AeroShell TECH TALK

GREASES - WHAT ARE THEY AND HOW DO THEY DIFFER?

Greases are lubricants which have a semi-liquid to solid consistency. They are not simply very viscous oils but are actually oils mixed with other ingredients to give a gel like consistency.

When they are used as lubricants, greases behave like oils in many ways. They reduce friction by providing a film that separates moving surfaces and, as we will see later on, it is actually oil that carries out this lubrication rather than the grease itself. However, unlike oils, greases have the advantage that they tend to stay where they are put. They are less likely than oils to leak out of a machine and less likely to flow away from the surface that they lubricate under the effect of gravity or centrifugal forces. At the same time, and this can be significant in many airframe applications, greases can form an effective seal against moisture and solid contaminants.

These properties mean that greases can often act as effective and economical lubricants, especially in mechanisms which are hard to reach or require infrequent lubrication.

SO HOW IS A GREASE MADE?

All greases consist basically of a base oil, a thickener (essentially a lattice which gives the stable semi solid consistency) and performance improving additives. Varying these three basic ingredients leads to different greases suitable for a vast range of applications. However, in broad terms, a typical grease would consist of about 80% - 90% base oil, 10% - 15% thickener and about 5% - 10% additives.

BASE OILS

Choosing a base oil for a grease is essentially determined by the type of application the grease will be used for. For example, with mineral oil based greases, if the application involves heavy load conditions a heavy viscosity base oil will be used (for example in AeroShell Grease 5 which is commonly used in General Aviation as an undercarriage wheel bearing grease).

However, high viscosity mineral oils do not perform well at low temperature as they become too thick, and so for more general use a lighter base oil will be used. This is the case with the general purpose AeroShell Grease 6 which has an operating temperature range of -40/+121 Deg C compared with -20/+177 Deg C for AeroShell Grease 5. As you will appreciate, there are few airframe applications which exceed the 121 Deg C limit of AeroShell Grease 6, but wheel bearings using AeroShell Grease 5 will sometimes be exposed to high temperatures with high rolling friction and hard braking which takes into account the 177 Deg C upper limit for this grade.

As you can start to see, it is important to use the correct grade for the correct use.

Greases which are required to operate over a very wide temperature range are often base on synthetic oils, often derived from esters rather then mineral oils. However, these oils are more aggressive to seal materials and should not be used unless specified for your aircraft. An example of a grease with a synthetic base oil is another multipurpose grease, AeroShell Grease 7, which is used extensively on commercial aircraft where there is frequent exposure to extremely low temperatures at altitude. AeroShell Grease 7 has an operating temperature range of -73/+149 Deg C.

THICKENING AGENTS

The amount and type of thickening agent used in making a grease has the biggest effect on its consistency, that is its softness or stiffness. The thickener does not perform any lubrication - that is the job of the oil - but it does hold the oil in a lattice rather like a sponge. Again like a sponge, when pressure or stress is applied, oil is released which then lubricates the mechanism and, when the stress is released, the thickener and oil return to a semi-solid state.

The consistency of greases can vary from very soft, semi-fluid cream like consistencies through to hard wax-like solids. The consistency is measured by allowing a standard metal cone to sink into the grease and measuring its penetration. This is often called the Unworked Penetration value of the grease.

Most greases tend to soften slightly when heavily worked and the ability of the grease to resist changes in consistency during working is an important characteristic, particularly if vibration is present. This "Working Stability" is quantified by working the grease with perforated mechanical plunger and measuring it penetration value afterwards, the result often being referred to as the "Worked Penetration" value of the grease. The difference between the worked and unworked penetration values gives an indication of the working stability of the grease.

The majority of aviation greases have unworked penetration values of around 260-320 which is the normal consistency suitable for roller bearings, but also can be suited to fretting and sliding type applications as demonstrated by AeroShell Grease 14, the leading multi purpose Helicopter grease.

The common types of thickeners are generally "soap" based or "clay" based. A soap is a salt formed when a metal hydroxide, or alkali, is reacted with a fatty acid; a kind of organic acid derived from fats. The first greases were made with Calcium and Sodium soaps but Lithium soaps, and less commonly Aluminium and Barium soaps, are now also being used.

Calcium soaps have a smooth texture and have good water resistance, but have very low operating temperatures normally not more that 60 Deg C. This can be improved by reacting the Calcium soap with organic acids to form a Calcium Complex thickener. It is a Calcium Complex thickener that is used in the helicopter grease AeroShell Grease 14 which has a temperature range of -54/+93 Deg C.

Sodium soaps have a higher melting point than plain Calcium soaps, have a fibrous texture and have good adhesive properties. However, they have relatively poor water resistance and risk suffering water washout in very wet conditions.

Lithium soaps have a butter like texture, relatively high temperature (up to about 135 Deg C) and have good water resistance.

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However all of the soap thickeners are limited by their high temperature performance as the thickeners tend to melt and the grease softens markedly.

Most of the AeroShell range of greases therefore use a patented thickener known as Microgel. This is a specially treated clay based thickener, which has:

- No upper temperature limit (the upper temperature is limited by the base oil)
- Very little change in consistency with variation in temperature
- Extremely good water resistance due to the treatment of the clay
- Low oil separation, or "bleeding" of the grease.
- Excellent Working Stability.

The Microgel thickener used in AeroShell Grease 5 and AeroShell Grease 6 gives excellent working stability; the unworked/worked penetration figures for these two greases are 281/284 and 287/300 respectively. A further advantage of the use of non soap type thickeners can also be seen with greases such as AeroShell Grease 16 which is used in high speed / high temperature applications and has a temperature range of -54/+204 Deg C, an upper temperature limit not achievable with soap type thickeners.

ADDITIVES

The additives used in greases are similar to those used in oils, such as anti oxidants, corrosion inhibitors, load carrying additives etc. However, some greases are fortified with solid film lubricants such as Graphite or Molybdenum Disulphide (sometimes referred to as Moly). These solid film lubricants give no real benefit in rolling element bearings but are particularly suited to heavily loaded, sliding applications such as splines, landing gear bogie pivot pins and the like. AeroShell Grease 17 is one such grease using this type of additive.

MIXING OF GREASES

Greases which have either different base oils or different thickeners should not be mixed. With the mixing of base oil types, there can be a problem of seal compatibility if a system designed for use with mineral oil based greases is exposed to a synthetic based grease. If different thickener types are mixed, it is often the case that the working stability of the resultant mix is poorer than that of either of the two greases used. Because of this, the performance is compromised by the grease softening excessively in use even though it would appear to be a similar consistency in the tin. If in doubt, seek advice from your grease supplier.

OPERATIONAL ADVICE

Oil separation to a greater or lesser extent occurs with all greases. Unless the separation is excessive, the grease can be used provided it is stirred well before use.

When re-greasing a bearing with a grease gun, always apply enough grease for fresh, clean grease to be seen coming out of the bearing. This ensures that the bearing purged of the old, degraded grease which can then be wiped off and discarded.

The inspection or assembly of new bearings should be as follows:

- Wear protective gloves - not just for your own safety but also to prevent oil from your fingers from effecting the lubrication of the raceway.
- Remove the old bearing, clean off the old grease and rinse in a degreasing bath. Remove traces of old grease from the bearing housing and grease channels. If old grease cannot be removed from nipples, drillings and cut outs by cleaning alone, then apply fresh grease to the grease nipple and purge the channels whilst the bearing is removed.
- Inspect the old bearing and replace if outside limits.
- Having inspected the new or serviceable bearing, rinse the bearing through with Iso Propyl Alcohol (IPA) or a similar solvent to remove any traces of finger marks. The grease from your fingers can prevent some of the grease additives from bonding effectively with the bearing surfaces and so should be removed.
- Pack the bearing with fresh grease prior to assembly. Ensure that the race is full and wipe off any excess.
- Assemble the bearing to the manufacturer's instructions and using the correct tooling. Remember more bearings fail through improper assembly or misalignment than for any other reason.

THE FUTURE

A number of years back, Shell introduced a new Grease to it's portfolio, AeroShell Grease 33 which is now used on all new manufactured commercial Boeing aircraft. This grease was specifically developed to be as broadly used as possible on these commercial aircraft. AeroShell Grease 33 can do the job previously covered by 4 different greases and, of over 359 grease application points on a Boeing 737, all but 9 are now lubricated by AeroShell Grease 33. Perhaps this is the way of the future...

HAPPY FLYING

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