KYODO YUSHI TECHNICAL BULLETIN
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DECOMPOSITION OF OILS BY ACTION OF DISCHARGE PLASMA (3)
-OXYGEN CONTAINING HYDROCARBON COMPOUNDS-

In the last issue, various hydrocarbon compounds were tested using a newly invented needle-plate electrodes discharge plasma generator and we found that they were decomposed by discharge plasma action to produce hydrogen. This report summarizes our findings of how hydrogen production is affected by the structure of oxygenated hydrocarbon compounds.

Table 1 shows the oil species, structural formula, hydrogen production caused by discharge plasma action and volume resistivity of the oxygenated hydrocarbon compounds tested, where the amount of hydrogen production indicates the percentage when that of *n*-hexadecane is 100. In the ester compounds, the volume resistivity and hydrogen production volume is increased with increasing in the alkyl chain length. This trend does not depend on the posiotion of the alkyl chain, neither at the center or at the ends. On the other hand, in the ether compounds, the volume resistivity and the amount of hydrogen are decreased with increasing in the number of oxygen atoms in the molecule. Glycol compounds showed lower volume resistivity than other oxygenated hydrocarbon compounds and no hydrogen production.

Table 1 Oxygenated hydrocarbon compound samples – molecular structure, hydrogen production and volume resistivity

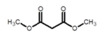
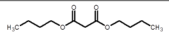
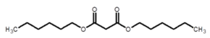
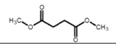
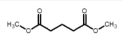
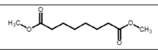
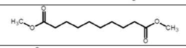
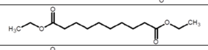
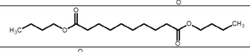
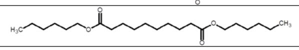
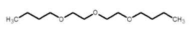
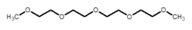
Oil Species		Structural formula	H_2, %	Volume resistivity Ω・cm
Di-Ester	Dimethyl Malonate		0	2.2×10^{7}
	Dibutyl Malonate		0	4.1×10^{8}
	Dihexyl Malonate		1	4.4×10^{9}
	Dimethyl Succinate		0	2.7×10^{7}
	Dimethyl Glutarate		0	6.0×10^{7}
	Dimethyl Adipate		0	1.1×10^{9}
	Dimethyl Sebacate		17	3.5×10^{9}
	Diethyl Sebacate		67	1.3×10^{10}
	Dibutyl Sebacate		93	6.1×10^{10}
	Dihexyl Sebacate		95	2.2×10^{11}
Ether	Dihexyl Ether		103	6.3×10^{12}
	Dioctyl Ether		91	2.2×10^{13}
Glycol Ether	Diethylene Glycol Dibutyl Ether		88	1.4×10^{10}
	Tetraethylene Glycol Dimethyl Ether		0	3.5×10^{7}
Glycol	Tripropylene Glycol		0	2.0×10^{7}
	Tetraethylene Glycol		0	6.8×10^{6}

Figure 1 shows the amount of evolved hydrogen as a function of volume resistivity of the ester, ether and glycol compounds tested. No hydrogen is produced at and below the volume resistivity of 1.1×10^{9} Ω· cm. However at and above 3.5×10^{9} Ω· cm, hydrogen is clearly produced, the volume of which increases steeply with the volume resistivity, approaching to an almost constant maximum value. This means that there exists a critical volume resistivity to cause hydrogen production, which is 10^{9}Ω・cm. It should be noted that for all types of oxygenated hydrocarbon compound tested, the relation between hydrogen production and volume resistivity lies on a single curved line.

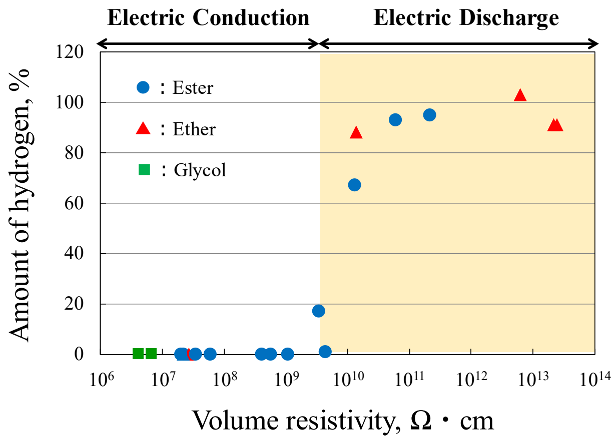


Fig. 1 Dependence of hydrogen production on volume resistivity

These results suggest that oils having volume resistivity of less than 10^{9} Ω· cm can be a promising lubricating oil to be developed for avoiding the shortened (fatigue) service life of rolling bearing through white structure flaking.

Noyama, S., Iijima, M., Dong, D., Nakayama, K.: JAST Tribology Conference, 2018 Autumn Ise, A34
Noyama, S., Iijima, M., Dong, D., Nakayama, K.: JAST Tribology Conference, 2019 Spring Tokyo, A2