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Lubricating Oils

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The object of lubrication is to prevent the wear, friction, and heat due to the rubbing of one surface upon another. A lubricant should possess enough body to keep the moving surfaces from coming into contact and as much fluidity as is consistent with this property. Besides preventing friction a lubricant should distribute the heat generated; and if it is subjected to pressure and to changes of temperature, it must be capable of withstanding heat and pressure without splitting up, and must remain semi-fluid at a low temperature.

The bodies having in greatest degree the property of lubrication are the oils. These are widely distributed in the animal and vegetable kingdoms and are also obtained from mineral sources.

The petroleum, or mineral, oils are hydrocarbons and are found in rock or shale. From the crude oils are distilled rhigolene, cymogene, napthas, kerosene, lubricating oils, petroleum jelly, and paraffin. These differences are due to the manner of combination of the elements hydrogen and carbon. Petroleum is widely distributed, Russia and the United States

furnishing the greatest amounts.

In the animal kingdom oil is very abundant. The chemical composition is that known as glycerides: that is, glycerine in combination with fatty acids. When these compounds are boiled in a solution of caustic soda or of caustic potash, the glycerine is liberated by the stronger base, which base forms with the fatty acids the product soap. Some of the acids contained in the glycerides are stearic, capric, and palmitic. A general formula for the series is $C_nH_{2n}O_2$ The process of extracting animal oil is known as rendering. The animal matter containing the oil is heated, which causes the oil cell to burst and the oil to flow out.

Vegetable oil is abundant in the seeds of most plants, and its uses are the same as those of animal oil.

Each of the three classes of oil furnishes compounds capable of lubricating under all conditions and may therefore be substituted for one another with more or less advantage. However, one has some qualities which can not be furnished by the others.

In the case of a leather belt which has become glazed and slips around the pully, a mineral oil would make the belt slip more easily; while an animal oil would remove the glaze, render the belt more flexible, and give it a firm hold on the pully. Again all oils make a stain; but that made by an animal oil may

be removed by proper treatment, while traces of a mineral oil stain will always remain. Most oils oxide somewhat at the normal temperature. Those which oxide rapidly soon become rancid. Such an oil may generate sufficient heat of itself to ignite. This may occur whenever oily waste or shavings are left about. The surface exposed is great enough to cause such rapid oxidation as to ignite the oil or the shavings, and many fires are started by this spontaneous combustion. This is the case with only animal, vegetable or mixed oils. A mineral oil can never ignite in this way.

Oils commonly marketed for lubricating purposes may be either animal or vegetable, but in a great many cases a mixed oil is sold. These oils, if properly mixed, may be cheaper than any pure oil and entirely suitable for ordinary purposes. So in use it is always best before applying an oil to determine by test whether it be suitable for the work required. The essential qualities of an oil must vary to meet special requirments. Thus for high speed a light fluid is used and for high pressure a viscid oil is required; that is, for speed an oil is required whose cohesive force is not too great to prevent its rapid flow, and for this purpose a light thin oil is used; while for high pressure, the cohesive and adhesive forces must be great in order to keep the surfaces apart and prevent friction. This requires a heavy viscid oil. Another

important feature is temperature. It is found that conditions of heat and moisture affect an oil; for example, one would be unfit for one case which would be efficient at the normal temperature. The effect of heat and moisture on an oil is to lessen its viscosity and to impair greatly its lubricating properties. Some oils suffer more by this action than others, and care should be taken to select those which are least effected. Formerly animal and vegetable oils, such as neat's-foot and castor oil, were used in the cylinder. These oils should never be used because the presence of heat and steam causes them to split up forming glycerine and fatty acids. These fatty acids form into cakes or balls and cause the metal to corrode. The oils which have the greatest lubricating power and at the same time are least corrosive to the cylinder are petroleum oils prepared especially for this purpose. There are two kinds. The first is a dark viscid oil made from the crude oil by distilling off the volatile oils and refrigerating and filtering, which clears it from paraffin and grit. These cylinder oils are low in specific gravity and dark in color. Their lubricating properties vary greatly; some are solid at low temperatures, but on heating become very thin and are of little use. The second, pale cylinder oils, are brownish-yellow in color and are fluid. Their specific gravity is greater and they flash at a lower tem-

perature than the darker varieties. Cylinder oils should have a higher flashing-point: they should not evaporate at 212°F. Their viscosity should be great and be maintained at high temperatures, and they should be free from fatty oils.

The tests usually applied to oil are the specific gravity, alkali, sulphuric acid and the free acid tests. These are made in various ways. The specific gravity will not determine the purity of an oil but will discover impurities. The alkali test ascertains whether an oil is a pure fat, an hydrocarbon oil, or a mixture of both. The sulphuric acid test determines the proportions of the constituents of a mixed oil whose composition is known: the results are shown by a change of color or temperature caused by the mixing of known proportions of an oil and acid. The free acid test is important especially in case the oil is to be used where the temperature is high, as a small quantity of acid present in a hot bearing or upon a bearing of brass or copper has a great corroding effect. If the best results are to be obtained, these tests should be applied to all oils which are to be used as lubricants; and in case of mineral and mixed oils, there are three other tests to be made. These are the viscosity, flashing-point, and evaporating tests. The viscosity is the fluidity or body of an oil, and being known, shows at what speed and pressure the oil is suitable for

use. The flashing-point and evaporating tests indicate the safety and durability of an oil. In case a moderate viscosity only is wanted, the flashing-point should not be high, as high viscosities go together. A thorough test of the lubricating power of an oil and its adaptability to any special purpose may be ascertained by a mechanical test: that is by placing the oil in a machine under the same conditions as those at which it is to be used and noting the power required, the heat developed, and the durability of the oil. These results may be compared with standards obtained by other tests and the oil's efficiency determined. A machine to perform this test should be capable of adjusting various pressure speeds and temperatures and of furnishing accurate means of reading the results.