CHAPTER IV

RESULTS AND DISCUSSIONS

4.1 Identification of Individual Aldehydes and Ketones.

HPLC was used for analysis of individual aldehydes and ketones . It were analysed by form derivative with 2,4-dinitrophenylhydrazine to 2,4-dinitrophenylhydrazone derivative. The compositions were identified by comparing with chromatogram of standard, that was formed derivative with 2,4-dinitrophenylhydrazine. The chromatogram of sample and standard are shown in Figure 4.1-4.2. The chromatogram of 2,4-dinitrophenylhydrazone derivative were indicated peaks, that is shown in Table 4.1as follows.

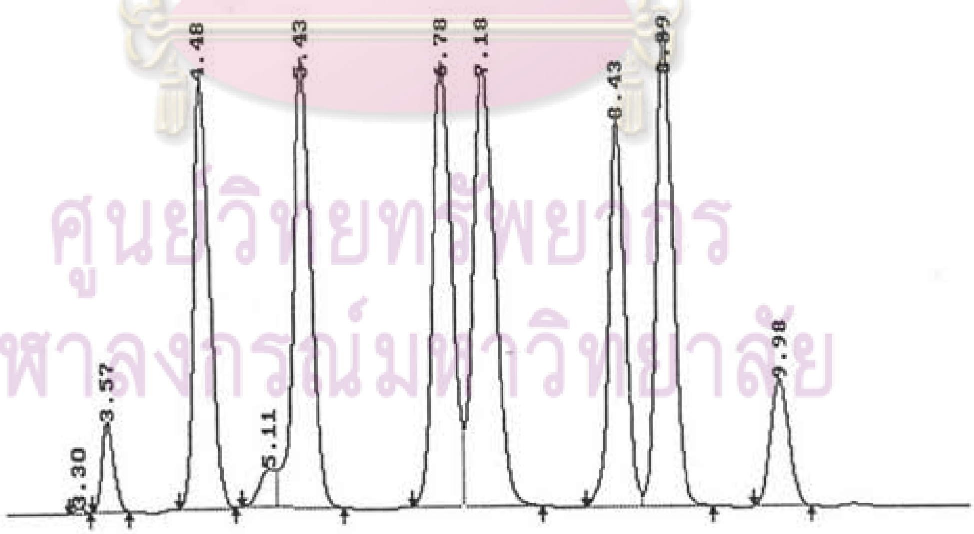

Figure 4.1 HPLC Chromatogram of standards.

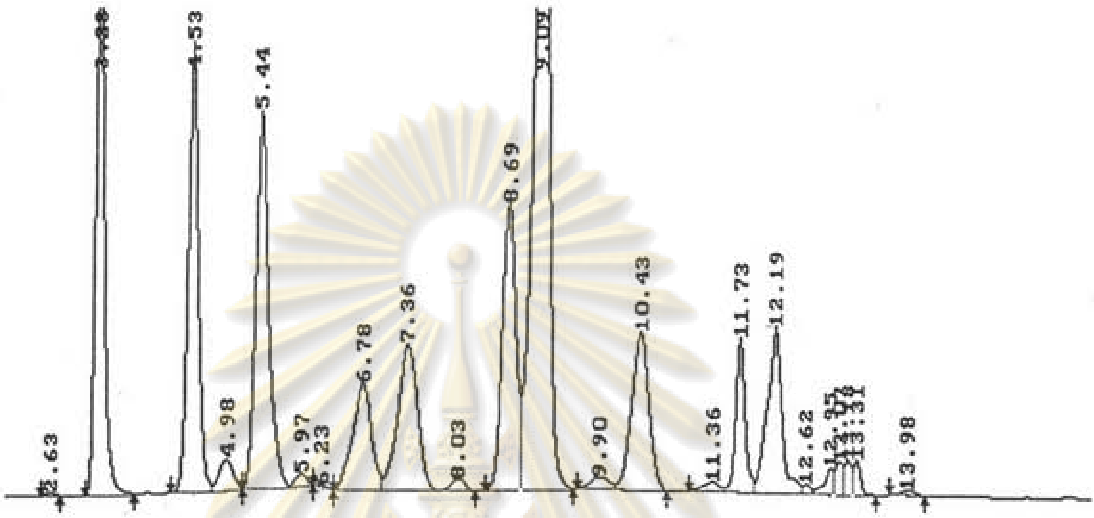

Figure 4.2 HPLC Chromatogram of sample

Table 4.1 Identification of standards and sample

Aldehydes and ketones	Retention time (min.)	
	Standard	Sample
Formaldehyde	4.48	4.53
Acetaldehyde	5.43	5.54
Acetone	6.78	-
Propionaldehyde	7.18	7.36
Crotonaldehyde	8.43	8.69
2-Butanone	8.89	9.09
Benzaldehyde	9.98	-

4.2 Effect of Engine on Exhaust Emissions.

The two parameters effecting the engine performance are spark timing and speeds. In this study, gasoline base from PPT was chosen to investigate these two parameters.

4.2.1 Effect of Spark Timing.

To study the effect of spark timing on exhaust emissions, the engine speeds was fixed at 1000 rpm and spark timing was varied to be 5, 9, 10,and 15 ^{O}BTDC. The amount of CO and HC in exhaust emission were analysed. The results obtained are shown in Table 4.2.

Table 4.2 The amount of CO and HC in exhaust emission.

Timing (^{O}BTDC)	Carbon monoxide (%vol)	Hydrocarbons (ppm)
5	0.78	110
9	0.72	110
10	0.79	120
15	0.84	140

The data in Table 4.2 show the relationship between spark timing and percent volume of carbon monoxide and the relationship between spark timing and concentration of hydrocarbons. The spark timing at 9 ^{O}BTDC was lowest,0.72 percent volume carbon monoxide and 100 ppm hydrocarbons. Thus, spark timing of 9 ^{O}BTDC should be appropriate to be used in the next experiment because it could be observed that the content of carbon monoxide and hydrocarbon are best at this timing.

4.2.2. Effect of Engine Speed.

In the study of the effect of engine speed on exhaust emission, engine spark timing was fixed at 9 ^{O}BTDC and engine speed was varied to be 1000, 1500, 2000, 2500, and 3000 rpm.

The percent volume of CO and concentration of hydrocarbon were measured and recorded in Table 4.3 as follows.

Table 4.3 The CO and HC in exhaust emission from gasoline base at various operating speeds.

Speed (rpm)	Carbon monoxide (%vol)	Hydrocarbons (ppm)
1000	0.74	110
1500	0.19	30
2000	0.65	40
2500	0.76	50
3000	1.31	60

The data in Table 4.3 were plotted to show the relationship between engine speed and percent volume of carbon monoxide and the relationship between engine speed and concentration of hydrocarbon in Figure 4.3-4.4, respectively.

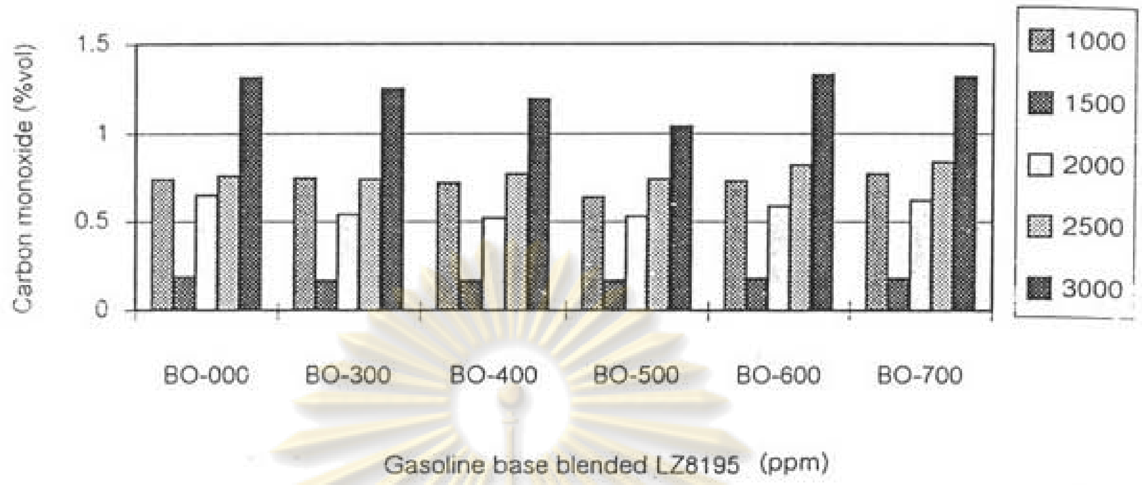

Figure 4.3 Effect of engine speed on carbon monoxide.

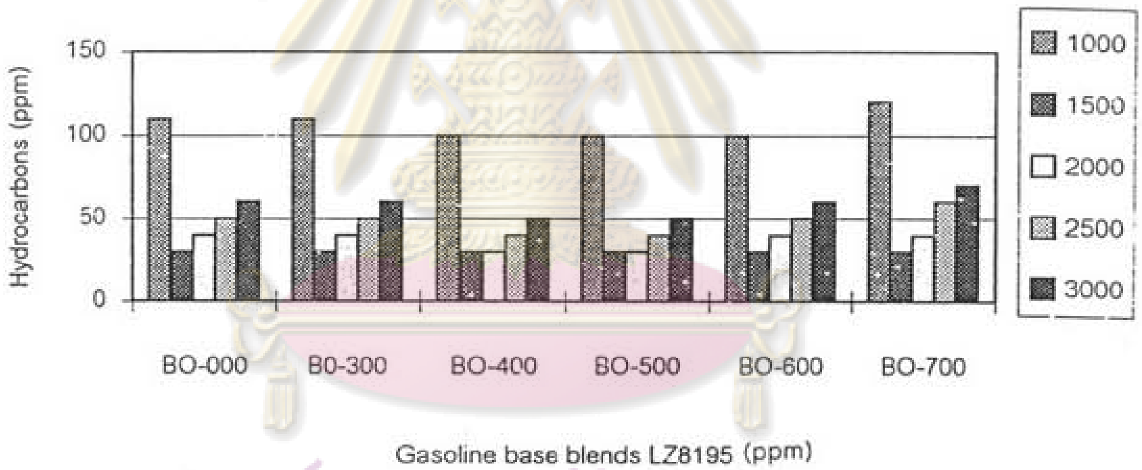

Figure 4.4 Effect of engine speed on hydrocarbons.

Emissions at an engine speed of 1500 ppm was lowest, 0.19 percent volume of carbon monoxide and 30 ppm concentration of hydrocarbons. The carbon monoxide and hydrocarbons were significantly increased with increasing engine speed.

4..2.2 Effect of engine speed on individaul aldehydes and ketones.

In studying the effect of engine speed on individual aldehydes and ketones, the gasoline base was used in testing. The concentration of aldehydes and ketones were measured and recorded in Table 4.5 as follows.

Table 4.4 Concentration of aldehydes and ketones in exhaust emission from gasoline base at various operating speeds.

Speed (rpm)	Formald (mg/m^3)	Acetald (mg/m^3)	Propionald (mg/m^3)	Crotonald (mg/m^3)	2-Butanone (mg/m^3)
1000	1.00	1.60	0.44	0.99	1.87
1500	0.77	1.26	0.41	1.04	1.97
2000	1.54	1.16	0.22	1.56	3.63
2500	1.55	1.20	0.29	0.92	3.70
3000	2.71	2.49	0.98	4.40	6.00

The data in Table 4.5 were plotted to show the relationship between engine speed and concentration of individual aldehydes and ketones in Figure 4.5, respectively.

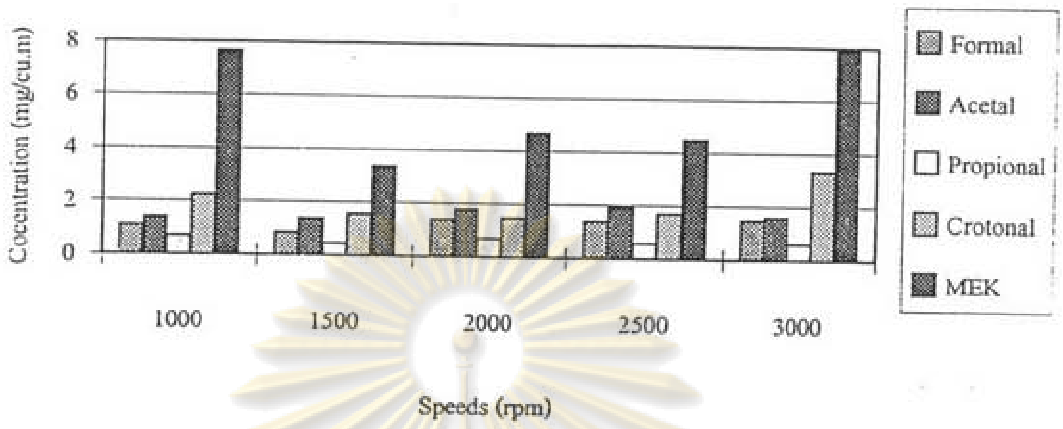

Figure 4.5 Effect of engine speed on aldehydes and ketones

The Figure 4.5 show the effect of engine speed on aldehydes and ketones. The trends are similar to those of carbon monoxide and hydrocarbons in Figure 4.3-4.4

At the low engine speed, the manifold and cylinder walls were cold. In order to form a combustible mixture enough fuel must be vaporised the so that vapour-air mixture entering the cylinder was in the ignitable range. Since only part of the fuel was vaporised the fuel-rich by choking. The mixture that enters the combustion chamber under this choked-carburettor condition was a fuel air-vapour mixture .During this period the exhaust will have a high concentration of CO and HC with some of the HC coming from fuel vaporised from the piston and walls late in the combustion process or during the exhaust stroke.

In a throttle-controlled engine the intake manifold pressure increases as engine speed increases. This increase in manifold pressure causes some of the fuel vapour in the vapour-air mixture in the manifold to condense out before reaching the cylinder causing the mixture actually reaching the cylinder to become momentarily lean. The opposite effect can occur, of course, when manifold pressure decrease. To compensate for this condensing effect with increased engine speed the carburettor has a fuel pump that, when the throttle is depressed, sprays additional gasoline into the carburettor. The quantity of fuel sprayed into the venturi has to satisfy both cold as well as warmed-up engine operating conditions, and was usually adjusted for cold concentrations. The effect of this momentary rich mixture was an increase in HC and CO. The formation of aldehydes and ketones is similar to carbon monoxide

4.4 Effect of Dispersant in Gasoline Fuel.

The following tests were carried out for comparison of the exhaust emissions obtained from gasoline base with gasoline base that was blended with dispersant. Concentration of dispersant was varied between be 300, 400, 500, 600, and 700 ppm. The pollutants in exhaust emission such as carbon monoxide, hydrocarbons, aldehydes and ketones were measured

4.4.1 Effect of Dispersant on carbon monoxide and hydrocarbons.

In studying the effect of dispersant in gasoline engine on carbon monoxide and hydrocarbons , engine timing was fixed at 9 ^{O}BTDC and engine speeds were varied to be 1000, 1500, 2000, 2500, and 3000 rpm. The percent volume of carbon monoxide and concentration of hydrocarbons were measured and recorded in Table 4.6-4.7.

Table 4.5 Carbon monoxide in exhaust emission from gasoline fuel with varied concentration of dispersant.

Concentration of dispersant (ppm)	Carbon monoxide (%vol)				
	1000 (rpm)	1500 (rpm)	2000 (rpm)	2500 (rpm)	3000 (rpm)
000	0.74	0.190	0.65	0.76	1.31
300	0.75	0.17	0.52	0.74	1.25
400	0.72	0.17	0.52	0.77	1.19
500	0.64	0.17	0.53	0.74	1.04
600	0.73	0.18	0.59	0.82	1.33
700	0.77	0.18	0.62	0.84	1.32

Table 4.6 Hydrocarbons in exhaust emission from gasoline fuel with varied concentration of dispersant.

Concentration of dispersant (ppm)	Hydrocarbons (ppm)				
	1000 (rpm)	1500 (rpm)	2000 (rpm)	2500 (rpm)	3000 (rpm)
000	110	30	40	50	60
300	110	30	40	50	60
400	100	30	30	40	50
500	100	30	30	40	50
600	100	30	40	50	60
700	120	30	40	60	70

The data in Table 4.6-4.7 were plotted to show the relationship between concentration of dispersant in gasoline fuel with percent volume of carbon monoxide and concentration of hydrocarbons to give graphs in Figure 4.6 and 4.7, respectively.

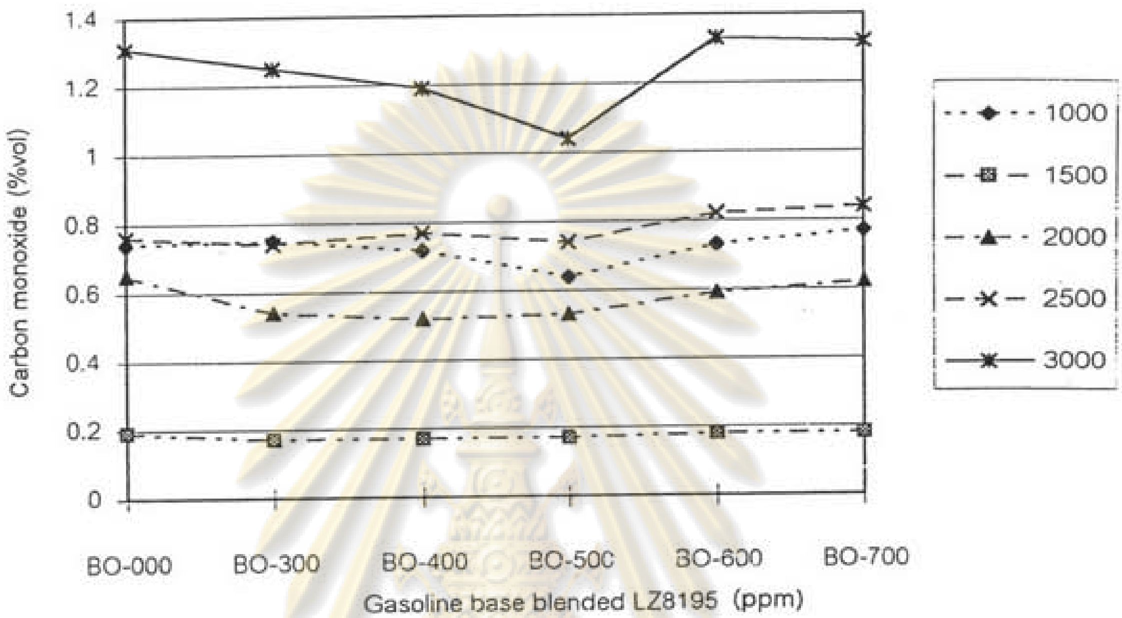

Figure 4.6 Effect of concentration of dispersant on carbon monoxide.

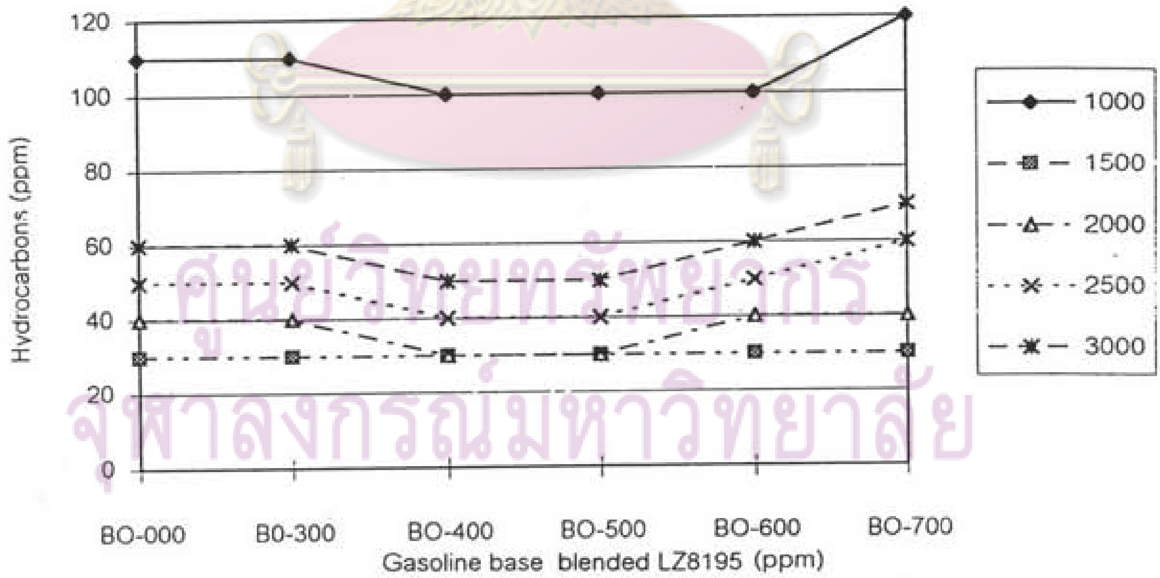

Figure 4.7 Effect of concentration of dispersant on hydrocarbons.

Figure 4.6 show the effect of concentration of dispersant in gasoline fuel on carbon monoxide. With concentrations of dispersant at 300 ppm to 500 ppm, the percent volume of carbon monoxide was significantly decreased with increasing concentration of dispersant., after it was significantly increased with increasing concentration of dispersant. The trends for hydrocarbons in Figure 4.7 were similar to carbon monoxide in Figure 4.6.

4.4.2 Effect of dispersant on aldehydes and ketones.

In the studying the effect of dispersant in gasoline fuel on aldehydes and ketones. The various operating conditions were similar to those used to study similar carbon monoxide and hydrocarbons.

Formaldehyde :

The data in table 4.7 were plotted to show the relationship between concentration of dispersant in gasoline fuel with concentration of formaldehyde to give the graph in Figure 4.8, respectively.

Table 4.7 Concentration of formaldehyde in exhaust emission with varied concentration of dispersant.

Concentration of dispersant (ppm)	Formaldehyde (mg/m^3)				
	1000 (rpm)	1500 (rpm)	2000 (rpm)	2500 (rpm)	3000 (rpm)
000	0.99	0.77	1.54	1.55	2.71
300	1.08	0.83	1.38	1.37	1.477
400	1.61	1.00	1.26	1.80	1.94
500	0.97	0.89	1.03	1.20	1.85
600	1.72	1.61	2.17	2.20	2.40
700	1.85	0.95	2.06	2.21	2.37

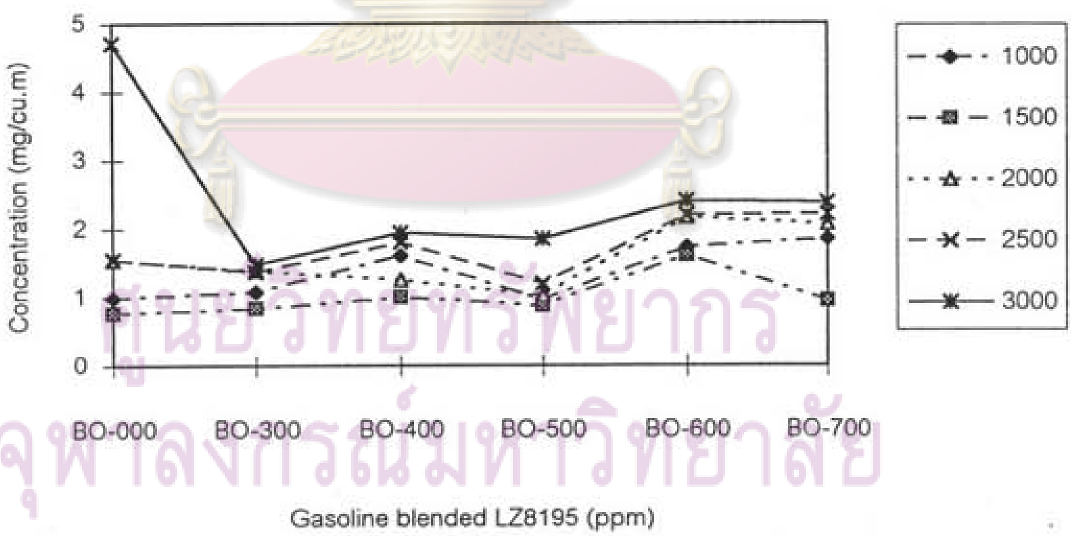

Figure 4.8 Effect of concentration of dispersant on formaldehydes

Figure 4.8 shows the effect of concentration of dispersant in gasoline fuel on formaldehyde. With a concentration of dispersant of 300 ppm to 400 ppm, the concentration of formaldehyde was significantly increased with increasing concentration of dispersant. At 500 ppm it had decreased, after which it was significantly increased with increasing concentration of dispersant.

Acetaldehyde :

The data in Table 4.8 were plotted to show the relationship between concentration of dispersant in gasoline fuel with concentration of acetaldehyde to give the graph in Figure 4.9, respectively.

Table 4.8 Concentration of acetaldehyde in exhaust emission with varied concentration of distpersant.

Concentration of dispersant (ppm)	Acetaldehyde (mg/m^3)				
	1000 (rpm)	1500 (rpm)	2000 (rpm)	2500 (rpm)	3000 (rpm)
000	1.65	1.72	1.78	1.90	2.49
300	1.60	1.45	1.62	1.51	1.93
400	1.50	1.38	1.57	1.58	1.91
500	1.40	1.26	0.93	1.20	1.59
600	1.55	1.91	1.16	1.50	1.93
700	3.08	2.25	3.97	3.50	3.69

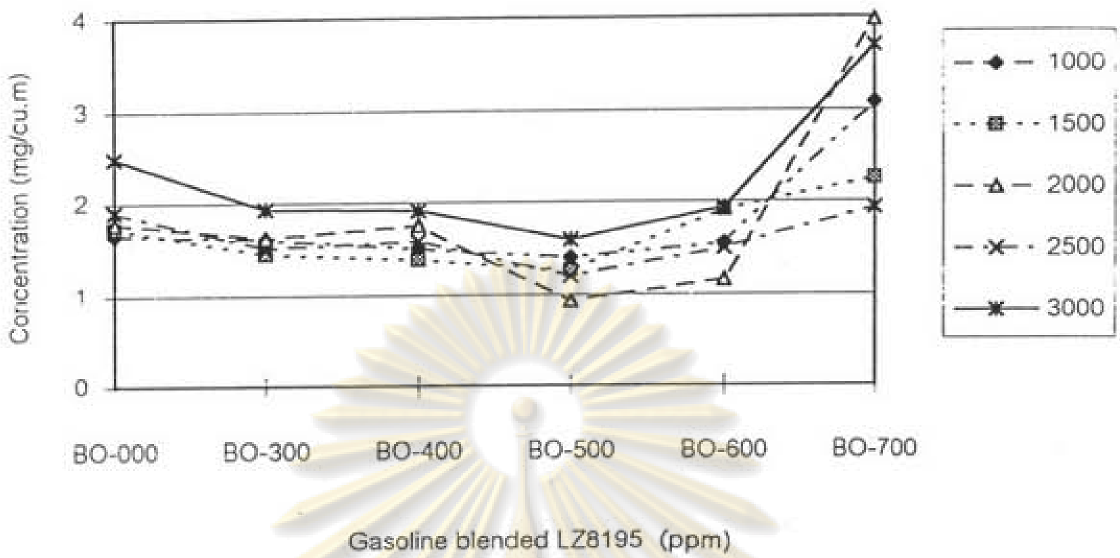

Figure 4.9 Effect of concentration of dispersant on acetaldehydes.

Figure 4.9 shows the effect of concentration of dispersant in gasoline fuel on acetaldehyde. With a concentration of dispersant at 300 ppm to 500 ppm, the concentration of acetaldehyde was significantly decreased with increasing the concentration of dispersant. After that it was significantly increased with increasing concentration of dispersant.

Propionaldehyde :

The data in Table 4.9 show the relationship between concentration of dispersant in gasoline fuel with concentration of propionaldeyde to give graph in Figure 4.10.

Table 4.9 Concentration of propionaldehyde in exhaust emission with varied concentration of distpersant.

Concentration of dispersant (ppm)	Propionaldehyde (mg/m^3)				
	1000 (rpm)	1500 (rpm)	2000 (rpm)	2500 (rpm)	3000 (rpm)
000	0.44	0.41	0.22	0.29	0.98
300	0.68	0.46	0.70	0.58	0.60
400	0.87	0.54	0.48	0.56	0.69
500	0.56	0.47	0.48	0.51	0.71
600	0.61	0.62	0.53	0.47	0.73
700	0.66	0.50	1.71	1.17	1.87

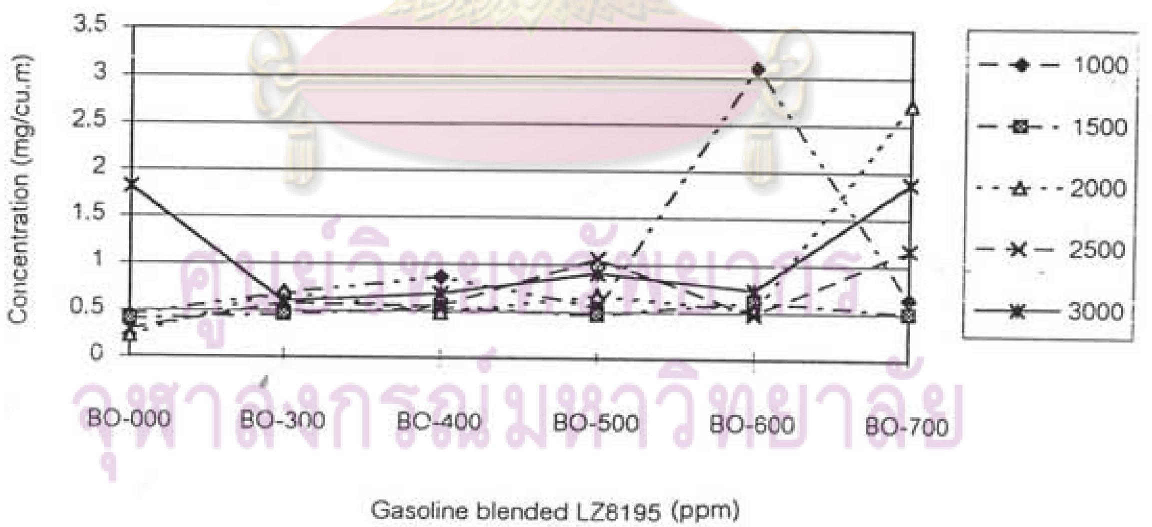

Figure 4.10 Effect of concentration of dispersant on propionaldehyde.

The Figure 4.10 show the effect of concentration of dispersant in gasoline fuel on propionaldehyde. With concentrations of dispersant of 500 ppm or less, the concentration of propionaldehyde changed little.

Crotonaldehyde :

The data in Table 4.11 were plotted to show the relationship between concentration of dispersant in gasoline fuel with concentration of crotonaldehyde to give the graph in Figure 4.10.

Table 4.10 Concentration of crotonaldehyde in exhaust emission that was varied concentration of distpersant.

Concentration of dispersant (ppm)	Crotonaldehyde (mg/m^3)				
	1000 (rpm)	1500 (rpm)	2000 (rpm)	2500 (rpm)	3000 (rpm)
000	0.99	1.04	1.56	0.92	4.40
300	2.24	1.57	1.46	1.68	3.30
400	2.03	1.44	2.39	1.49	1.37
500	0.82	0.99	1.36	0.62	1.99
600	1.57	1.03	1.73	1.45	1.11
700	2.22	0.86	3.71	3.76	4.37

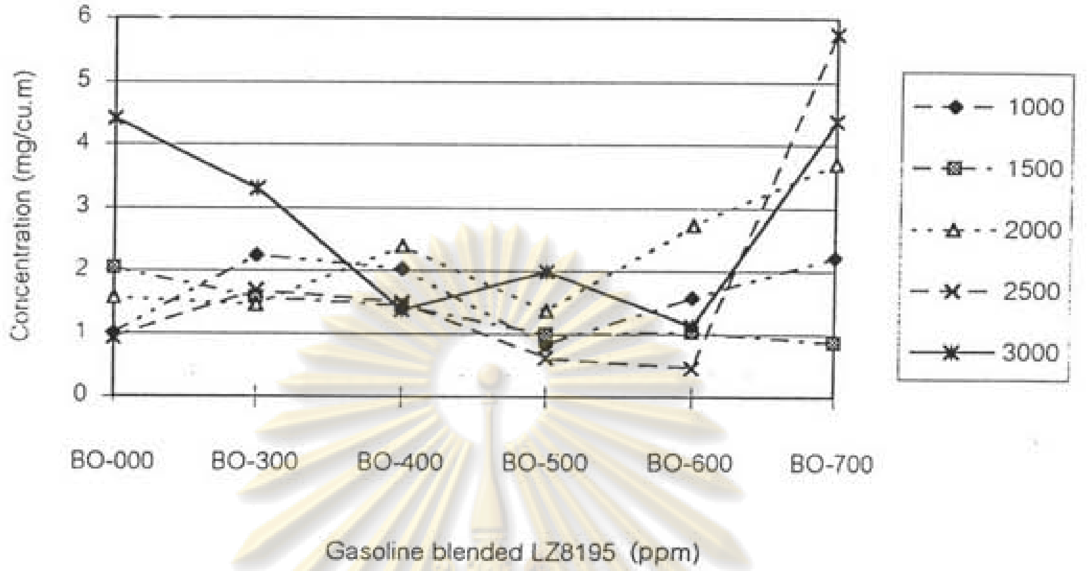

Figure 4.11 Effect of concentration of dispersant on crotonaldehydes.

Figure 4.10 shows the effect of concentration of dispersant in gasoline fuel on crotonaldehyde. With concentrations of dispersant of 300 ppm to 500 ppm, the concentration of crotonaldehyde was significantly decreased with increasing the concentration of dispersant, after that it was increased with increasing the concentration of dispersant.

2-Butanone :

The data in Table 4.11 were plotted to show the relationship between concentration of dispersant in gasoline fuel with concentration of 2-butanone to give the graph in Figure 4.12.

Table 4.11 Concentration of 2-butanone in exhaust emission with varied concentration of distpersant.

Concentration of dispersant (ppm)	2-Butanone (mg/m^3)				
	1000 (rpm)	1500 (rpm)	2000 (rpm)	2500 (rpm)	3000 (rpm)
000	4.87	2.97	3.63	3.70	6.00
300	7.67	3.34	4.6	4.46	7.89
400	5.99	4.17	6.32	4.04	3.33
500	2.29	2.41	2.34	2.41	4.59
600	4.20	3.50	8.89	0.97	3.99
700	6.41	2.72	8.55	11.98	10.98

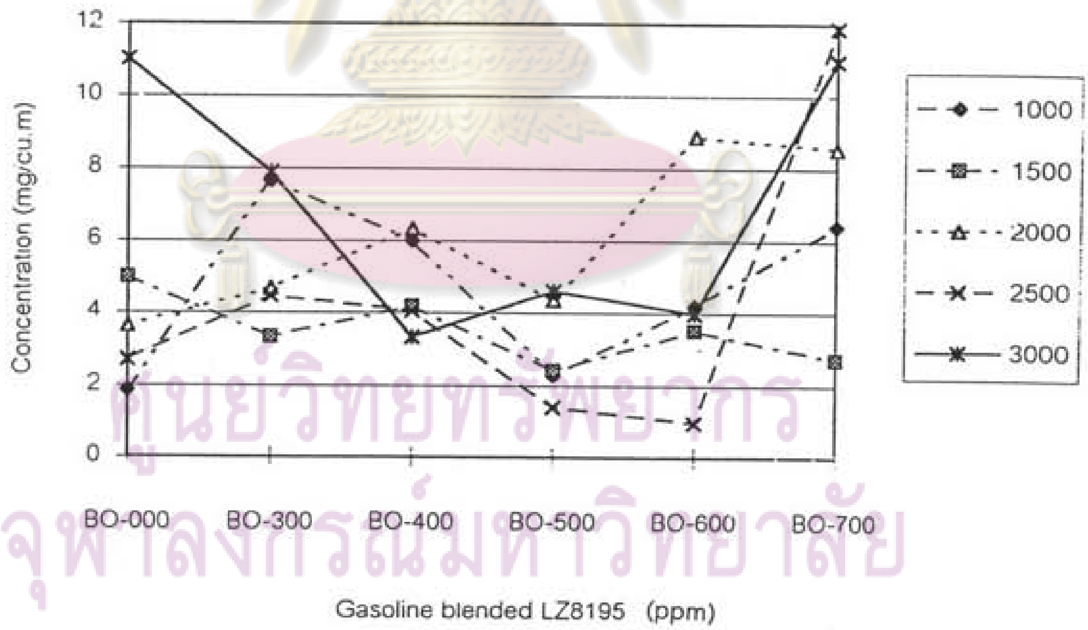

Figure 4.12 Effect of concentration of dispersant on 2-butanone.

The Figure 4.12 show the effect of concentration of dispersant in gasoline fuel on 2-butanone. The trends of 2-butanone were similar with crotonaldehyde in Figure 4.11.

Total aldehydes and ketones:

The data in Table 4.12 were plotted to show the relationship between concentration of dispersant in gasoline fuel and engine speed with concentration of total aldehydes and ketones to give histograms in Figure 4.13-4.14, respectively.

Table 4.12 Concentration of total aldehydes and ketone in exhaust emission with varied concentration of distpersant.

Concentration of dispersant (ppm)	Total aldehydes and ketone (mg/m^3)				
	1000 (rpm)	1500 (rpm)	2000 (rpm)	2500 (rpm)	3000 (rpm)
000	8.94	6.91	8.73	8.36	16.58
300	13.27	7.65	9.76	9.59	15.59
400	12.00	8.53	12.02	9.47	9.29
500	6.04	6.02	6.14	5.94	10.73
600	9.65	8.67	14.48	6.59	10.16
700	14.22	7.28	20.00	22.62	23.28

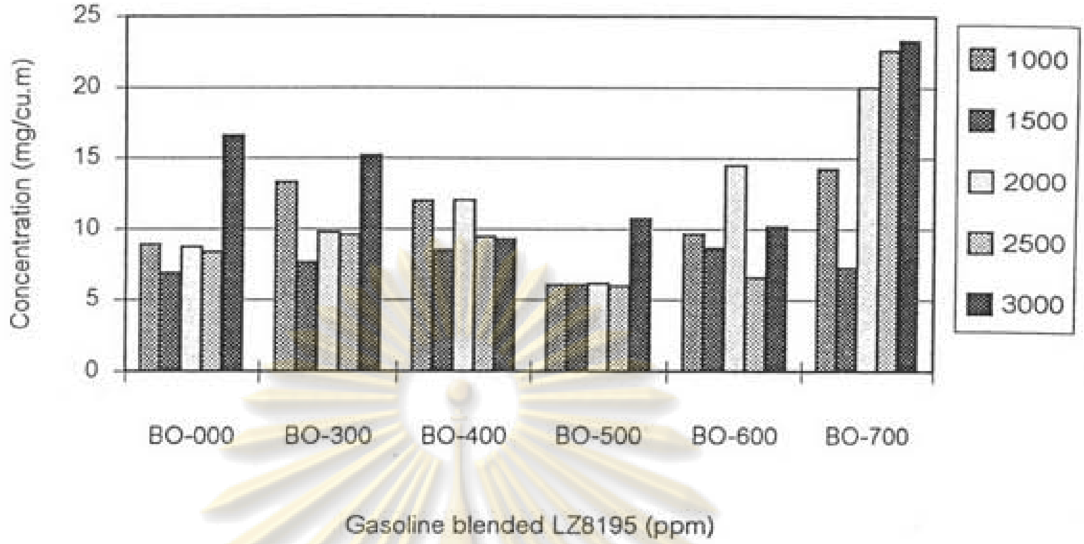

Figure 4.13 Effect of concentration of dispersant on total aldehydes and ketone.

The Figure 4.13 show the effect of concentration of dispersant in gasoline fuel on total aldehydes and ketone. A concentration of 500 ppm corresponded to lowest total aldehydes and ketone except for the 3000 rpm engine speeds. With concentration of dispersant at 300 ppm to 400 ppm the total aldehydes and ketone were rather constant. After the concentration of total aldehydes and ketone was significantly increased with increasing the concentration of dispersant.

Most dispersants currente in use are prepared from polyisobutylenes of 1000 to 10000 molecular weight which are heavier than the hydrocarbons in gasoline. The heavy components in gasoline retarded oxidation, causing pollutants to increase occured with fuel that had the higher concentration of dispersant.(22)

The concentration of dispersant at 500 ppm corresponds to the lowest pollutants in exhaust emission. Comparison effeciencies between gasoline base and blended 500 ppm dispersant gasoline are shown in Table 4.13

Table. 4.13 % Change of pollutant at 500 ppm dispersant

speed(rpm)	% change of pollutant at 500 ppm dispersant		
	CO	HC	Aldehydes and ketone
1000	-13.51	-9	-32.44
1500	-10.52	-	-12.88
2000	-18.46	-25	-29.67
2500	-2.63	-20	-36.63
3000	-20.61	-16.67	-35.28