the supply of oil to the bearing surfaces since the oil is by-passed.

Many motorists make a practice of changing the filtering element, or filter, when the oil first shows signs of having carbonaceous matter in it. While this may not be necessary, it insures a clean oil in the crankcase at all times.

No definite rules can be given regarding the changing of the crankcase oil when using an efficient filter. In contrast with the usual procedure, some motorists have found it satisfactory not to change oil except possibly in the spring and fall, but merely to change filtering elements, or filters, as soon as the oil shows signs of carbonaceous matter. This practice may have serious consequences if the oil develops a high acidity and if the filter is being used on an engine equipped with the newer bearing materials, such as copper-lead, lead-bronze, or cadmium-silver. If the filtering medium is not absorbent clay, or similar material, the oil may appear clean and still have sufficient acidity to cause corrosion of the bearing material.

Not only is it impracticable for the motorist to determine for himself the acidity of the crankcase oil, but even if the acidity were known, there is not sufficient information on this problem to state whether the oil could safely be used without danger of bearing corrosion. Intensive investigations on corrosion of bearings are being carried on in a number of laboratories, leading towards the establishment of the safe limit for oil acidity and towards the development of non-corroding bearing materials. Until these investigations are completed, the motorist should follow the recommendations of the filter manufacturers (or the car manufacturers if filters are standard equipment on these cars) regarding the draining of the crankcase oil and the replacement of the filtering element or filter.

One other point should be taken into consideration. Before a filter is first installed in a car which has been run for some time, the crankcase should be thoroughly cleaned. If this is not done, no harm will result but the life of the filtering element will probably be considerably less than that stated by the manufacturer, as the result of the retention in the filter of dirt, sludge, asphaltenes and carbonaceous material which had accumulated in the crankcase before the filter was installed.

VII. General Conclusions

While an oil filter is not essential to the operation of an internal combustion engine, the use of one of the more efficient types will permit extending the period between oil changes, and the saving in oil thereby effected may, in some cases, more than cover the cost of the filter. Also the use of an oil filter may reduce wear of cylinder walls and piston rings and in this way minimize oil consumption and possibly fuel consumption. A considerable number of commercial oil filters, which will maintain oil in clean condition for long periods of time, are available, from which the car owner can make his choice. Some of these filters will maintain the acidity of the oil at low values and thereby minimize corrosive effects, particularly on the newer bearing materials.