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Developing optimal oil for grease for CVJ boots

Greases for constant velocity joints (CVJs) need to be compatible with the construction material of the boots that protect the joints – a challenge facing developers of new base oils for such greases. Nynas Naphthenics' Valentina Sera-Holm explains how the naphthenic base oil S 150 was made suitable for this application, whilst fulfilling other requirements.

Introduction

Commonly used in drive-line applications, constant velocity joints (CJVs) are special types of universal couplings which can transmit drive from the final reduction gear to a road wheel axle at constant rotation velocity. Constant velocity joints are protected by sealing boots made of chloroprene rubber or thermoplastic elastomer (TPE) which are usually bellows-shaped. The primary functions of the boot are to retain the lubricating grease in the joint and keep out contaminants. Two of the main requirements on the grease for CVJs are optimal compatibility with the boot material and very good low temperature properties.

When it comes to grease compatibility with the boot material and risk of deterioration of the boots, base oils have a relevant impact. In fact, all mineral and synthetic base oils extract the plasticisers from the elastomers. Some base oils diffuse very little into the elastomer, causing shrinkage, and others diffuse extensively, causing excessive swelling. Both shrinkage and excessive swelling are undesired as they compromise the stability of the sealing boot, ultimately resulting in failure of the CVJ. Paraffinic base oils and polyalphaolefins are examples of oils that cause shrinking of chloroprene rubber and TPE, while standard naphthenic oils cause swelling. Naphthenic oils are typically included in grease formulations in order to ensure good low temperature properties. The combination of the excellent low temperature properties of naphthenic base fluids with optimal elastomer compatibility in a single oil would make this material a very interesting candidate to be a base fluid for CVJ greases.

Such oil can be produced by very severe hydrotreatment of a naphthenic distillate. The resulting oil will have a very low aromatic content and therefore a higher aniline point than standard naphthenic oils. The aniline point can be optimised in order to achieve optimal elastomer compatibility, meaning a limited degree of swelling which ensures an improved sealing of the boot, without affecting the elastomer stability.

Experimental

Materials

The newly developed naphthenic oil (designated with the letter S 150) was compared to a paraffinic and several naphthenic base oils. The naphthenic base oils S 150, BNS 150 and BT 150 are manufactured by severe hydrotreatment of naphthenic distillates. The naphthenic base oil SR 130 is produced by solvent refining. All the oils tested had a polyaromatic content, measured by IP 346[1], lower than 3 %, which is the carcinogenicity limit according to the EU legislation[2,3]. The paraffinic base oil was produced by solvent refining. The main difference between the naphthenic base oils is the severity of the hydrotreatment process, which in turn affects the oil's solvating power. The solvating power can be measured with different methods, the most common ones being Aniline Point (AP) and Viscosity Gravity Constant (VGC). The aniline point method (ASTM D611) involves measuring the temperature at which aniline dissolves in the oil. The higher the solvating power, the lower the aniline point. Viscosity Gravity Constant (VGC) is a dimensionless constant that is based on a mathematical processing of the viscosity and density values according to ASTM D2501 and provides a weighted value between the viscosity effect on the solvating power and the chemical nature of the oil. The higher the solvating power, the higher the value of VGC. In Table 1 the main properties of the oils tested are summarised.

Table 1. Base Oils Main Properties

Characteristics	Test method (ASTM)	Base Oils				
		Naphthenic base oil S 150	Naphthenic base oil SR 130	Naphthenic base oil BNS 150	Naphthenic base oil BT 150	Paraffinic base oil SN 700
Density @ 15°C (59°F), g/cm3	D4052	0.905	0.908	0.914	0.922	0.889
Viscosity 40°C (104°F), mm^2/s (SUS)	D445	152 (704)	144 (667)	150 (695)	152 (704)	151 (700)
Viscosity 100°C (212°F), mm2/s (SUS)	D445	11.7 (65.3)	10.7 (62.0)	11.2 (63.5)	11.1 (63.1)	14.5 (76.0)
Flash point PM, °C (°F)	D93	228 (442)	225 (437)	222 (432)	220 (428)	251 (484)
Pour point, °C (°F)	D97	-30 (-22)	-27 (-17)	-27 (-17)	-27 (-17)	-12 (10)
Viscosity Index	D 2270	48	29	36	31	94
Aniline point, °C (°F)	D611	106 (223)	95 (203)	96 (205)	89 (192)	113 (235)
VGC	2501	0.837	0.841	0.850	0.860	0.814
C_A %	D2140	3	5	7	13	4
C_N %	D2140	44	37	42	38	27
C_P %	D2140	53	58	51	49	69