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A comparison of hydrocarbons emission from engine running $85^{\#}$ gasoline and M-100 methanol fuel

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Abstract— Increasing global interest in methanol fuel has led us to investigate the exhaust emissions of its engine. Analysis of its inorganic and organic emissions, such as CO, NO_x and hydrocarbons (total HC) have been widely reported. This paper presents an analysis of more than 20 kinds of hydrocarbons in the emissions obtained from a spark-ignition Shanghai car running $85^{\#}$ gasoline and a comparison with emission from a Santana test car running M-100 methanol fuel. A set of enrichment method has also been described. Test results show that at the current stage of methanol engine development the concentration of individual hydrocarbon including some poisonous substances is lower than those of normal gasoline engine.
Keywords: engine running; $85^{\#}$ gasoline; M-100 methanol fuel; atmosphere; health.

1 Introduction

A wide variety of hydrocarbons in exhaust gas has of a strong impact on environment. Most analysis efforts have been devoted to the determination of total hydrocarbon (William, 1984; Haku, 1980). Paying less attention to the effect of each individual HC which have their own toxicity to human health (Sichmann, 1984; Kirshenblatt, 1988). Both qualitative and quantitative analysis are needed in order to assess its effect on atmosphere and health of the general public.

According to the studies published (Hiro, 1988; Allsup, 1977), hydrocarbon emissions of methanol engine are less than that of engine running normal gasoline. And CO, NO_x etc. were reported to be reduced by using methanol fuel. The actual concentration of individual hydrocarbons and its impact upon human health have not been thoroughly investigated.

In our experiment exhaust gas from methanol engine and normal engine were first enriched by liquid nitrogen with a packed glass tube, and then qualitative identification was carried out by GC/MS with help of some pure substances used as reference (Termonia, 1985; Mattsson, 1982). The results show that the concentration level of hydrocarbons from methanol engine, especially those which have adverse effect on human health are lower than that of gasoline engine.

2 Experiment

2.1 Concentration

A glass tube (8mm × 15cm) filled with diatomaceous earth (40 − 60 mesh) is kept in the liquid nitrogen as illustrated in Fig. 1. With a narrow bore latex tube, one end of the glass tube was connected with a purifying tube (packed with $CaCO_3$ and alkaline asbestos) in which H_2O and CO_2 were removed from the gas leading to the cold trap. Flow rate of sampling pump was set at 200 ml/min. All enrichment system has to be made leak-proof without transferring other contaminations to the cryogenic tube. A teflon gas bag filled with exhaust gas (about 3 liters) was linked with purifying tube. After certain period of time, both the sampling pump and the purifying tube can be taken away from the cold trap. One end was squeezed with spring clamp at latex tube ending, another end was connected with a glass syrige of 100 ml. Then put it into paraffin oil which is heated by electric heater, the maximum temperature would gradually reach 180 − 200 ℃. The expanded gas would push the piston out to read of 20 − 40ml. The gas enriched in the tube could be injected into gas chromatography for separation and MS identification.

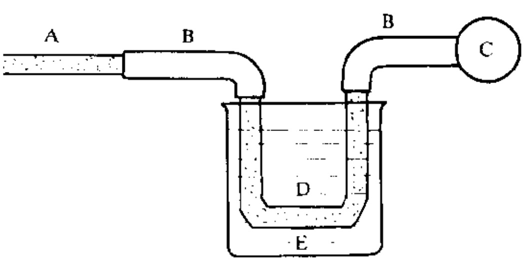

Fig. 1 System of experiment

A: purifying tube B: latex tube
C: air sampling pump
D: diatomaceous earth (40 − 60 mesh)
E: liquid nitrogen

2.2 GC/MS

The analytical results reported were obtained on a HP. 5890A gas chromatography coupled with MS (VG. 70−SE). The chromatographic column was 25m × 0.25mm id. fused silicon capillary column. Station phase was HP-101 (similar to OV-101), with film thickness of 0.2μm, split ratio was 10:1. Qualitative analysis was performed on FID, HP3392A was used as a integrator for giving both chromatogram and retention time. The column temperature was cooled below −20 ℃ by putting a beaker of liquid nitrogen inside the column chamber with the door shut and fan running.

To begin the operation, temperature was first halted at −20℃ about 10 min by carefully controlling the amount of liquid nitrogen. Electronic device used for making temperature programming was than turned on. Temperature increased as it had been programmed. Injector temperature was 190°C, detector temperature was set at 260°C. A common average response factor used for calibration of the concentration was obtained by using methane, butane and 1,3-butadiene as reference gas. The sum of analytical error was estimated to be within 20%.

3 Results and discussion

The chromatogram of exhaust gas obtained from Shanghai car running 85# gasoline is illustrated in Fig. 2. Results are listed in Table 1. Hydrocarbons which can also be found in the methanol engine emissions are listed in the table as comparison. Toxicity of some hydrocarbons is shown in the table as reference. Qualitative results made by GC/MS are based at least on one of the three following principles: first, MS fit value of hydrocarbons detected must be high enough for identification, for example 850 and more; then fit value of hydrocarbons listed in Table 1 must be 5−10 higher than other possible qualitative identification; finally if pure substances could be found in the laboratory, compound identification must be performed by comparison of the MS of unknowns with reference spectra under the same GC/MS condition and by comparison of their retention time under the same chromatographic condition.

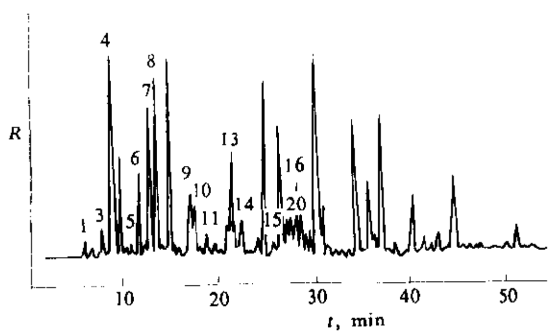

Fig. 2 Hydrocarbons in engine exhaust gas (Shanghai car)

It should also be noted that with the principles above Some compound such as formic acid, aldehyde and melthyl nitrite etc., which can certainly be found in the exhaust gas was kept out from Table 1.

Concentration and structure of each hydrocarbons in engine emissions are highly dependent on the running condition. Different condition will turn out to be different results. The test methanol angine used was a Santana test car, it had a stroke volume of 1781 mm the cylinder diameter was 812 mm, compression ratio 12.5 engine was operated at a speed of 1000 r/min. The M-100 fuel fed in the engine contains some substances which can improve the engine operation. Shanghai car fed with 85# gasoline operated under the similar running condition.

Table 1 Hydrocarbons in engine emissions

Pk No.	Name	Mo. for	Con., ppm		Method	Tox.
			M-100	85#		ppm
1	Propene	C_3H_6	16	15	GC/MS,GC	1000
2	Methanol	CH_4O	1100	8	GC/MS,GC	200
3	n-butene	C_4H_8	12	19	GC/MS,GC	ana.
4	n-pentane	C_5H_{15}	110	298	GC/MS,GC	1000
5	Acetonitrile	C_2H_3N		65	GC/MS	40
6	2-me-butane	C_5H_{12}	29	49	GC/MS,GC	1000
7	1-chloro-3-me-2-Pentanone	$C_5H_{11}C$		125	GC/MS	
8	3-me-butene	C_5H_{10}		89	GC/MS	ana.
9	3-me-butanol	$C_5H_{10}O$	35	83	GC/MS	100
10	3-me-octane	$C_6H_{12}O$	12	92	GC/MS	ana.
11	2,3-dime-butane	C_6H_{14}	9	32	GC/MS	ana.
12	2-me-pentane	C_6H_{12}		190	GC/MS	
13	Propylcyclopropane	C_6H_{12}		63	GC/MS	
14	3-hexene	C_6H_{12}	8	28	GC/MS	ana.
15	2,4-dime-pentane	C_7H_{16}	8	48	GC/MS	
16	Benzene	C_6H_6	12	49	GC/MS, GC	25
17	2-me-hexane	C_7H_{16}	9	27	GC/MS	ana.
18	2,3-dime-pentane	C_7H_{18}		66	GC/MS	ana.
19	3-me-hexane	C_8H_{17}		54	GC/MS	ana.

Tox: minimum amount which have adverse effect on human health
ana: anaesthesia

From the result above, the following conclusions could be made:

Among almost all hydrocarbons which can be found in both emissions, concentration level of HC from emissions of engine fed with M-100 is considerably lower than those from engine fed with the normal fuel.

Other contaminations such as methanol, aldehyde and so on are required to be further reduced in the final methanol engine exhaust gas leading to the atmosphere.

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