40th Leeds-Lyon Symposium on Tribology & Tribochemistry Forum 2013
September 4-6, 2013, Lyon, France

The Thermal Properties of Polyaryletherketones (PAEKs) and their Influence on Tribological Performance

C. J. Dyson*[1, 2], M. F. Fox[1], W. Hopkins[2], M. Priest[1]

[1)] iETSI, School of Mechanical Engineering, University of Leeds, UK
[2)] ROCOL Lubricants, Swillington, Leeds, UK

*Corresponding author c.dyson@leeds.ac.uk, chris.dyson@rocol.com

1. Introduction

Polyaryletherketones are a family of semi-crystallines thermopolymers. They are known for excellent chemical stability and for their excellent mechanical properties at elevated temperatures. PAEKs have been used in some tribological applications. Such applications are characterised by high temperatures, low contact pressures and, often, high sliding speeds. In these cases, fibre reincorcement of the PAEK matirx is commonly used to reduce wear and, under some conditions, friction.

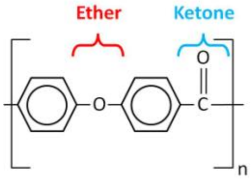

Figure 1: A Typical PAEK Monomer (PEK)

2. Polyaryletherketones (PAEKs)

Polymers in the PAEK family are differentiated by the ratio of ether and ketone groups. Typical PAEKs are shown in Figure 1. Changes in this ratio affect the mechanical properties and the thermal properties. I particular, decreasing the ratio of ether to ketone increases the melting temperature and the glass transition temperature. This is shown for various PAEKs in Table 1.The glass transition temperature (T_G) is the region above which the amorphous regions of the material soften. The melting temperature (T_M) is the temperature above which the crystalline regions of the material become liquid.

Table 1: Glass Transition Temperature and Melting Point of Various PAEKs

PAEK	Ether : Ketone	T_G (°C)	T_M (°C)
PEEK[1]	2	143	343
PEK[1]	1	157	374
PEKEKK[1]	0.67	162	387
PEKK[2]	0.5	165	357

3. Tribological Proprties

PAEKs, like other polymers, produce transfer films when sliding against a harder counterface. These films form with both reinforced and unreinforced polymers. At low contact pressures and temperatures, the friction and wear of PAEKs is characterised of a mild abrasion and polishing of the polymer surface. At higher contact pressures and temperatures, surface melting and scouring is seen. Previous work by these authors and by other groups has identified a potential link between this transition in tribological mechanism and the glass transition temperature of the polymer.

This study aims to identify the nature of the link between the glass transition tempearture and the tribological properties of various PAEKs. The effects of different PAEKs with different values of T_G are also considered.

4. Experimentation

A pin-on-disc machine was used to evaluate the friction, wear and operating temperature of pins of reinforced PAEK sliding against a steel disc, Figure 2. The effects of sliding speed and contact pressure were considered. The four varieties of PAEK that were tested are shown in Table 1. These materials were all reinforced with 30% carbon fibre whiskers.

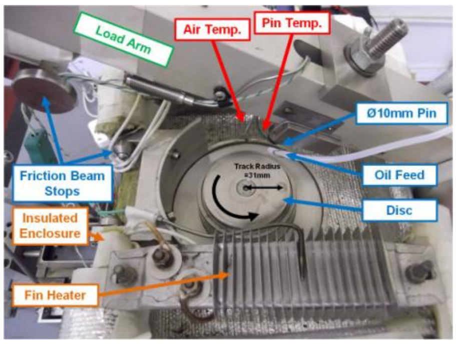

Figure 2: High Speed Pin-on-Disc Tribometer

5. References

[1] Victrex plc, 2012 www.victrex.com
[2] Arkema France, 2012 www.arkema.com
[3] Zhang, G, et al. "Temperature Dependence of the Tribological mechanisms of Amorphous PEEK (Polyetheretherketone) under Dry Sliding Conditions." Acta Materialia 55: 2182, 2008