LUBE-TECH

NO.15

THE LUBRICATION OF OFF-ROAD VEHICLES AND EQUIPMENT

The adequate lubrication of vehicles and equipment used in a whole variety of off-road situations present the lubricant formulator with a number of challenges. In addition to ensuring the best possible lubrication in any given circumstance, there are increasing pressures to extend oil drain intervals, to reduce any environmental impact to the minimum, and, of course, there are the inevitable cost implications. Although there is a generalised categorisation of lubricants into those suitable for off-road use, the number of lubrication requirements in this category, which could include lubricants for diesel engine crankcases, for hydraulic systems, open gears, wire ropes, conveyor systems, etc., differ to such an extent that each individual category needs separate consideration.

However, in this generalised category, the lubricant formulator is likely to be faced with a number of common problems, i.e. the need to provide lubricants which will operate under harsh conditions, including high loads, extremes of temperature, variable speeds, reverse rotation and 24-hour operation. There are differences in requirements between pressure-fed systems, such as journal bearings in diesel engines, and non-pressurised systems, such as oil-bath gear lubrication.

However, in virtually all of these situations, the viscosity is of paramount importance. Oils of too low a viscosity may not have adequate film strength to prevent metal-to-metal contact, whereas oils of too high a viscosity may not be sufficiently pumpable on start-up at low temperatures.

The viscosity index, i.e. the rate of change of viscosity with temperature, is also important, since oils with low a viscosity index are only useable over a limited range of temperature.

The pour point of a lubricant is defined as the lowest temperature at which an oil will flow. However, this is misleading in that the user may incorrectly assume that the lubricant may be used at any temperature down to that of the pour point. In fact, a lubricant at a temperature approaching that of the pour point value will be far too thick to pump adequately. The oil pump will merely churn the oil, heating the oil locally but not producing any worthwhile flow to the bearings. Eventually, the prolonged churning will gradually heat up the bulk of the oil which may then start to flow, but during this significant time period, which may be 10 minutes or more, severe bearing damage may result from prolonged lubricant starvation.

The specific requirements of three of the more common applications are now considered separately.

HYDRAULIC SYSTEMS

Fluids intended for the hydrokinetic transmission of power are termed power transmission fluids; those intended for hydrostatic power transmission are termed hydraulic fluids. Fluids used in shock absorbing systems, used to suppress vibrations and as energy converters, represent a special case of hydraulic fluid. Properties required in hydraulic fluids can include viscosity, viscosity index, oxidation resistance, wear resistance, corrosion resistance, incompressibility, seal compatibility, air-release, anti-foam, filterability, shear stability, and possibly biodegradability.

Hydraulic fluids, particularly those used in off-road machinery and equipment, are normally based on mineral hydrocarbon oils (except biodegradable fluids, see below), but can also be based on water or a whole variety of synthetic fluids for more specialist applications.

The main problem encountered in hydraulic systems is contamination of the hydraulic fluid, this being the reason for some 70% of system failures according to some sources. Current trends towards higher operating pressures and speeds, the use of sophisticated electrical proportional control systems, coupled with tighter tolerances, smaller sumps, and extended drain intervals, result in more stress on the fluid and a greater sensitivity of the machinery to particulate contamination. During use, the hydraulic fluid can become contaminated with a variety of particulate materials, especially when operating in dusty environments such as mines where there can be as much as 7 to 8 mg. dust per cubic metre of air. Fluid systems are not always closed, and 'breathing' in the header tank vent due to normal ambient and operating temperature fluctuations can draw in dust from the atmosphere if the vent is not fitted with a filter. Also, dust can leak past cylinder seals. Such contaminants not only cause erosive wear in the equipment, but can also lead to premature deterioration of the fluid, accelerating oxidation causing thickening of the fluid and the possibility of sludge formation.

Traditional paper barrier filters will remove particles ranging from 15-50μ, but the harmful effects of particulate contamination can be due to smaller particles down to 5μ at which level the normal paper filter is not effective. However, the newer high-efficiency, synthetic fibreglass filters are much more efficient, removing particles down to 5μ on multi-passes.

Particulate levels can be quantified using the UK-made UCC CM20 optical particle counter, which counts the number of particles in a sample of fluid and rates the fluid against the industry standard ISO 4406. By sampling the fluids, a single particle counter can be used to monitor the fluid condition of a number of different items of equipment.

Many manufacturers of hydraulic machinery specify ISO standard levels of fluid cleanliness, and for maximum fluid and machinery life, the fluid should be regularly monitored and maintained at least at the ISO level specified by the manufacturer.

With increasing awareness of environmental matters, there is a growing demand for biodegradable hydraulic fluids, particularly when used in environmentally sensitive areas such as in forestry equipment or near watercourses. These fluids are intended to cause minimal environmental impact when natural or accidental losses occur from equipment in use. Such fluids are normally based on rapeseed oils and rapeseed oil esters and may also contain synthetic esters. Early experiences with rapeseed-based fluids were not favourable, in that users found that the fluids did not have the temperature capabilities needed for most off-road applications, gelling at low start-up temperatures, and oxidising at the upper operating temperatures. Oxidation caused polymerisation and the formation of sticky deposits which interfered with the operation of valves and other components. However, developments in improving the characteristics of the base fluids and in additive technology, and the use of alternative, synthetic fluids have not only overcome most of the original shortcomings, but have resulted with fluids of improved performance in some aspects compared with the non-biodegradable variety, albeit at a cost penalty. However, it must be emphasised that when such fluids are drained off for routine replacement, they should be disposed of in a responsible fashion as for any other waste oil, and not merely poured into a convenient

(Continued on Page II)