KYODO YUSHI TECHNICAL BULLETIN

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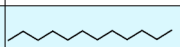
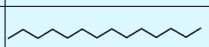
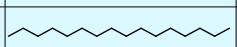
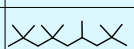
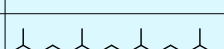
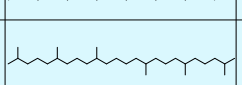
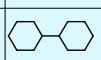
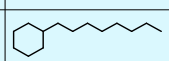
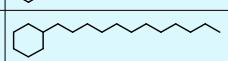
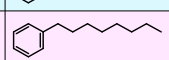
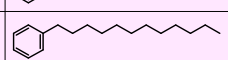
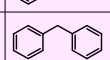
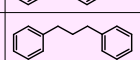
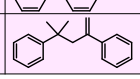
DECOMPOSITION OF OILS BY ACTION OF DISCHARGE PLASMA (2)
-HYDROCARBON COMPOUNDS-

In our last issue, a needle-plate electrodes discharge plasma generator was constructed. Using it, various hydrocarbon compounds were tested, and we found that they are decomposed by discharge plasma action to produce hydrogen. This report summarizes our findings of how hydrogen production is affected by the structure of aliphatic/aromatic hydrocarbon compounds.

Table 1 shows the oil species, molecular and structural formulae and hydrogen productions caused by discharge plasma action on the hydrocarbon compounds, where the amount of hydrogen production indicates the percentage when that of *n*-hexadecane is 100. Aliphatic hydrocabons show little difference in the volume of hydrogen productions, which range from 91 to 106 %. However over all types of aliphatic, straight, blanched and cyclic compounds tested, the hydrogen production volume increases with increasing molecular weight, i.e., with increasing molecular chain length.

Table 1 Hydrocarbon compound samples – molecular structure and hydrogen production

Oil species		Molecular formula	Structural formula	H_2, %
Aliphatics (Straight)	*n*-Dodecane	$C_{12}H_{26}$		90
	n-Tetradecane	$C_{14}H_{30}$		96
	n-Hexadecane	$C_{16}H_{34}$		100
Aliphatics (Blanched)	2,2,4,4,6,8,8-Heptamethyl nonane	$C_{16}H_{34}$		97
	2,6,10,14-Tetramethyl pentadecane	$C_{19}H_{40}$		104
	2,6,10,15,19,23-Hexamethyl tetracosane (Squalane)	$C_{30}H_{62}$		106
Aliphatics (Cyclic)	Bicyclohexyl	$C_{12}H_{22}$		98
	n-Octyl cyclohexane	$C_{14}H_{28}$		102
	n-Dodecyl cyclohexane	$C_{18}H_{36}$		104
Aromatics (Mono-)	*n*-Octyl benzene	$C_{12}H_{22}$		94
	n-Dodecyl benzene	$C_{14}H_{28}$		93
Aromatics (Di-)	Diphenylmethane	$C_{13}H_{12}$		2
	Diphenylpropane	$C_{15}H_{16}$		3
	Cis-1,2-Diphenylethylene	$C_{14}H_{14}$		2
	4-Methyl-2,4-Diphenyl-1-Pentene	$C_{18}H_{28}$		72

As for aromatic hydrocarbon compounds, aromatics having one benzene ring with a linear aliphatic chain containing 8 or more carbon numbers produce hydrogen at almost the same level as that of aliphatic hydrocarbon compounds, but those having two benzene rings with aliphatic hydrocarbon groups between them produce less hydrogen. Prticularly, hydrogen production is extremely low for aromatics having 1 to 3 methylene groups (-CH_2-) and a methine group (-CH=) between the rings.

Figure 1 shows the amount of hydrogen as a function of, $\%C_A$, the ratio of the number of carbon atoms in an aromatic ring to all carbon atoms in the molecule. In aromatic hydrocarbon compounds, the amount of hydrogen production significantly depends on their molecular structure, and the hydrogen production decreases with increasing $\%C_A$, to be minimized at and above 80% .

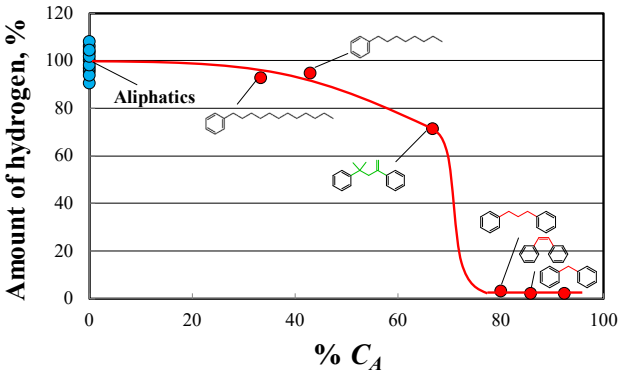


Fig. 1 Dependence of hydrogen production on $\%C_A$

These results suggest that aromatic oils can be a promising lubricating oil to be developed for avoiding the shortened service life of rolling bearing through white structure flaking.

NOYAMA, S., IIJIMA, M., DONG, D., NAKAYAMA, K.: JAST Tribology Conference, 2018 Spring Tokyo, E4