FACTFILE:

GCE TECHNOLOGY & DESIGN

1.47 LUBRICATION

Rewarding Learning

Lubrication

Learning outcomes

Students should be able to demonstrate knowledge and understanding of:

- lubrication, to include mechanics of lubrication, viscosity, classification of lubricants and applications; and
- seals, to include O-ring, gasket, garter and seal housings

Course content

Students should have a knowledge and understanding of the processes involved in lubrication. They need to understand why lubrication is important and should understand the consequences of not keeping machines and mechanisms well lubricated. They will need to understand what happens to oils within a system and in particular what might happen to lubricants at high and low temperatures. They should also have a knowledge of what could happen to machines if certain rules of lubrication are not adhered to.

They should also have a knowledge and understanding of oil seals and methods of ensuring that oil does not leak from a machine or system.

Lubrication

Lubrication is the process whereby a substance such as oil is placed between two, or more moving surfaces in close proximity, to reduce friction and wear.

Viscosity

Viscosity is defined as an oil's resistance to flow. It is the most important feature of an oil as the amount that it flows around an engine or machine can affect the wear rate of the parts of the engine that is being lubricated. The problem is that as an engine, such as a car engine, runs over time, its temperature rises and it gets hot. This means that the lubricant within the engine also gets hot. As an oil gets hotter with the rise in temperature of the engine so the viscosity lowers which means that the oil will flow faster and more easily. This could have a detrimental effect on the engine, so engineers need to consider this when designing and testing machines. The way in which an oil's viscosity is measured is what is referred to as the Kinematic Viscosity and this is the viscosity at the temperatures of 40°C and 100°C. This is the information that usually appears on oil data sheets that you might see in a garage. Kinematic Viscosity is defined as "the measure of an oils resistance to flow under the force of gravity". Basically it tells engineers how easily an oil will flow to different parts of an engine.

In USA, the society of Automotive Engineers (SAE) established a means of classifying oils by their viscosity using numbers. The numbers define the viscosity of the oil at a temperature of 99°C.

SAE number	Oil thickness	Application
10	Extra-light	Low pressure
20	Light	Sewing machines, printers etc.
30	Medium	General purpose, e.g. engines.
40	Medium-heavy	Bearings
50	Heavy	
60, 75, 140, 250	Extra heavy	High pressure, e.g. transmission and parts

Other related points also need to be considered when using oils in engines. For example, it is vital that oil is able to reach all the moving parts of an engine that need to be lubricated. Within an engine there are many small tubes and spaces designed to spread oil around the working parts. Engineers, when they design engines must take into consideration the ability of an oil to flow through the narrow confines of an engine particularly when the lubricant comes into contact with warm components such as cams and followers. This can influence wear and tear and even fuel consumption. Engineers also need to consider viscosity when an engine is cold on a frosty morning when it is first turned over.

Classification of lubricants and applications

There are a number of types of lubricants that are in use that have a variety of applications. The majority of lubricants are oil based but some are produced using vegetable oils and some are synthetic. By varying the mixture of various lubricants different requirements can be met.

Different oils have varying Viscosity Index numbers that help define their uses.

Mineral oil is a term used to describe oils derived from crude oil. Group 1 and Group 2 mineral oils have a viscosity index of 80 – 120. They are high grade oils that have good anti-oxidation properties. Group 3 oils have a viscosity index over 120. Lubricants that are used in car engines include additives that help reduce oxidation and improve the lubrication process.

It has been found that some synthetic oils can have advantages over mineral oils. Synthetic oils are man made. Chemists have found that they can create highly effective oils by controlling the molecular structure of the oil they are creating. They are manufactured from organic and inorganic materials and are produced to synthesise natural oil compounds. By developing specially made oils, better high and low level viscosity can be maintained, better cold performance can be found and even fuel efficiency improved. The disadvantage of synthetic oils is that they can be expensive to produce.

Multigrade oil used in cars has been used to replace the more traditional methods of engine lubrication. It was common for cars to use a low viscosity oil (thin) in winter and a high viscosity (thick) oil in summer. This meant changing the oil with seasonal change. With multigrade oil this no longer needs to be done. Multigrade oil has a low viscosity and flows easily at low temperature. As the engine heats up, so does the oil, causing the viscosity to increase so that it thickens. The oil reverts to its original state as the engine cools down.

Seals
O-ring

An “O-ring” is a circular gasket that is in the shape of a round doughnut and has a round cross-section. It is manufactured from an elastic material that can be compressed to produce an oil tight seal between two component parts. An O-ring is designed to be positioned in a groove on a pipe or other component where two elements are to be joined together creating a perfect oil tight seal. As the component parts are tightened together the O-ring is compressed thus creating an oil or water or gas proof seal.

O-ring
http://www.tss.trelleborg.com/de/de/products_2/orings_2/detailpages_orings/o-ring.html

Gasket

A gasket is a seal which fills the space between two adjoining surfaces and is designed to prevent any oil leakage between those surfaces. The gasket is kept under compression in order to stop oil seeping out. They are found, for example, between the cylinder block and cylinder head of a car engine to prevent oil leaks. Here they are referred to as a "head gasket". They are useful in this application, as in others, because gaskets have a slight amount of "give", and although the cylinder head might appear to be flat, there are often irregularities and the gasket can take these irregularities into account and form a sound seal.

Cylinderhead gasket

Garter (Spring) seal

A garter (Spring) seal has a coiled spring that is shaped to create a ring. They are used for oil seals because their circular shape allows them to withstand forces from any direction. They work well under pressure and can withstand temperature changes. The spring often has a rubber seal around them that allow the joint to be totally secure.

Garter spring seal

Seal Housings

It is important to consider sealing lubrication in the system of machines that require constant lubrication. For example, where there are bearings or oil filler points it is vital that there are no leaks. For example, when seals such as O-rings and Garter springs are being used, it is essential that the seal is inserted correctly to prevent leakages of fluid out of the system and the contamination of the system by unwanted dirt being introduced into the system. Further consideration should be taken when sealing moveable components such as the bearings on shafts such as found in the power system of vehicles. In these instances special seals are produced to enable the shaft to rotate but at the same time preventing any leakage of lubricating fluids.

Revision Questions

1 Explain the term "Viscosity" and outline how viscosity should be considered when replacing the oil in a car engine.

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2 Using notes and sketches outline the role that a gasket plays in a car engine.

3 Explain the differences between Mineral and Synthetic oils.

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