Lube-Tech
PUBLISHED BY LUBE: THE EUROPEAN LUBRICANTS INDUSTRY MAGAZINE
No.77 page 1

Oil Soluble Synthetic Polyalkylene Glycols

A New Type of Group V Base Oil

Abstract
Since their commercialisation over 50 years ago, polyalkylene glycol (PAG) lubricants have continued to solve problems that mineral oils cannot. Conventional polyalkylene glycols that are derived from the polymerisation of ethylene oxide and/or propylene oxide provide many performance benefits such as excellent friction control, good low temperature properties, high viscosity indices and excellent deposit control. One limitation is their poor miscibility in hydrocarbon oils. A new range of oil soluble PAGs (OSP) has recently been developed and derived from downstream derivatives of butylene oxide. These new API Group V base oils offer many of the traditional advantages of PAGs. Moreover, they offer formulators an additional tool for upgrading hydrocarbon oils by using them as a co-base oil or performance enhancing additive to improve deposit control, friction control and extend fluid life.

Introduction

Conventional polyalkylene glycols (PAG) are generally regarded as niche synthetic lubricants and are used across the lubricant industry to solve problems that petroleum oils can't solve. Most PAGs in use are manufactured from downstream derivatives of ethylene oxide (EO) and propylene oxide (PO). They offer many technical benefits over mineral oils such as excellent lubricity, good load bearing characteristics, good low temperature properties, high viscosity indices and high flash points making them suitable for a variety of applications [1]. Furthermore, synthetic processes used for manufacturing PAGs are very versatile which allows polymers to be designed to have many different functional properties [2]. In the lubricant industry today there are over 100 different polymer chemistries that are used and there are many hundreds more for applications beyond lubricants.

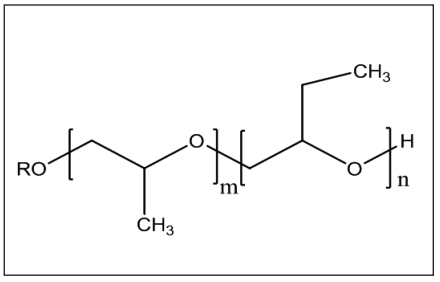
This versatility can be exemplified in the design of water soluble PAGs from copolymers of ethylene oxide with propylene oxide. These polymers can be synthesised to have a broad range of molecular weights and viscosities (e.g. up to 50,000cSt at 40°C) with different EO/PO ratios and polymer architectures such as random or block structures. These are the only major water soluble lubricant base oil available today. This unique feature provides functional advantages for fire resistant hydraulic fluids, metalworking fluids, quenchant, textile lubricants and many more.

One known disadvantage of conventional PAGs is their poor oil miscibility. This has two key implications. Firstly when end users wish to convert their equipment from a hydrocarbon oil to a conventional PAG, extensive flushing procedures are often required. Secondly, formulators can't use conventional PAGs as co-base fluids or additives in their hydrocarbon oils to enhance performance. This is in contrast to other synthetic lubricant chemistries such as polyalphaolefins (PAO), polyisobutylenes (PIB) and esters which are used to form semi-synthetic lubricants that can meet higher performance specifications. Therefore it is envisioned that the design of oil soluble PAGs that offer many of the inherent benefits of conventional PAGs can provide opportunities to formulators to upgrade hydrocarbon oils and solve many of today's lubrication challenges by leveraging the inherent functional benefits of PAGs.

Synthesis & Physical Properties of Oil Soluble PAGs

The design of oil soluble PAGs can be accomplished by synthesising downstream derivatives of butylene oxide (BO) to form polybutoxylate homo-polymers or by synthesising copolymers of PO and BO. Butylene oxide is available on an industrial scale and is used to produce polymers for other applications such as fuel additives but has been largely unexplored as a building block for lubricant base oils. Figure 1 illustrates a typical polymer architecture of an OSP base oil.

Figure 1 – Structure of oil soluble PAG



Note: for OSP copolymers, PO and BO are randomly distributed; for BO homo-polymers then m = 0.

The molecular weight and thereby the viscosity of PAGs can be influenced during the preparation and can be adjusted within narrow limits. This way, a very broad product design space is available and polymers can be tailored and engineered according to the specific application needs. Table 1 shows the physical properties of the new oil soluble PAG base oils. The polymers have been labelled OSP-32 to 680 with the numeric digits referring to the ISO viscosity grade classification. The PO/BO copolymers are OSP-32 to 220 and the BO homo-polymers are OSP-320 to 680.