CHARPTER IV

RESULTS AND DISCUSSIONS

The goal of this research was developing the method to determine the dispersant additive in gasoline and diesel oil. As proposed in the previous chapter, the results will be shown and discussed in each part consequently.

1. GASOLINE

1.1 Select conditions for HPLC/GPC system

The various conditions are found to be optimized as selective columns, temperature of the EMD, flow rate of Nitrogen gas and flow rate of THF (mobile phase) to run HPLC/GCP system.

1.1.1 Various columns

There are three types of columns; PLgel 5 μm 50 A 300x7.5 mm, PLgel 5 μm 100 A 300x7.5 mm and PLgel 3 μm Mixed-E 300x7.5 column. For selected optimum, it can make 10 methods to connect column with EMD. Some methods used single column such as 50 A column, 100 A column and Mixed-E column, other methods used two column with connected ,such as 50 A and 50 A columns, 50 A and 100 A columns, 50 A and Mixed-E columns, 100 A and Mixed-E columns, 100 A and 50 A columns, Mixed-E and 50 A columns and final method was Mixed-E and 100 A columns. They show chromatogram in figure B1- B10. It found that the single column, 50 A column and two columns, 50 A and 50 A columns were good condition because of they can separated dispersant polymer molecules (peak 1) from fluidizer or solvent molecules (peak 2) in package of LZ 8195, which is dispersant additive in gasoline. But the 50 A column had short time to run HPLC/GPC system. In various column, the 50 A column was the best and chromatogram is shown in figure B1. It showed 2 peaks, the first peak at 5.036 min was dispersant polymer molecules and second peak at 5.974 min was fluidizer or solvent molecules in additive package.

1.1.2 Various temperature of the Evaporative Mass Detector

The temperature of the EMD was very important because at high temperature base oil gasoline or solvent in additive package were more volatilization. Figure B11-B13 show chromatogram at various temperature of EMD at 60^0C, 80^0C and 100^0C, respectively. It found that at 100^0C of EMD was the best temperature as showed in figure B13. Chromatogram was very clear to separate dispersant polymer peak from solvent peak.

1.1.3 Various flow rate of Nitrogen gas

The flow rate of Nitrogen gas can scatter the molecules of base gasoline or dispersant polymer or solvent which depart from GPC column before enter to EMD. Figure B14 - B16 show chromatogram at various flow rate of Nitrogen gas at 7 l/min, 8 l/min and 9 l/min, respectively. At the 7 l/min Nitrogen gas was rarely scattering material but at the 9 l/min the Nitrogen gas was more scattering and make a lot of base line in chromatogram. Therefore the 8 l/min was the best flow rate of Nitrogen gas that showed in Figure B15.

1.1.4 Various flow rate of Tetrahydrofuran (mobile phase)

Tetrahydrofuran (THF) is used as mobile phase in GPC column. Mobile phase was varied to select optimum condition such as other conditions. The various flow rate of THF at 0.8 ml/min, 1.0 ml/min and 1.2 ml/min are shown in figure B17 - B19. At the 1.2 ml/min chromatogram had a lot of base line.The 0.8 ml/min and 1.0 ml/min were good condition that can separated dispersant polymer molecules from solvent or base gasoline but at the 0.8 ml/min had long time to run. Thus the 1.0 ml/min was the best condition.

As mentioned above the suitable conditions are usable to operate the HPLC/GPC system are

- PLgel 5 μm 50 A 300x7.5 mm column
- 100^0C of the EMD temperature
- 8 l/min of Nitrogen gas flow rate

and 1 ml/min of THF as mobile phase flow rate.

1.2 Calibration curve of LZ 8195

1.2.1 Chromatogram of standard LZ 8195

LZ 8195 is dispersant additive package for gasoline. Standard gasoline which added LZ 8195 were prepared containing 400, 500, 600, 700, 800 and 900 ppm wt/wt. Injection base gasoline and standard gasolines in HPLC/GPC system. Figure B20 shows chromagram of LZ 8195 in THF.It had 2 peaks ; peak 1 at 5.038 min was dispersant polymer molecules and peak 2 at 5.933 min was solvent molecules in LZ 8195 package.

There are many base gasolines from many crude oil sources. So base gasolines from different sources are difference. Figure B21 - B25 show 3 types in these chromatogram of base gasoline; peak 1 at about 5 - 6 min was high molcular weight base gasoline and peak 2 at about 8 min was azodye (colour ; green , red or yellow) which added gasoline.

Chromatograms of standard gasoline with LZ 8195 are shown in figure B26 - B31. They showed 3 peaks ; peak 1 was dispersant polymer molecules, peak 2 was solvent in LZ 8195 package or high molecular weight molecules in base gasoline and peak 3 was azodye in base gasoline. Chromatograms were integrated at the peak 1 in term of peak area (μV*sec). Peak area of peak 1 are shown the concentration (ppm wt/wt) of LZ 8195 in gasoline. Peak area from standard gasolines(400 - 900 ppm) are shown in table 4.1 and used these peak area to prepare standard calibration curve of LZ 8195 in gasoline which showed in figure 4.1

Table 4.1 Peak area of standard LZ 8195 in gasoline

Standard gasoline	Peak area (μV*sec)
400 ppm wt/wt	526196.6
500 ppm wt/wt	679677.1
600 ppm wt/wt	884290.9
700 ppm wt/wt	1086855.2
800 ppm wt/wt	1319347.9
900 ppm wt/wt	1559194.9

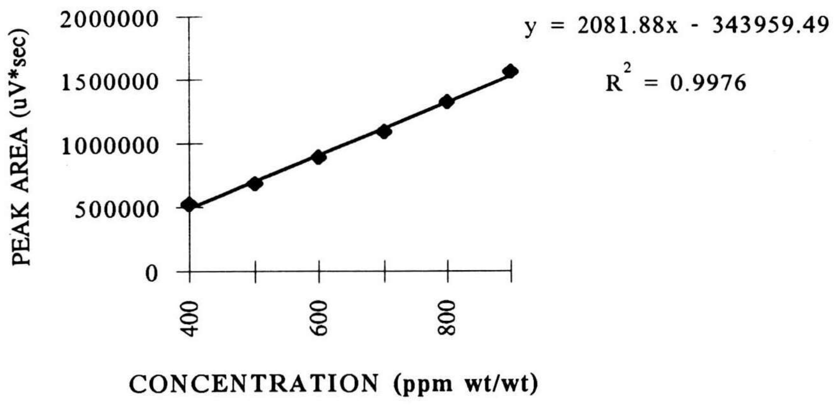

Figure 4.1 Standard calibration curve of LZ 8195 in gasoline

1.2.2 Calculated concentration of LZ 8195 in gasoline samples

The treat rate of LZ 8195 in gasoline is 600 ppm wt/wt. Thus 550 ppm and 650 ppm were prepared as known gasoline samples to check the precission of standard calibration curve and to confirm this method.

Figure B32 - B36 show chromatograms of known gasoline samples at 550 ppm and figure B37 - B41 show chromatograms of known gasoline samples at 650 ppm. From figure 4.1 standard calibration curve of LZ 8195 shows linear graph and equation is

$$y = 2081.88x - 343959.49$$

where :

y = peak area of the peak 1 (μV*sec)

x = concentration of LZ 8195 in gasoline sample (ppm wt/wt)

2081.88 is slope of standard calibration curve

-343959.49 is intercept of standard calibration curve

and correlation coefficient (R^2) is 0.9976.

The concentration of LZ 8195 in known gasoline samples were calculated according to the equation

$$x = (y + 343959.49)/2081.88$$

Table 4.2 Peak area and concentration of known gasoline samples with LZ 8195

Gasoline sample	Peak area (μV*sec)	Concentration (ppm wt/wt)	Error (%)
Sample 1. 550 ppm	807956.9	553.30	0.60
Sample 2. 550 ppm	826066.4	562.00	2.18
Sample 3. 550 ppm	833522.3	565.58	2.83
Sample 4. 550 ppm	826011.6	561.98	2.18
Sample 5. 550 ppm	810585.8	554.57	0.83
			$\bar{x}$ = 1.72
Sample 6. 650 ppm	1054505.6	671.73	3.34
Sample 7. 650 ppm	1056440.0	672.66	3.49
Sample 8. 650 ppm	1057713.1	673.27	3.58
Sample 9. 650 ppm	991911.0	641.66	1.28
Sample 10. 650 ppm	1003541.0	647.25	0.42
			$\bar{x}$ = 2.42

The concentration and % error of LZ 8195 in known gasoline samples are shown in table 4.2. They had a little error; the 550 ppm had an average of error was 1.72 % and the 650 ppm was 2.42 %.Then the standard calibration curve of LZ 8195 in gasoline in figure 4.1 can get in working condition to calculate concentration of LZ 8195 dispersant additive in unknown gasoline sample right.

1.3 Other dispersant additive packages for gasoline

Oil business competition give rise to develop high quality and advantage of dispersant additive. There are many dispersant additive packages to use for gasoline which from same company or different company.

1.3.1 LZ 8252

LZ 8252 is dispersant additive package for gasoline. Figure B42 shows chromatogram of LZ 8252 in THF. There were 2 peaks in chromatogram; one was large peak at 5.021 min was dispersant polymer molecules and another smaller peak at 5.568 min was solvent in LZ 8252 package.The treat rate of this package is 250 ppm wt/wt.

Standard gasolines which added LZ 8252 were prepared containing 100, 200, 300, and 400 ppm. Injection these standard gasolines into HPLC/GPC system.

Figure B43 - B47 show chromatograms of standard gasolines with LZ 8252. They had 3 peaks like in LZ 8195 chromatogram.Dispersant polymer molecules peak (peak 1) was integrated in term of peak area which show in table 4.3 and used these peak area to prepare standard calibration curve of LZ 8252 in gasoline that shows in figure 4.2.

Table 4.3 Peak area of standard LZ 8252 in gasoline

Standard gasoline	Peak area (μV*sec)
100 ppm wt/wt	36941.3
200 ppm wt/wt	100730.1
300 ppm wt/wt	174364.0
400 ppm wt/wt	245728.6

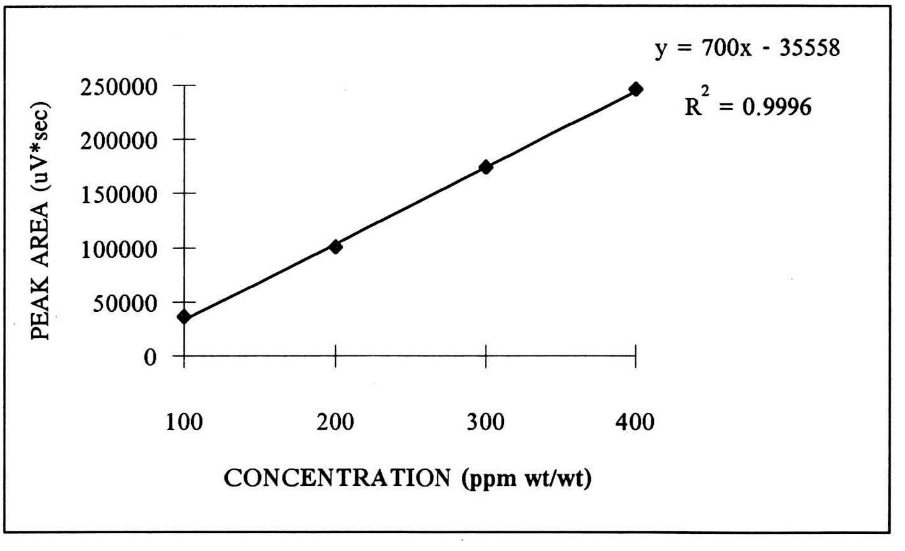

Figure 4.2 Standard calibration curve of LZ 8252 in gasoline

Known gasoline samples with 250 ppm LZ 8252 were prepared to check the precision of standard calibration curve. Chromatograms of known gasoline samples are shown in figure B47 - B51. Figure 4.2 shows linear graph and equation is

$$y = 700x - 35558$$

and correlation coefficient (R^2) is 0.9996.

The concentration of LZ 8252 in known gasoline samples were calculated according to the equation

$$x = (y + 35558)/700$$

Table 4.4 Peak area and concentration of known gasoline samples with 250 ppm wt/wt LZ 8252

Gasoline sample	Peak area (μV*sec)	Concentration (ppm wt/wt)	Error (%)
Sample 1	147549.8	261.58	4.63
Sample 1	131215.9	238.25	4.70
Sample 1	144462.3	257.17	2.87
Sample 1	135420.7	244.26	2.30
Sample 1	132513.8	240.10	3.96
			$\bar{x} = 3.69$

The concentration and % error of LZ 8252 in known gasoline samples are shown in table 4.4. They had a little error, 3.69 %. Therefore the standard calibration curve of LZ 8252 in gasoline in figure 4.2 can submit to calculated the concentration of LZ 8252 dispersant additive in unknown gasoline sample.

1.3.2 LZ 8250

LZ 8250 dispersant additive package is used to improve property of gasoline by 400 ppm wt/wt treat rate. Chromatogram of LZ 8250 in THF is shown in figure B82. The 2 peaks can show as in LZ 8195 at 5.034 min and 5.680 min. Standard gasoline samples which added LZ 8250 were prepared containing 150, 300, 450 and 600 ppm. Known gasoline samples with 400 ppm was prepared, too.

Figure B53 - B57 show chromatogram of standard gasolines and figure B58 - B62 show chromatogram of known gasoline samples.They have 3 peaks like in LZ 8195 chromatograms. Dispersant polymer molecule peak (peak 1) was integrated and shown in table 4.5. These peak area were used to prepared standard calibration curve of LZ 8250 in gasoline that showed in figure 4.3.

Table 4.5 Peak area of standard LZ 8250 in gasoline

Standard gasoline	Peak area (μV*sec)
150 ppm wt/wt	43409.6
300 ppm wt/wt	133366.5
450 ppm wt/wt	235123.1
600 ppm wt/wt	347174.8

The standard calibration curve of LZ 8250 in gasoline is linear graph and equation is

$$y = 675.368x - 63495$$

and correlation coefficient (R^2) is 0.9988.

The concentration of LZ 8250 in known gasoline samples were calculated according to the equation:

$$x = (y + 63495)/675.368$$

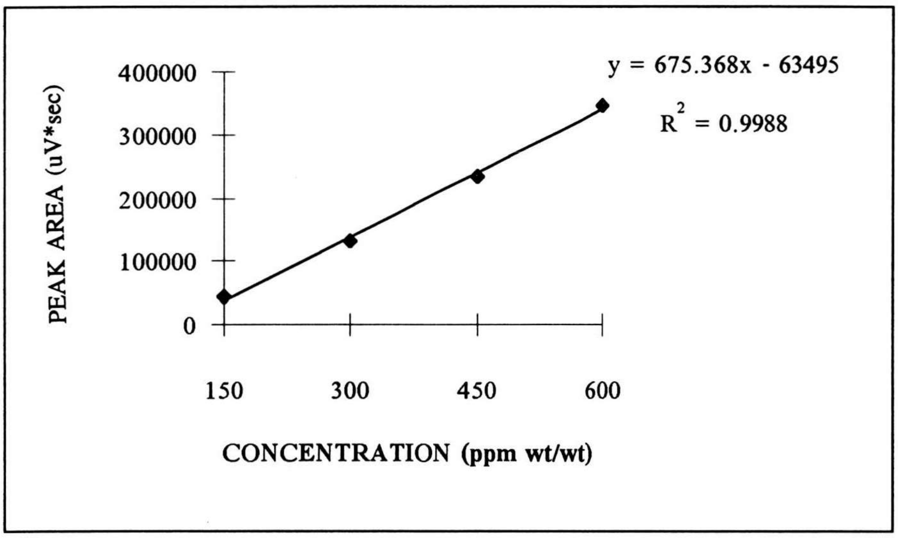

Figure 4.3 Standard calibration curve of LZ 8250 in gasoline

Table 4.6 Peak area and concentration of known gasoline samples with 400 ppm wt/wt LZ 8250

Gasoline sample	Peak area (μV*sec)	Concentration (ppm wt/wt)	Error (%)
Sample 1	195969.0	384.18	3.96
Sample 2	199248.8	389.04	2.74
Sample 3	200092.1	390.28	2.43
Sample 4	204867.6	397.36	0.66
Sample 5	199672.6	389.66	2.58
			$\bar{x}$ = 2.47

The concentration and % error of LZ 8250 in known gasoline samples are shown in table 4.6. There was a little error, 2.47%. Thus this standard calibration curve can usable to calculate this concentration of LZ 8250 dispersant additive in unknown gasoline sample.

1.3.3 LZ 8250 (new)

LZ 8250 (new) is dispersant additive package for gasoline. The treat rate of LZ 8250 (new) is 400 ppm wt/wt like in LZ 8250. Then standard gasoline and known gasoline samples were prepared like in LZ 8250, as well.

Chromatogram of LZ 8250(new) in THF is shown in figure B62. It just like the chromatogram of LZ 8250 but differentiable in the ratio between dispersant polymer molecule peak and solvent peak.

Figure B63 - B67 show chromatograms of standard gasolines and figure B68 - B72 show chromatograms of known gasoline samples with added LZ 8250 (new). They were alike in LZ 8250, too. Table 4.7 shows peak area of standard gasoline which were integrated in dispersant polymer molecule peak. Standard calibration curve of LZ 8250 (new) in gasoline is shown in figure 4.4.

Table 4.7 Peak area of standard LZ 8250 (new) in gasoline

Standard gasoline	Peak area (μV*sec)
150 ppm wt/wt	43286.3
300 ppm wt/wt	126261.6
450 ppm wt/wt	211848.0
600 ppm wt/wt	283396.5

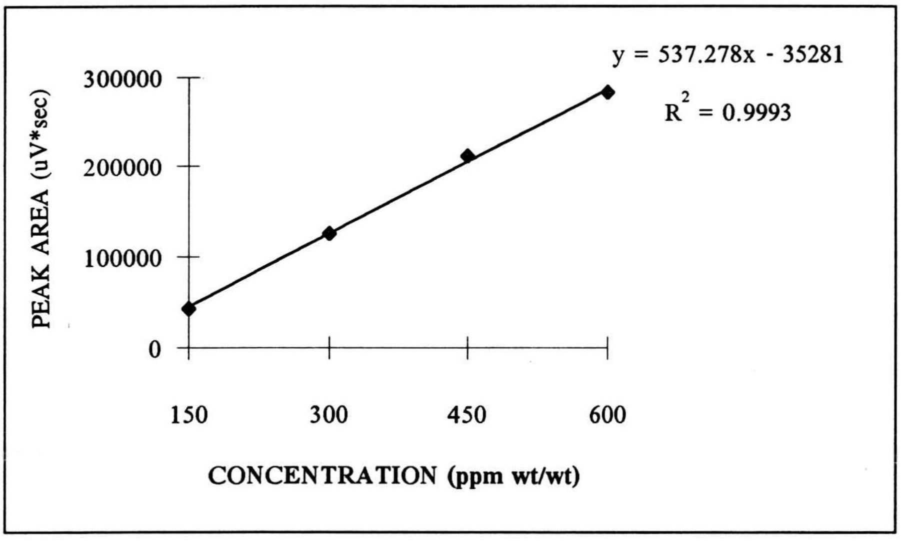

Figure 4.4 Standard calibration curve of LZ 8250 (new) in gasoline

From figure 4.4 standard calibration curve of LZ 8250(new) in gasoline is linear graph and equation is

$$y = 537.278 - 35281$$

and correlation coefficient (R^2) is 0.9993.

The concentration of LZ 8250 (new) in known gasoline samples were calculated according to the equation

$$x = (y + 35281) / 537.278$$

Table 4.8 Peak area and concentration of known gasoline samples with 400 ppm wt/wt LZ 8250 (new)

Gasoline sample	Peak area (μV*sec)	Concentration (ppm wt/wt)	Error (%)
Sample 1	180086.4	400.85	0.21
Sample 2	180189.0	401.04	0.26
Sample 3	177228.9	395.53	1.12
Sample 4	184407.2	408.89	2.22
Sample 5	178976.1	398.78	0.30
			$\bar{x} = 0.82$

The concentration and %error of LZ 8250 (new) in known gasoline samples are shown in table 4.8. There was a little error, 0.82%. Therefore this standard calibration curve can usable to calculate the concentration of LZ 8250 (new) dispersant additive in unknown gasoline sample.

1.3.4 LZ 8253

LZ 8253 dispersant additive package is used to improve property of gasoline by 600 ppm wt/wt treat rate. Chromatogram of LZ 8253 in THF is shown in figure B72. There were 3 peaks in chromatogram, peak 1 and peak 2 were similar to other packages peak 3 was small molecules or valve seat recession (Soduim or Potassium salt) molecules in LZ 8253 package.

Standard gasolines which added LZ 8253 were prepared containing 450, 550, 650 and 750 ppm. Known gasoline samples with 600 ppm were prepared, as well.

Figure B73 - B77 show chromatograms of standard gasolines and figure B78 - B82 show chromatograms of known gasoline samples. They had 3 peaks similar to chromatogram of LZ 8253 in THF. The chromatograms were integrated at dispersant polymer molecule peak which showed in table 4.9. These peak area were used to prepare standard calibration curve of LZ 8253 in gasoline that show in figure 4.5.

Table 4.9 Peak area of standard LZ 8253 in gasoline

Standard gasoline	Peak area (μV*sec)
450 ppm wt/wt	42818.8
550 ppm wt/wt	61061.5
650 ppm wt/wt	80919.9
750 ppm wt/wt	104687.0

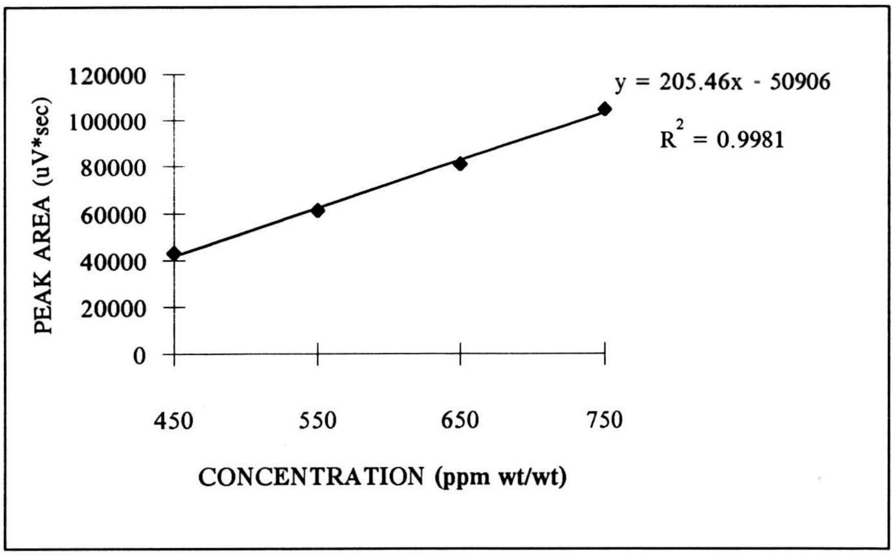

Figure 4.5 Standard calibration curve of LZ 8253 in gasoline

Standard calibration curve is linear graph and equation is

$$y = 205.46x - 50906$$

and correlation coefficient (R^2) is 0.9981.

The concentration of LZ 8253 in known gasoline samples were calculated according to the equation

$$x = (y + 50906)/205.46$$

Table 4.10 Peak area and concentration of known gasoline samples with 600 ppm wt/wt LZ 8253

Gasoline sample	Peak area (μV*sec)	Concentration (ppm wt/wt)	Error (%)
Sample 1	70745.3	592.08	1.32
Sample 2	73438.9	608.79	1.46
Sample 3	71019.8	596.64	0.60
Sample 4	72052.6	601.83	0.30
Sample 5	73348.3	608.33	1.39
			$\bar{x} = 1.01$

The concentration and % error of LZ 8253 in known gasoline samples are shown in table 4.10. There was a little error, 1.01 %. Then this standard calibration curve can submit to calculate the concentration of LZ 8253 dispersant additive in unknown gasoline sample.

1.3.5 Hitech-4961A

Hitech-4961A is dispersant additive package for gasoline with 200 ppm wt/wt treat rate. Chromatogram of Hitech-4961A in THF is shown in figure B82. Standard gasoline samples with hitech-4961A were prepared containing 75, 150, 225, and 300 ppm and known gasoline samples with 200 ppm were prepared, too.

Figure B93 - B87 show chromatograms of standard gasolines and figure B88-B92 show chromatograms of known gasoline samples.The chomatograms were integrated at dispersant polymer molecule peak which show in table 4.11. Standard calibration curve of Hitech-4961A in gasoline was prepared by used these peak area which show in figure 4.6.

Table 4.11 Peak area of stabdard Hitech-4961A in gasoline

Standard gasoline	Peak area (μV*sec)
75 ppm wt/wt	45286.7
150 ppm wt/wt	356650.1
225 ppm wt/wt	673866.9
300 ppm wt/wt	932095.1

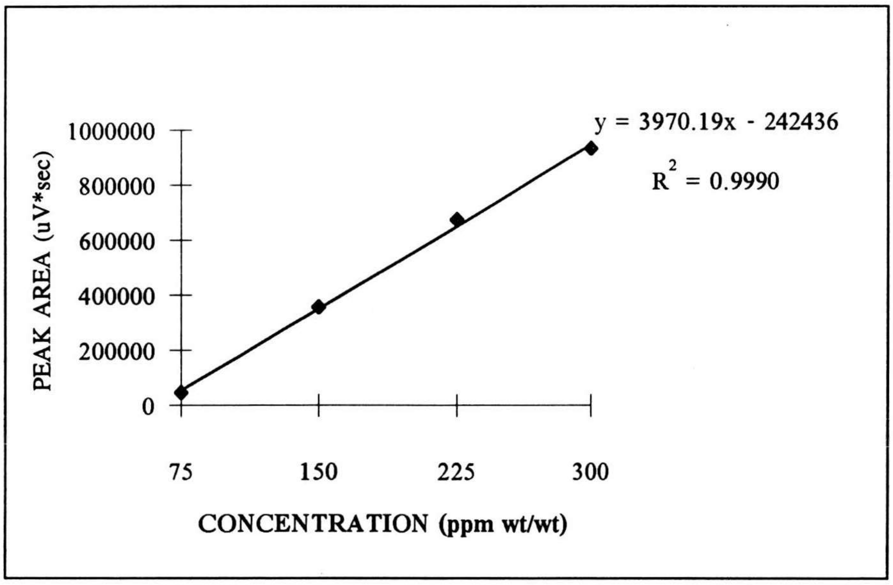

Figure 4.6 Standard calibration curve of Hitech-4961A in gasoline

Standard calibration curve is linear graph and equation is

$$y = 3970.19x - 242436$$

and correlation coefficient (R^2) is 0.9990.

The concentration of Hitech-4961A in known gasoline samples were calculated according to the equation

$$x = (y + 242436)/3970.19$$

Table 4.12 Peak area and concentration of known gasoline samples with 200 ppm wt/wt Hitech-4961A

Gasoline sample	Peak area (μV*sec)	Concentration (ppm wt/wt)	Error (%)
Sample 1	539036.5	196.84	1.58
Sample 2	538382.1	196.67	1.66
Sample 3	537860.7	196.54	1.73
Sample 4	535411.4	195.92	2.04
Sample 5	534359.4	195.66	2.17
			$\bar{x}$ = 1.84

The concentration and % error of Hitech-4961A in known gasoline samples are shown in table 4.12. There was a little error, 1.84 %. Then this standard calibration curve can usable to calculate the concentration of Hitech-4961A dispersant additive in unknown gasoline sample.

1.4 Calculation of commercial gasoline

Commercial gasoline must be added dispersant additive to improve property of gasoline on regulation. Therefore this method can be determined the concentration of dispersant additive which added in each commercial gasoline .

The commercial gasolines from 12 companies are taken to determine the concentration of dispersant additive. Figure B92 - B109 show chromatograms of commercial gasolines. Consideration of each chromatograms and compared with each commercial gasoline dispersant additive packages. Thus commercial gasolines; BANGCHAK, KUWAIT PETROLEUM, BP OIL, PTT and PT PETROLEUM are concluded that they added LZ 8195 but others are not concluded because there were not dispersant additive packages as standard which they added.

The commercial gasolines which added LZ 8195 can be calculated the concentration of LZ 8195 by used the equation from standard gasoline (with LZ 8195 400-900 ppm) which injected in the same conditions into HPLC/GPC system. Table 4.13 show peak area, dispersant additive package and the concentration of each commercial gasolines.

Table 4.13 Peak area, dispersant package and concentration of commercial gasoline samples

Gasoline sample	Peak area (μV*sec)	Dispersant package	Concentration (ppm wt/wt)
PETROLEUM ASIA	99034.2	ND	ND
BANGCHAK	324930.4	LZ 8195	466.45
CALTEX	103037.6	ND	ND
ESSO	272029.8	ND	ND
KUWAIT PETROLEUM	398535.2	LZ 8195	536.81
MP PETROLEUM	77402.0	ND	ND
BP OIL	348952.2	LZ 8195	489.41
PTT	333473.6	LZ 8195	474.61
PT PETROLEUM	342093.8	LZ 8195	482.85
MOBIL	313484.6	ND	ND
JET JIFFY OIL	102352.8	ND	ND
SHELL	169813.8	ND	ND

ND = Not determine

2. DIESEL

Diesel can not injected into HPLC/GPC directly because the effect from high molecular weight molecules in base diesel which can showed in figure C1,C3 and C4. Then it must separated dispersant additive molecules away from base diesel before injected into HPLC/GPC system to determine the concentration of dispersant additive in diesel.

2.1 Separating LZ 9530T away from base diesel

LZ 9530T is dispersant additive package for diesel. The chromatogram of LZ 9530T in THF is shown in figure C2.

The steps for separated dispersant molecules in LZ 9530T away from base diesel were

1. loaded diesel with LZ 9530T through absorbent for separated some base diesel and dispersant molecules are trapped on the absorbent
2. loaded solvent through the absorbent for separated all base diesel away from the absorbent
3. loaded another solvent through the absorbent for separated dispersant molecules away from the absorbent
4. evaped the solvent in 3.until dried and make exactly volume by suitable solvent.

In various conditions for separated dispersant molecules away from base diesel as follow;

1. volume of diesel for loading in syringe
2. type and weight of absorbent

3. type and volume of solvent for separated dispersant away from base diesel
4. type and volume of solvent for separated dispersant molecules away from absorbent.

Figure C5 -C51 show chromatograms of various conditions for separated dispersant molecules away from base diesel. The best condition that used to separate dispersant is shown chromatogram in figure C45; alumina neutral 2 g, 25 ml diesel, 10 ml hexane and 10 ml THF are used. Chromatograms from figure C42 and C51 can confirm that there were not dispersant passed through alumina neutral by loading hexane and diesel steps. And figrure C46, C47, C49 and C50 can confirm that there were not dispersant on alumina neutral after load 10 ml THF. Therefor the dispersant which received were all dispersant in diesel.

2.2 Calibration curve of LZ 9530T

The treat rate of LZ 9530T in diesel is 300 ppm wt/v. Standard diesel with LZ 9530T are prepared containing 200,250,300,350,400 and 500 ppm. Known diesel samples with 320 ppm are prepared, as well.

Figure C52-C57 show chromatograms of standard diesel which had 2 peaks; the first peak was dispersant polymer molecules and another peak was solvent in LZ 9530T package or polar molecules in base diesel. And figure C58-C62 show chromatograms of known diesel samples. The chromatograms were integrated at dispersant peak in term of peak area which showed in table 4.14. Standard calibration curve of LZ 9530T in diesel was prepared by used these peak area which showed in Figure 4.7

$$y = 1999.36x - 130345.19$$

and correlation coefficient (R^2) is 0.9997

The concentration of LZ 9530T in known diesel samples were calculated according to the equation

$$x = (y + 130345.19)/1999.36$$

Table 4.15 Peak area and concentration of known diesel samples with 320 ppm wt/v LZ 9530T

Diesel sample	Peak area (μV*sec)	Concentration (ppm wt/v)	Error (%)
Sample 1	514948.2	322.75	0.86
Sample 2	501662.1	316.10	1.22
Sample 3	504346.2	317.00	0.94
Sample 4	513868.6	322.21	0.69
Sample 5	500964.0	315.76	1.33
			$\bar{x}$ = 1.01

The concentration and %error of LZ 9530T in known diesel samples are shown in table 4.15. There was a little error, 1.01%. Therefore the standard calibration curve of LZ 9530T in diesel in figure 4.7 can get in working condition to calculate concentration of LZ 9530T in unknown diesel sample right.

Table 4.14 Peak area of standard LZ 9530T in diesel

Standard diesel	Peak area (μV*sec)
200 ppm wt/v	276928.7
250 ppm wt/v	364439.4
300 ppm wt/v	469153.6
350 ppm wt/v	565846.9
400 ppm wt/v	665834.8
500 ppm wt/v	874451.9

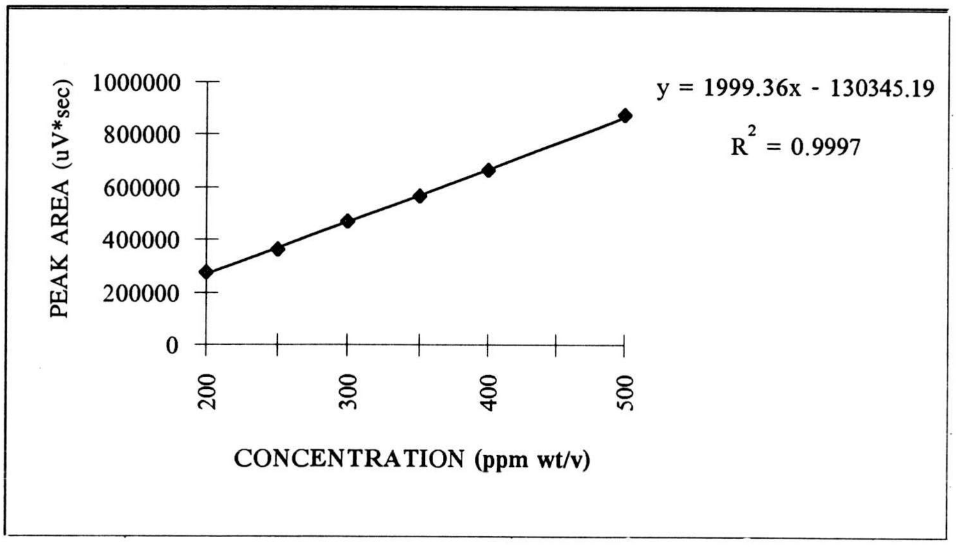

Figure 4.7 Standard calibration curve of LZ 9530T in diesel

Standard calibration curve of LZ 9530T in diesel is linear graph and equation is

2.3 Calculation of commercial diesel

commercial diesel must be added dispersant additive to adjust property of diesel on regulation. Thus this method can determine the concentration of dispersant additive. Figure C63 - C74 show chromatograms of commercial diesels.

Consideration of each chromatogram and compared with LZ 9530T chromatogram. Then commercial diesels which added LZ 9530T were PETROLEUM ASIA, KUWAIT PETROLEUM, MP PETROLEUM, PT PETROLEUM and MOBIL and. Other has not determined because there were not dispersant additive packages as standard which they added.

The commercial diesels which added LZ 9530T can calculated the concentration of LZ 9530T by used the equation from standard diesel (with LZ 9530T 200 - 500 ppm) which injected in the same conditions into HPLC/GPC system. Table 4.16 show peak area, dispersant additive package and the concentration of each commercial diesels.

Table 4.16 Peak area and concentration of commercial diesel samples

Gasoline sample	Peak area (μV*sec)	Dispersant package	Concentration (ppm wt/v)
PETROLEUM ASIA	253586.0	LZ 9530T	225.00
BANGCHAK	495813.4	ND	ND
CALTEX	185193.6	ND	ND
ESSO	402831.1	ND	ND
KUWAIT PETROLEUM	359222.1	LZ 9530T	286.19
MP PETROLEUM	681492.9	LZ 9530T	472.88
BP OIL	827935.3	ND	ND
PTT	1880122.5	ND	ND
PT PETROLEUM	367487.3	LZ 9530T	290.98
MOBIL	282921.6	LZ 9530T	241.99
JET JIFFY OIL	278145.9	ND	ND
SHELL	19305.9	ND	ND

ND = Not determine