Performance Comparison and Structure-Activity Relationship of Different Sulfured Olefins

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1. Background

Vulcanized olefin is an important extreme pressure anti-wear additive for lubricating oil. It has high active sulfur content, stable S-S bond in the structure, and good extreme pressure anti-wear performance. It plays an irreplaceable role in improving the bearing performance of lubricating oil, especially gear oil, hydraulic oil and cutting oil.

There are many kinds of vulcanized olefin additives, and the main ones that are widely used are sulfide isobutylene (T321) and sulfide isooctene (LZ5340). Among them, T321 has high sulfur content, excellent extreme pressure anti-wear performance, low copper corrosion, strong thermal stability, and can effectively prevent metal surface damage under high-speed impact load, so it is the most widely used vulcanized olefin additive. However, T321 has a strong pungent odor, and its application is increasingly limited under increasingly stringent environmental regulations. LZ5340 is a vulcanized olefin synthesized from C8 olefin. It has good oil solubility and higher active sulfur content. It can not only provide better extreme pressure performance, but also has almost no irritating odor, so it has broad application prospects.

Considering the structural differences between T321 and LZ5340, in order to investigate the properties of T321 and explore the influence of the structure of vulcanized olefin on its properties, this study analyzed the influence of the structure of vulcanized olefin on its properties, and provided guidance for the development and application of vulcanized olefin additives.

2. Structural Analysis of Sulfured Olefins

Analysis of the composition and structure of T321 and LZ5340 revealed that both sulfured olefins are multi-component mixtures. T321 has a high sulphur content and a low reactive sulphur content, while LZ5340 has a low sulphur content and a high reactive sulphur content. The reason for this is the longer alkyl chains in the molecular structure of the LZ5340 component and the lower strength of the S-S bond in the molecule, which makes it easy to become reactive sulphur and react with the metal to form a friction protection film at a lower temperature; However, reactive sulphur can cause severe corrosion of metals, resulting in poor friction reduction, wear and corrosion resistance; Meanwhile, due to the long alkyl chain, the content of volatile small molecule thiols, ketones and thioethers in LZ5340 is very low, and there is almost no irritating odour, so LZ5340 has the advantage of being more environmentally friendly than T321, and has a good prospect of application.

Table 1　Mass spectral component for T321 and LZ5340

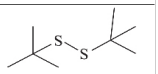
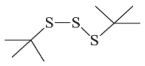
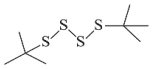
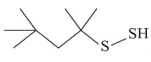
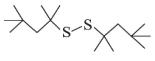
Components	Mass fraction，%	Molecular formula	Relative molecular mass	Chemical structure
T_1	16.19	$C_8H_{18}S_2$	178	
T_2	43.71	$C_8H_{18}S_3$	210	
T_3	28.43	$C_8H_{18}S_4$	242	
LZ_1	7.54	$C_8H_{18}S_2$	178	
LZ_2	8.47	S_8	256	
LZ_3	83.99	$C_{16}H_{34}S_2$	290	

Table 2　Elemental composition of T321 and LZ5340

Lubricant additives	ω（N），%	ω（C），%	ω（H），%	ω（S），%	ω（S_A），%
T321	0.83	41.88	7.204	43.581	7
LZ5340	0.58	48.05	7.598	36.851	36

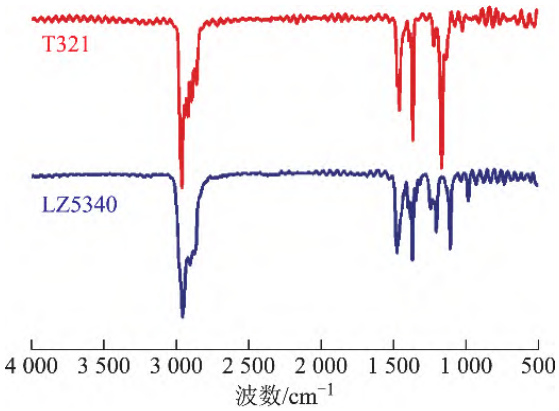


Fig. 1 IR profiles of T321 and LZ5340

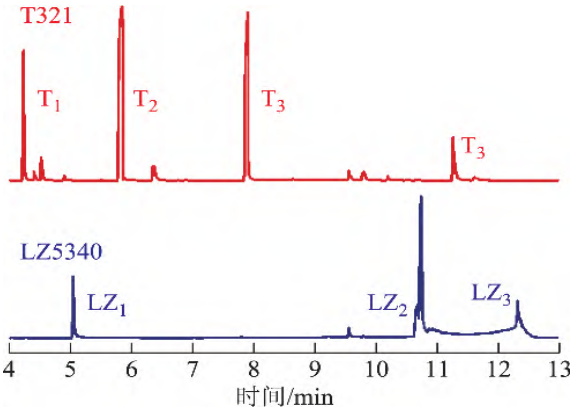


Fig. 2 TIC spectra of T321 and LZ5340

3. Tribological Properties of Sulfured Olefins

The friction-reducing, anti-wear and extreme pressure properties of two sulfured olefins (T321 and LZ5340) were investigated and their corrosion resistance was compared. The results show that T321 has superior friction reduction, antiwear, corrosion resistance and extreme pressure performance at low content, while LZ5340 exhibits superior extreme pressure performance at high content.

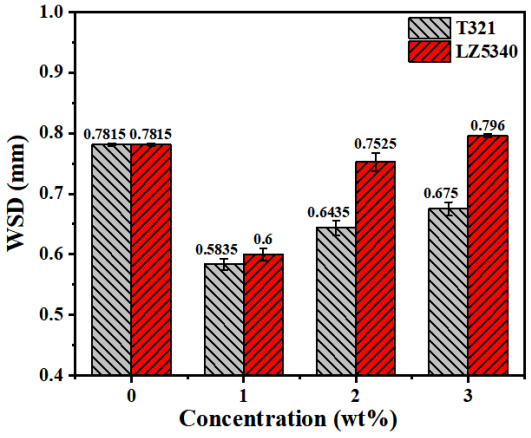


Fig. 3 Variation of WSD with the amount added

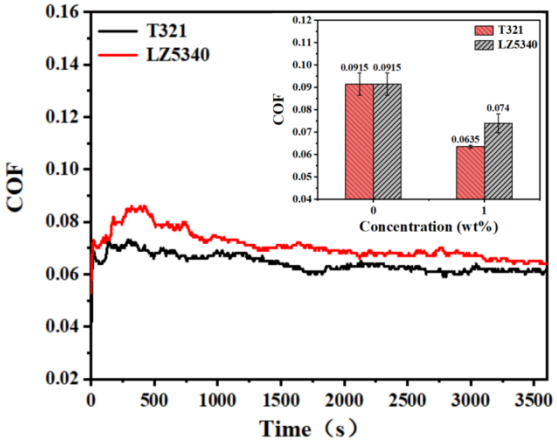


Fig. 4 COF of PAO4 with 1 wt% of T321 and LZ5340

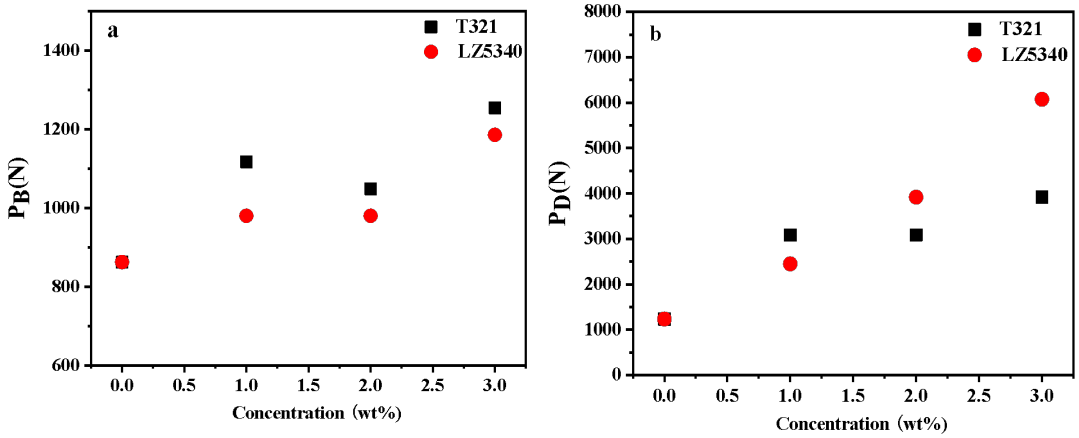


Fig. 5 Variation of P_B and P_D of oil samples with different sulfured olefin additions

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