REFERENCES

1. Collier, A.R., Rhead, M.M., Trier, C.J., and Bell, M.A. Polycyclic aromatic compound profiles from a light-duty direct-injection diesel engine. **Fuel**, 1995, 74(3), 362-367.
2. Nett Technologies, Inc. **Frequently asked questions about diesel emissions**.1997, available from http://www.nett.ca/faq_diesel.html; INTERNET.
3. Spence, S. **Bio-diesel**. 2001, available from http://www.webconx.dns2go.com/biodiesel1.htm; INTERNET.
4. Wacharakitipong, K. The effect of dispersant on polycyclic aromatic hydrocarbons in gasoline engine exhaust. **Master's Thesis**, Chulalongkorn University, 1996.
5. Rathore, H.S. **CRC handbook of chromatography: liquid chromatography of polycyclic aromatic hydrocarbons**. London: CRC Press, 1993.
6. Wongchanta, W. Synthesis of diesters as diesel fuel marker from palm oil. **Master's Thesis**, Chulalongkorn University, 1997.
7. Foglia, T.A., Jones, K.C., Haas, M.J., and Scoot, K.M. **Technologies supporting the adoption of biodiesel as an alternative fuel**. The Cotton Gin and Oil Mill Press, 2000.
8. Schuchardf, U., Sercheli, R., and Vargas, R.M. Transesterification of vegetable oils: a review. **J. Braz. Chem. Soc.**, 1998, 9(1), 199-210.
9. Song, C., Hsu, C.S., and Mochida, I. **Chemistry of diesel fuels**. Applied Energy Technology Series, 2000.
10. Hsu, C.S. Diesel fuel analysis. **Encyclopedia of Analytical Chemistry**. New York: John Wiley, in press, 2000.
11. Lai, W.-C. and Song, C. Temperature-programmed retention indices for GC and GC-MS analysis of coal- and petroleum-derived liquids. **Fuel**, 1995, 74(10), 1436-1451.
12. Schobert, H.H. **The chemistry of hydrocarbon fuels**. Butterworth-Heinemann, London, 1990, 348.
13. Westberg, K. **The chemistry of air pollution**. New York: MSS Information, 1973.

14. Johnson, D. PAH: Ambient air quality monitoring in British Columbia. **Environmental Protection Programme, Skeena Region**, 1995.

15. Pederson, P.S., Ingwersen, J., Nielsen, T., and Larsen, E. Effect of fuel, lubricant, and engine operating parameters on the emission of polycyclic aromatic hydrocarbons. **Environ. Sci. Technol.** 1980, 14(1), 71-79.

16. Rhead, M.M., and Trier, C.J. Fuel residues and organic combustion products in diesel exhaust emissions: sources, sampling and analysis, **Trends in Analytical Chemistry**. 1992, 11(7), 255-259.

17. Tancell, P.J., Rhead, M.M., Pemberton, R.D., and Braven, J. Diesel combustion of an alkylated polycyclic aromatic hydrocarbon. **Fuel**. 1996, 75(6), 717-723.

18. Williams, P.T., Abbass, M.K. and Andrews, G.E. Diesel particulate emissions: the role of unburned fuel. **Combustion and Flame**. 1989, 75, 1-25.

19. Williams, P.T., Bartle, K.D., and Andrews, G.E. The relation between polycyclic aromatic compounds in diesel fuels and exhaust particulates. **Fuel**. 1986, 65, 1150-1157.

20. Vo-Dinh, T. **Chemical analysis of polycyclic aromatic compounds**. New York: John Wiley & Sons, Inc. 1989, 219-225.

21. Tuntipisit, S. Effect of isoamyl alcohol on emission of toxic substances from diesel engine. **Master's Thesis**, Chulalongkorn University, 1997.

22. Agency for Toxic Substances and Disease (ATSDR). **Public health statement: polycyclic aromatic hydrocarbons (PAHs)**. 1990.

23. McCormick, R.L., Graboski, M.S., Alleman, T.L., and Herring, A.M. Impact of biodiesel source material and chemical structure on emissions of criteria pollutants from a heavy-duty engine. **Environ. Sci. Technol.** 2001, 35(9), 1742-1747.

24. Freedman, B., Butterfield, R.O., and Pryde, E.H. Transesterification kinetics of soybean oil. **JAOCS**, 1986, 63(10), 1375-1380.

25. Mittelbach, M., and Tritthart, P. Diesel fuel derived from vegetable oils, III. Emission tests using methyl esters of used frying oil. **JAOCS**, 1988, 65(7), 1185-1187.

26. Westerholm, R.N., Almen, J., and Li, H. Chemical and biological characterization of particulate-, semivolatile-, and gas-phase-associated compound in diluted heavy-duty diesel exhausts: A comparison of three different semivolatile-phase samplers. **Environ. Sci. Technol.** 1991, 25, 332-338.

27. Septhum, O. The effect of cetane improver on polycyclic aromatic hydrocarbons in diesel exhaust. **Master's Thesis**, Chulalongkorn University, 1996.

28. Starr, M.E. Influence on transient emissions at variuos injection timings, using cetane improvers, bio-diesel, and low aromatic fuels. **SAE paper**. 972904, 1997.

29. Buravannint, S. Effect of fusel oil on polycyclic aromatic hydrocarbons from exhaust emission of diesel engine. **Master's Thesis**, Chulalongkorn University, 1998.

30. Williams, P.T., and Taylor, D.T. Aromatization of Tyre pyrolysis oil to yield polycyclic aromatic hydrocarbons. **Fuel**, 1993, 72(11), 1469-1474.

31. ATSDR Public Health Statement. **Polycyclic aromatic hydrocarbons, 15 listings: First listed in the second annual report on carcinogens**. Agency for Toxic Substances and Disease Registry, Division of Toxicology, Atlanta, Georgia, 2000, available from www.atsdrl.cde.gov; INTERNET.

32. Pryde, E.H. **Vegetable oils as fuel alternatives - Symposium overview**. 74th AOCS Annual Meeting, Chicago, Illinois, May 8-12, 1983.

33. Ryan, T.W., Dodge, L.G., and Callahan, T.J. The effect of vegetable oil properties on injection and combustion in two different diesel engines. **JAOCS**, 1984, 61 (10), 1610-1619.

APPENDICES

APPENDIX A

Calibration Curve of Standard Polycyclic Aromatic Hydrocarbons for EPA 610

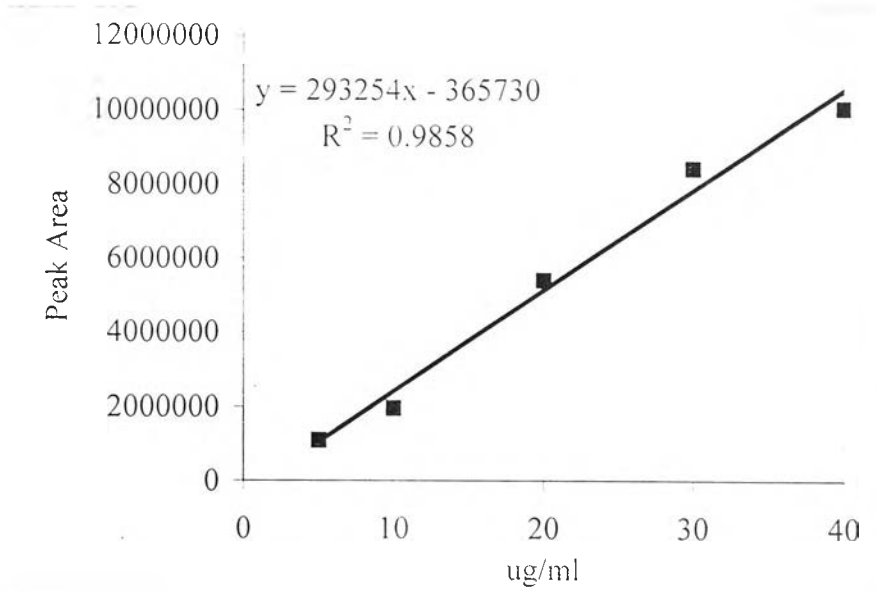

Figure A-1 Calibration curve of Naphthalene

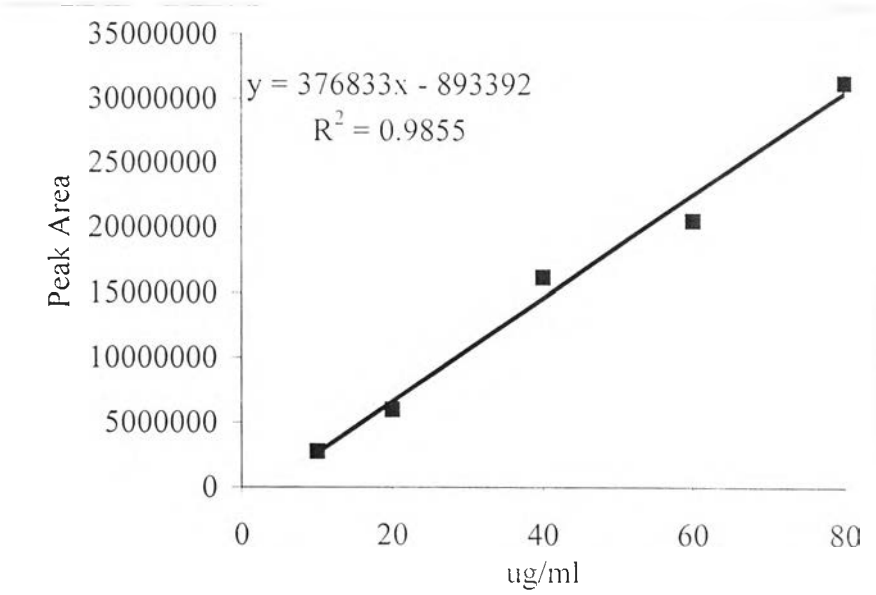

Figure A-2 Calibration curve of Acenaphthylene

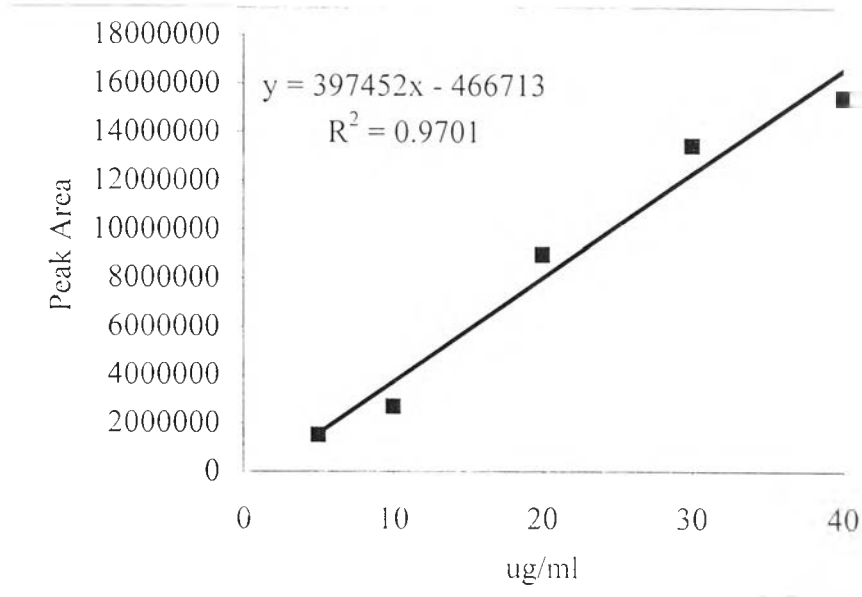

Figure A-3 Calibration curve of Acenaphthene

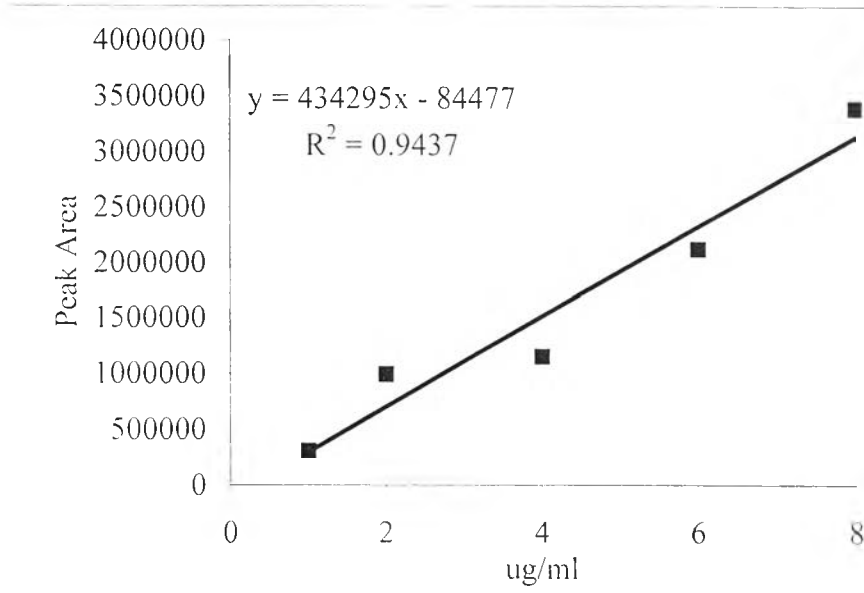

Figure A-4 Calibration curve of Fluorene

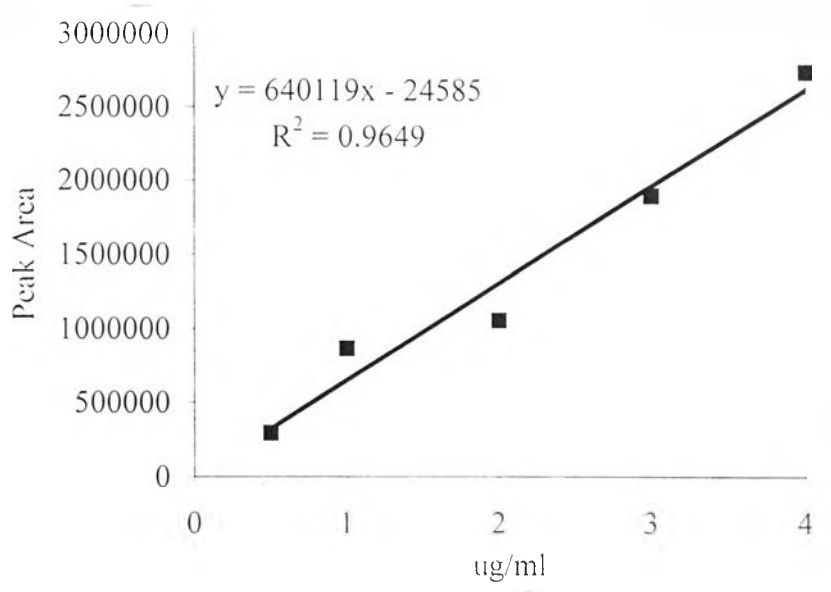

Figure A-5 Calibration curve of Phenanthrene

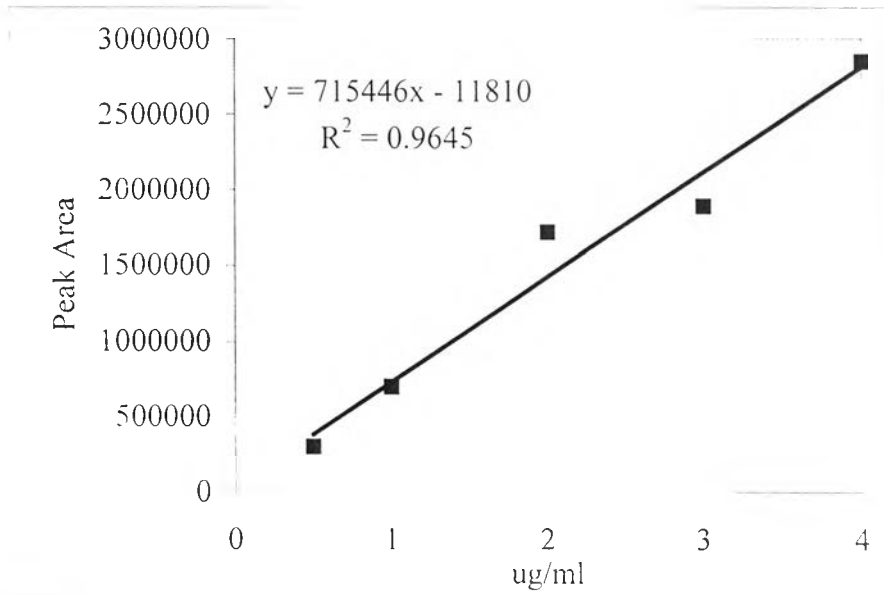

Figure A-6 Calibration curve of Anthracene

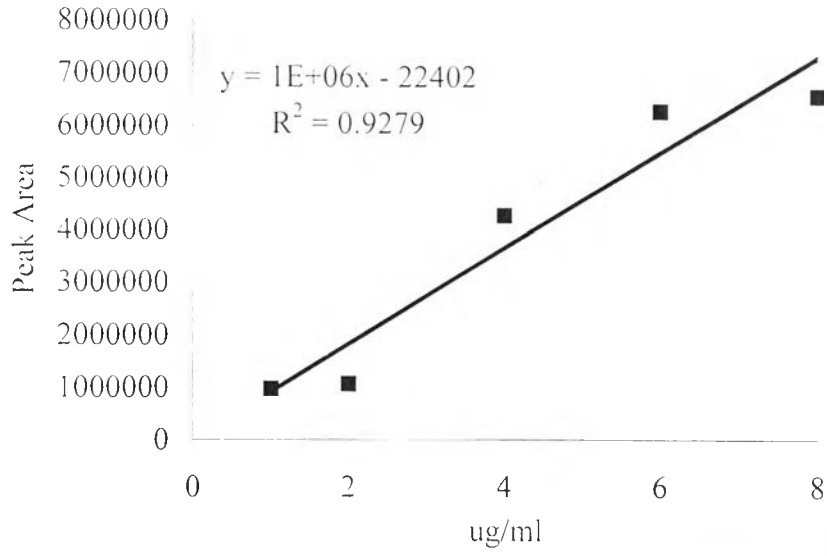

Figure A-7 Calibration curve of Fluoranthene

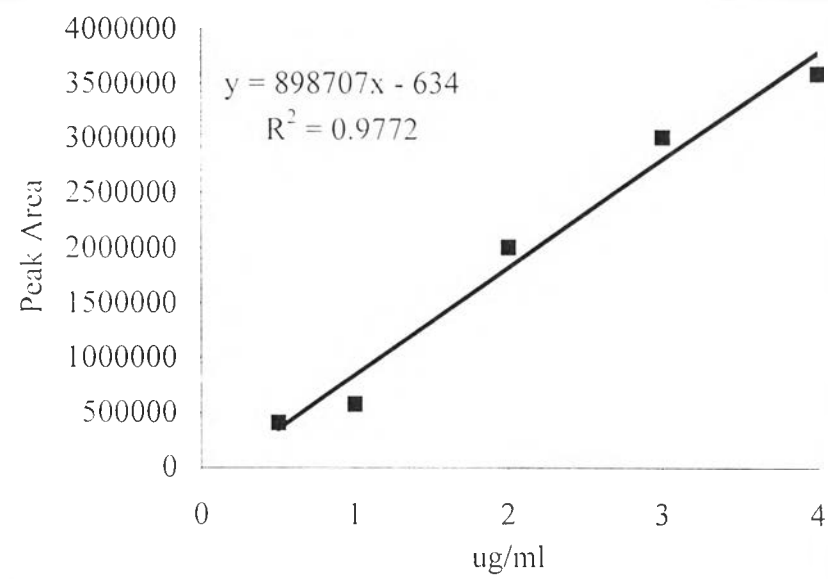

Figure A-8 Calibration curve of Pyrene

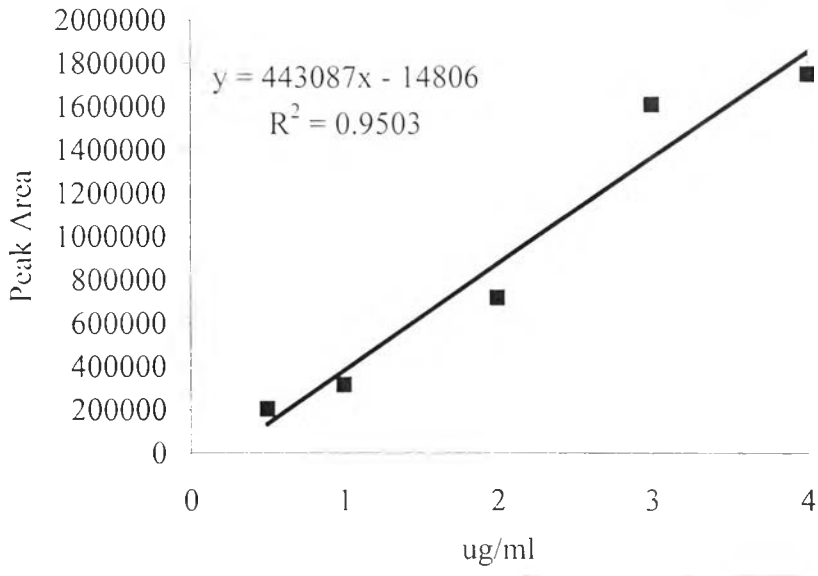

Figure A-9 Calibration curve of Benz(a)anthracene

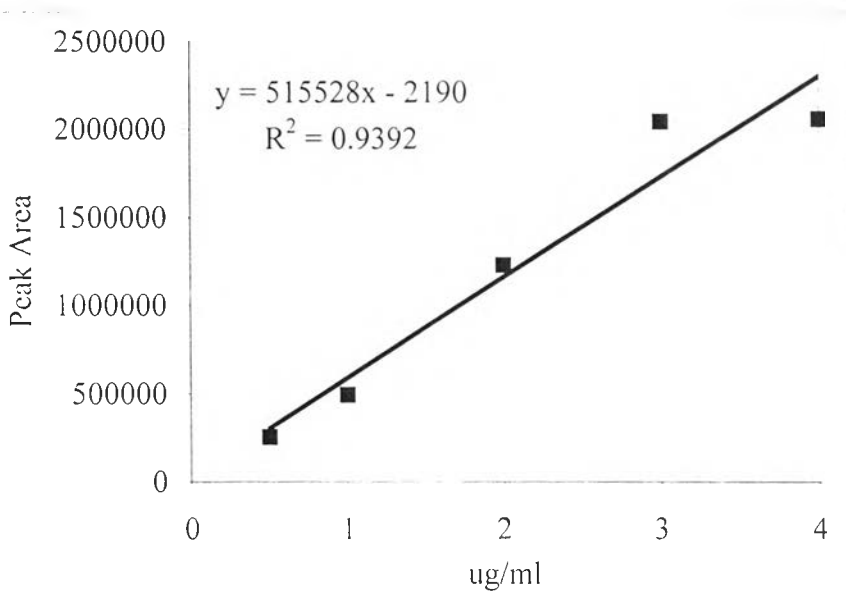

Figure A-10 Calibration curve of Chrysene

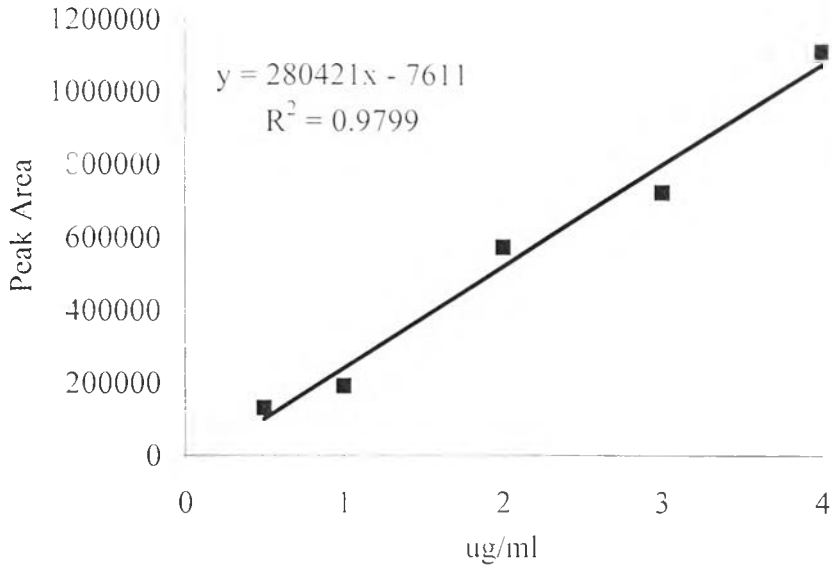

Figure A-11 Calibration curve of Benzo(k)fluoranthene

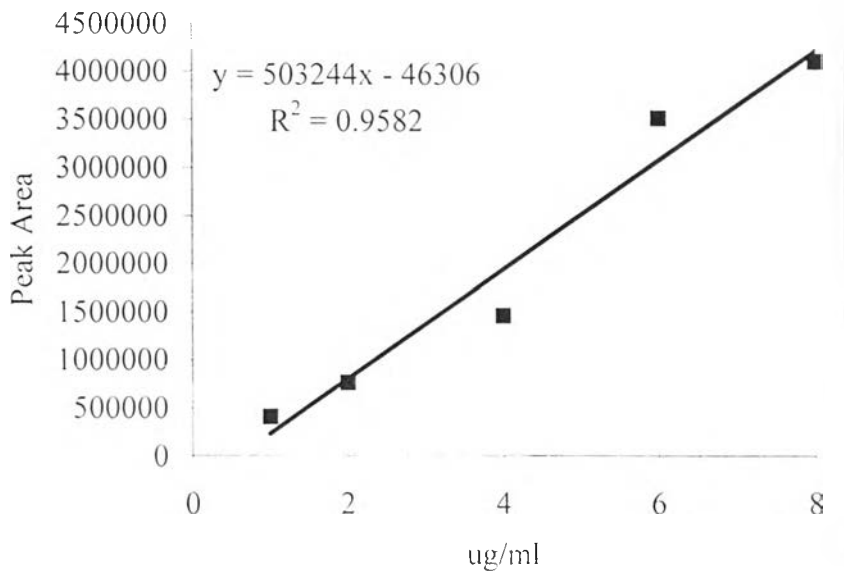

Figure A-12 Calibration curve of Benzo(ghi)perylene

APPENDIX B

The Chromatogram of Diesel Exhaust Emission

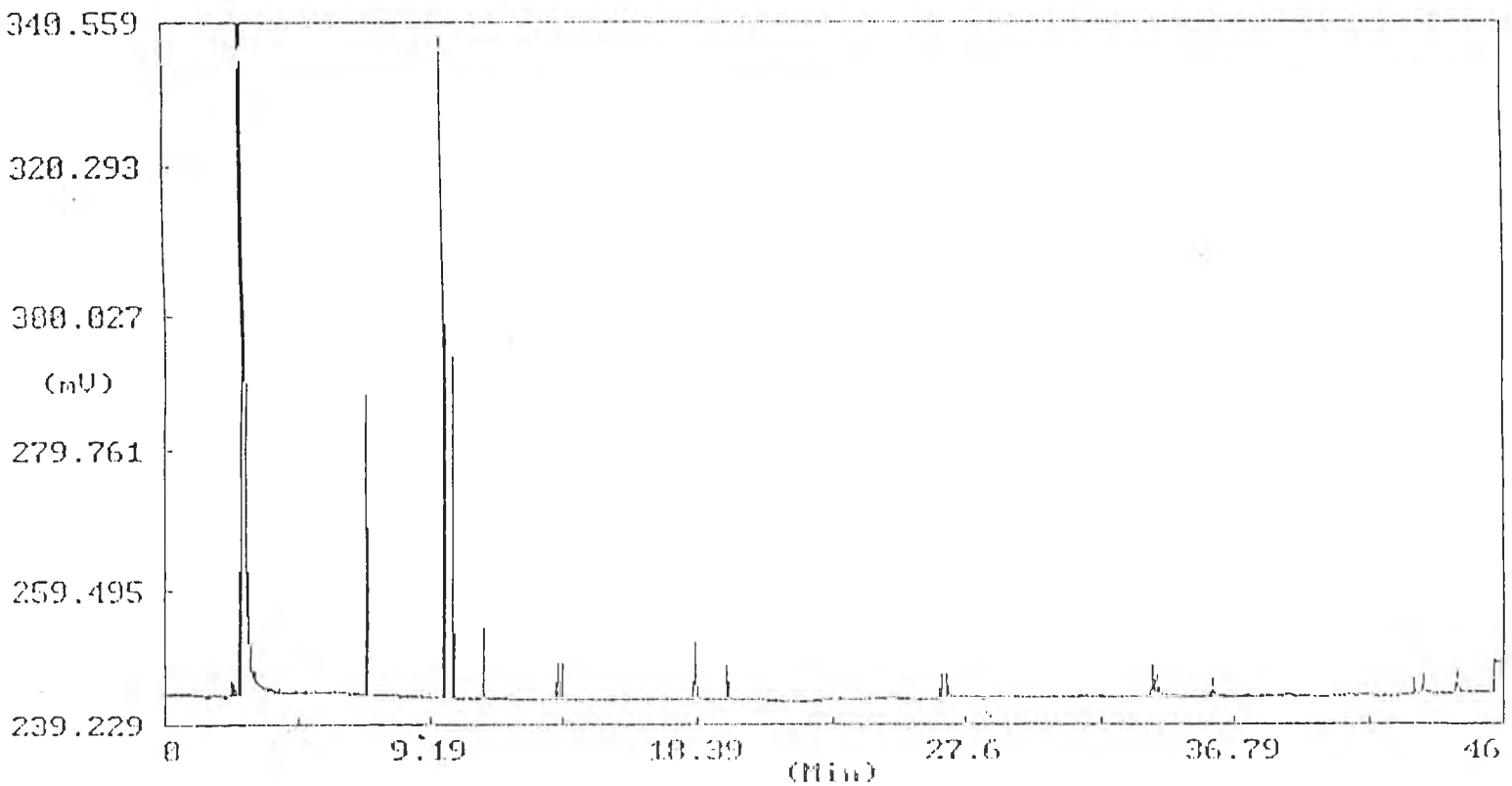

Figure B-1 The chromatogram of standard PAHs

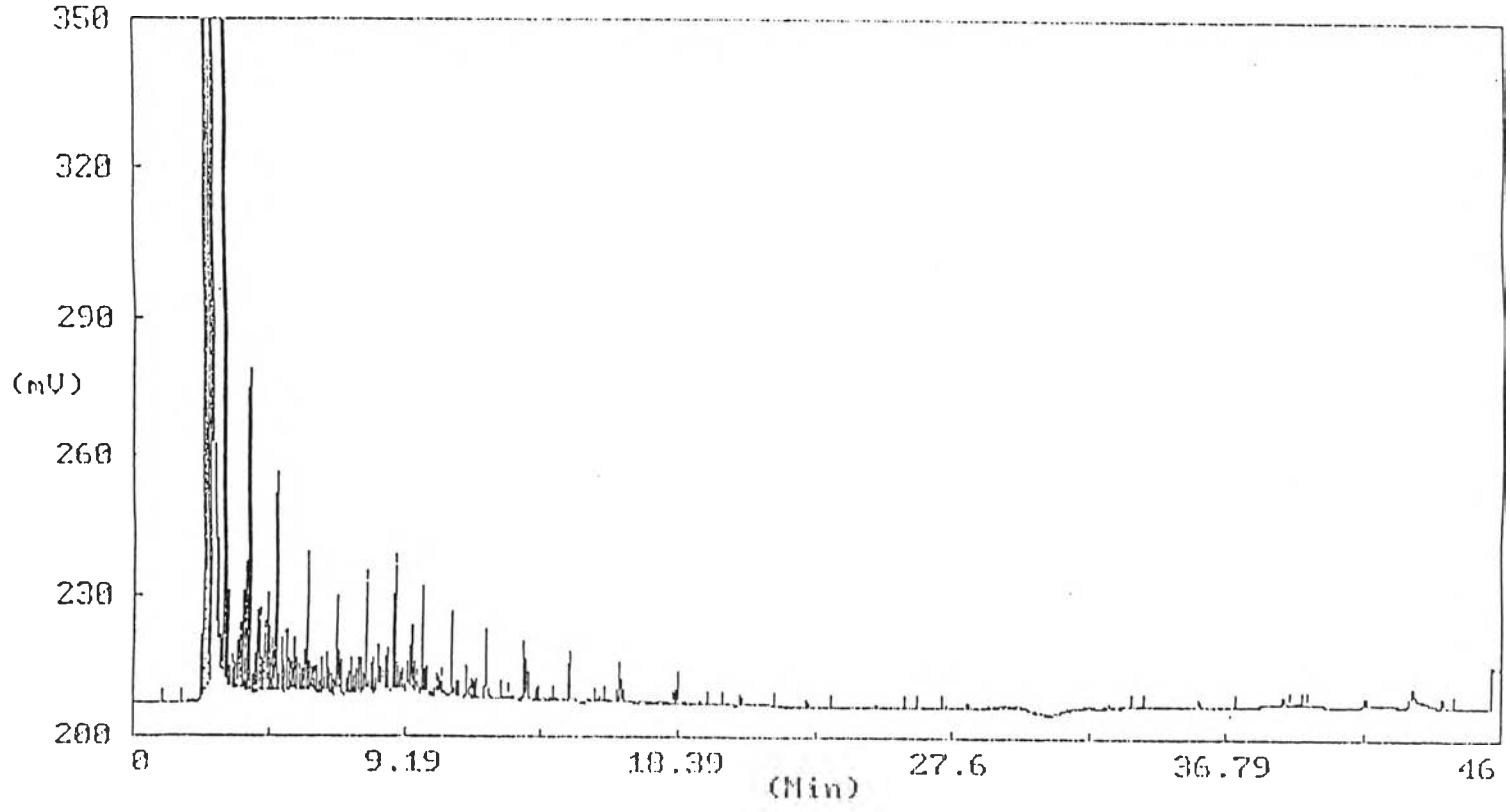

Figure B-2 The chromatogram of exhaust emission of base diesel fuel at 800 rpm

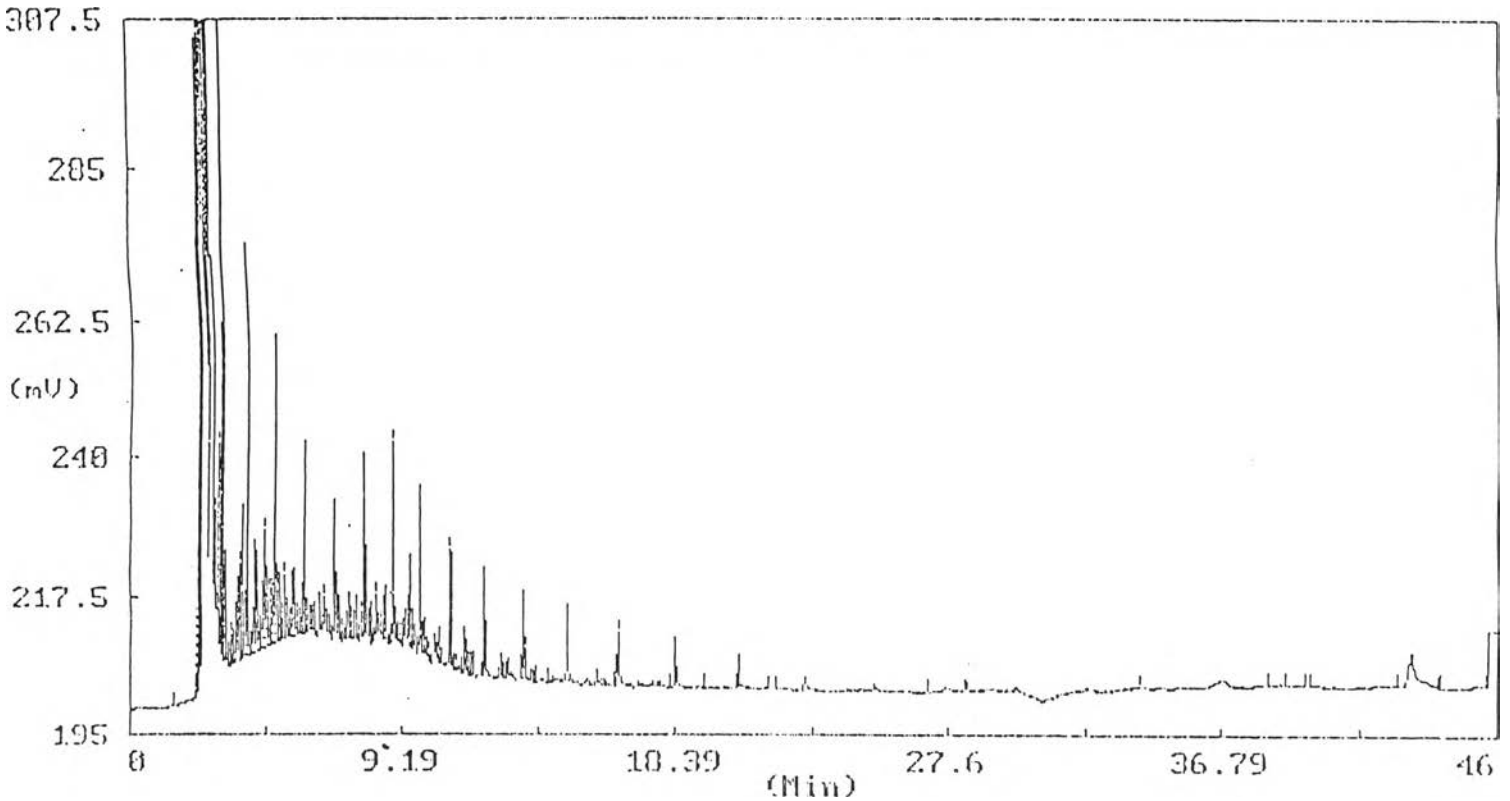

Figure B-3 The chromatogram of exhaust emission of base diesel fuel at 1600 rpm

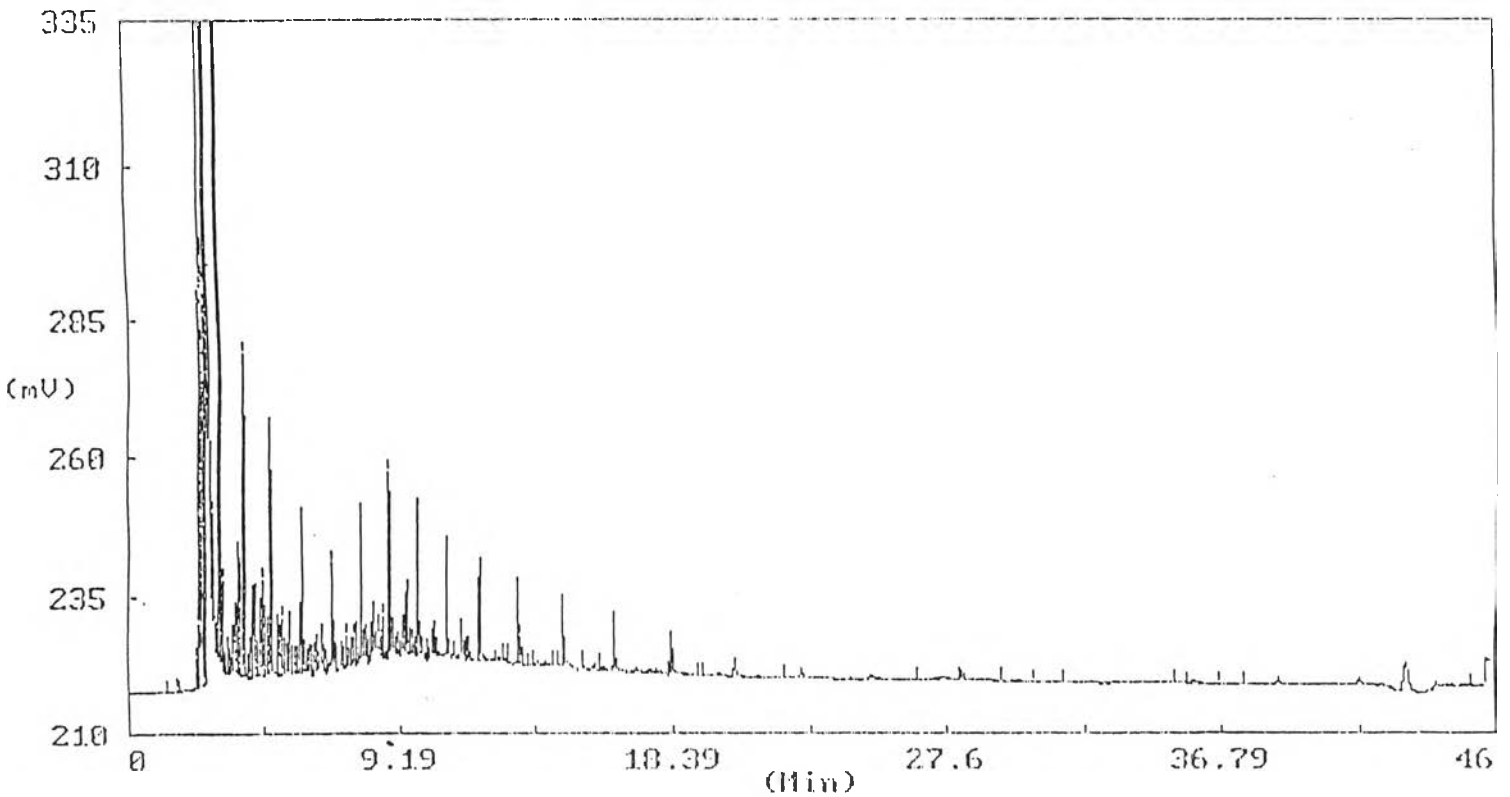

Figure B-4 The chromatogram of exhaust emission of base diesel fuel at 2400 rpm

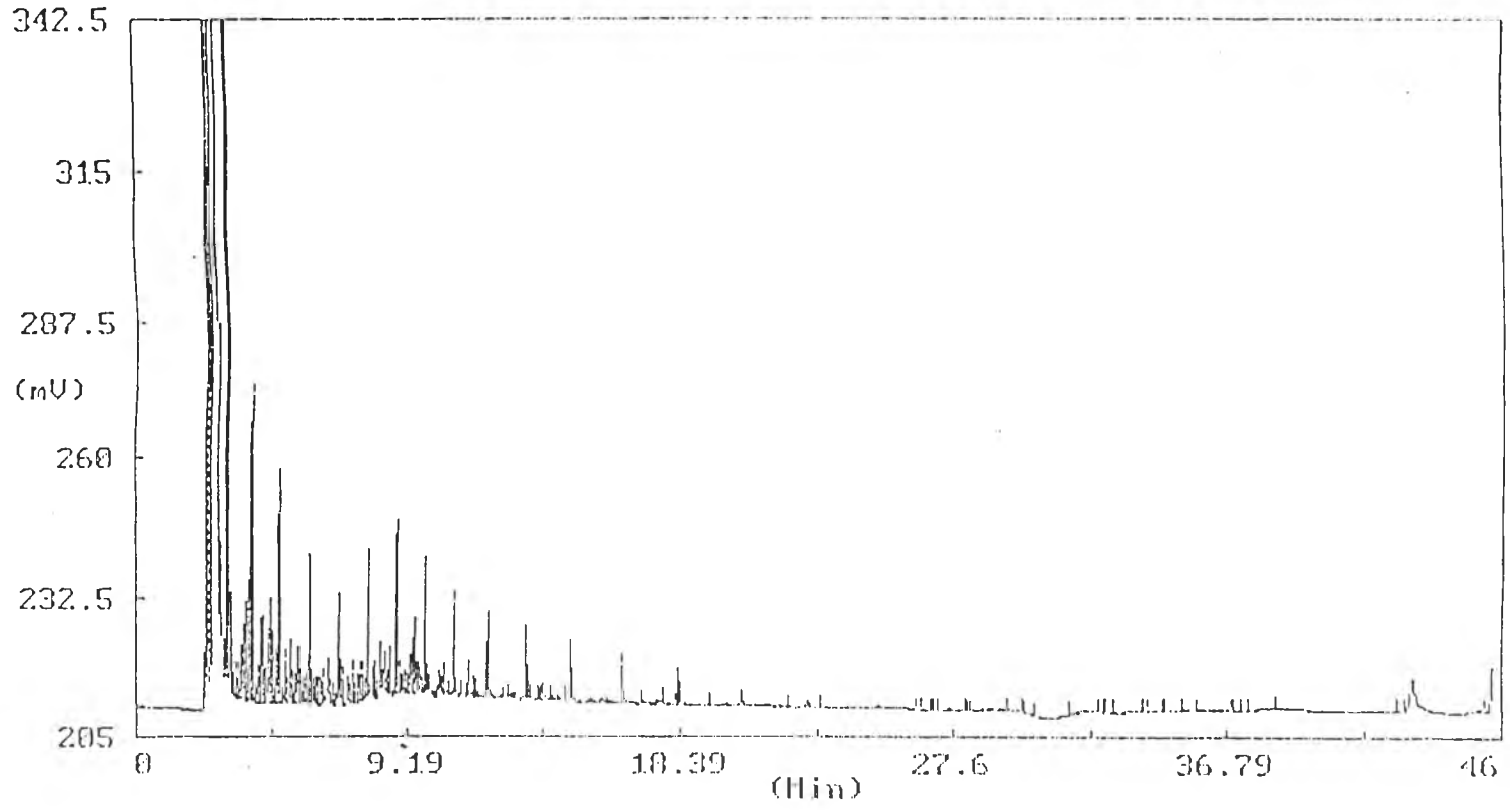

Figure B-5 The chromatogram of exhaust emission of B10 Blend at 800 rpm

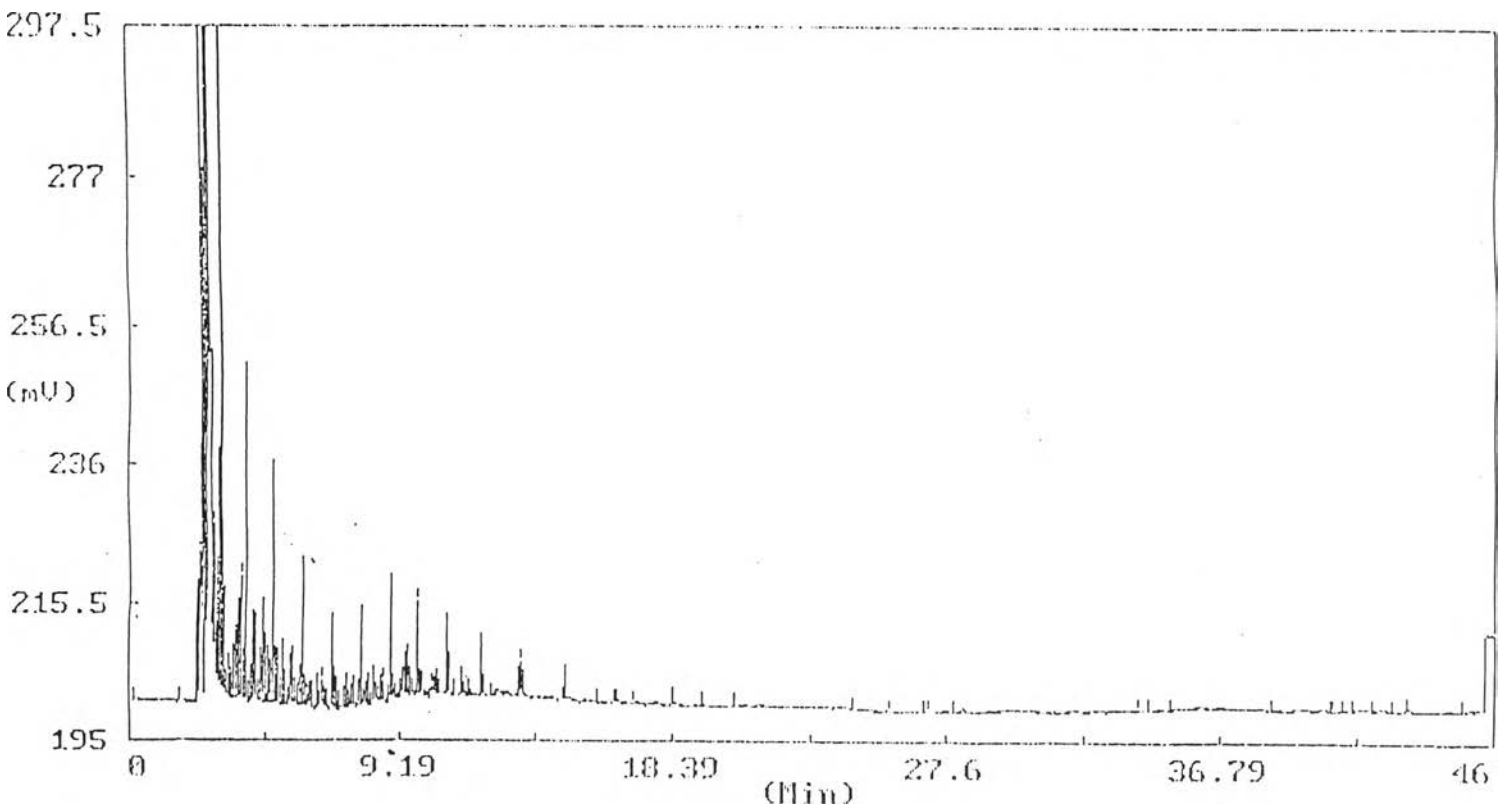

Figure B-6 The chromatogram of exhaust emission of B10 Blend at 1600 rpm

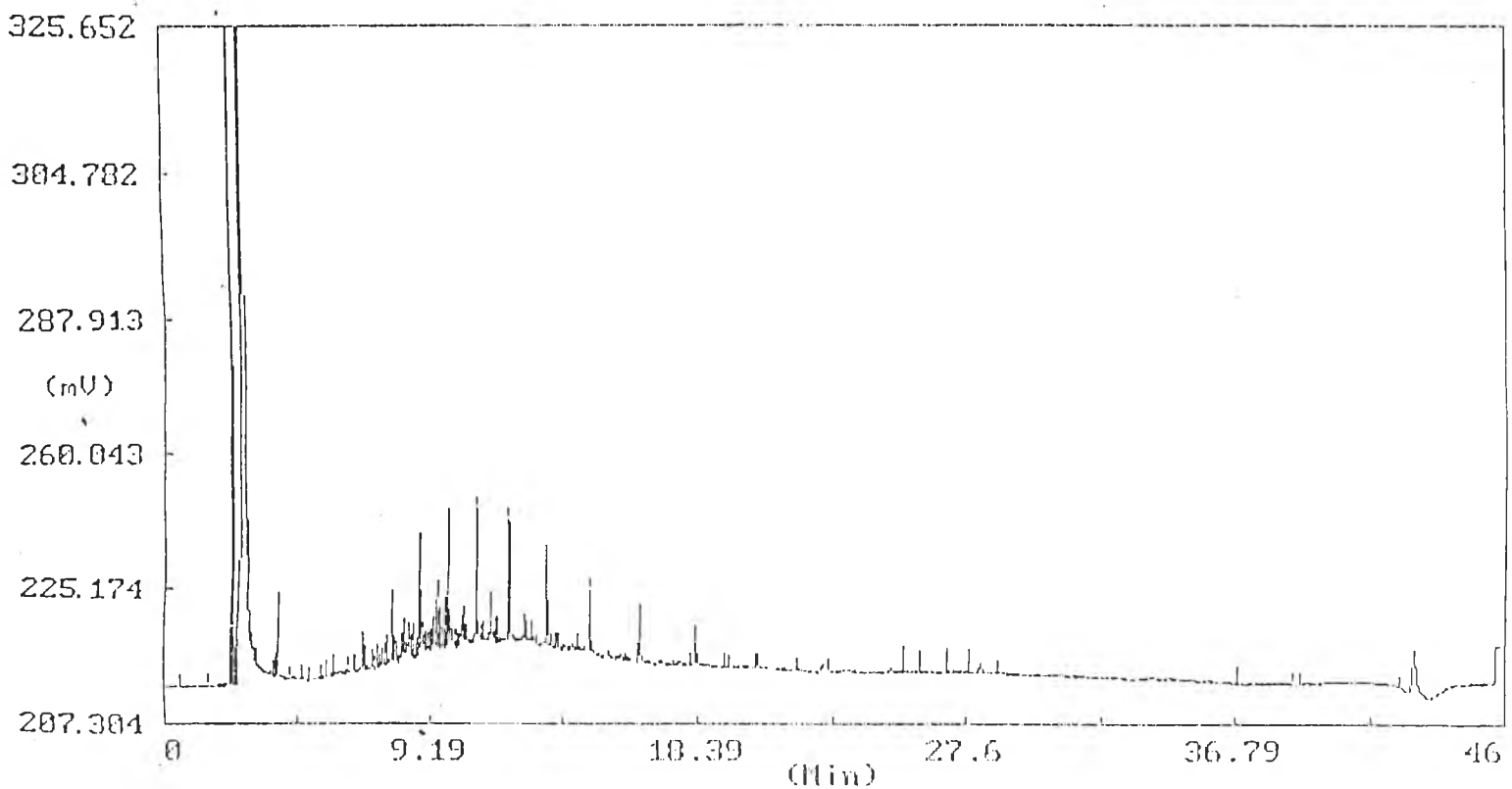

Figure B-7 The chromatogram of exhaust emission of B10 Blend at 2400 rpm

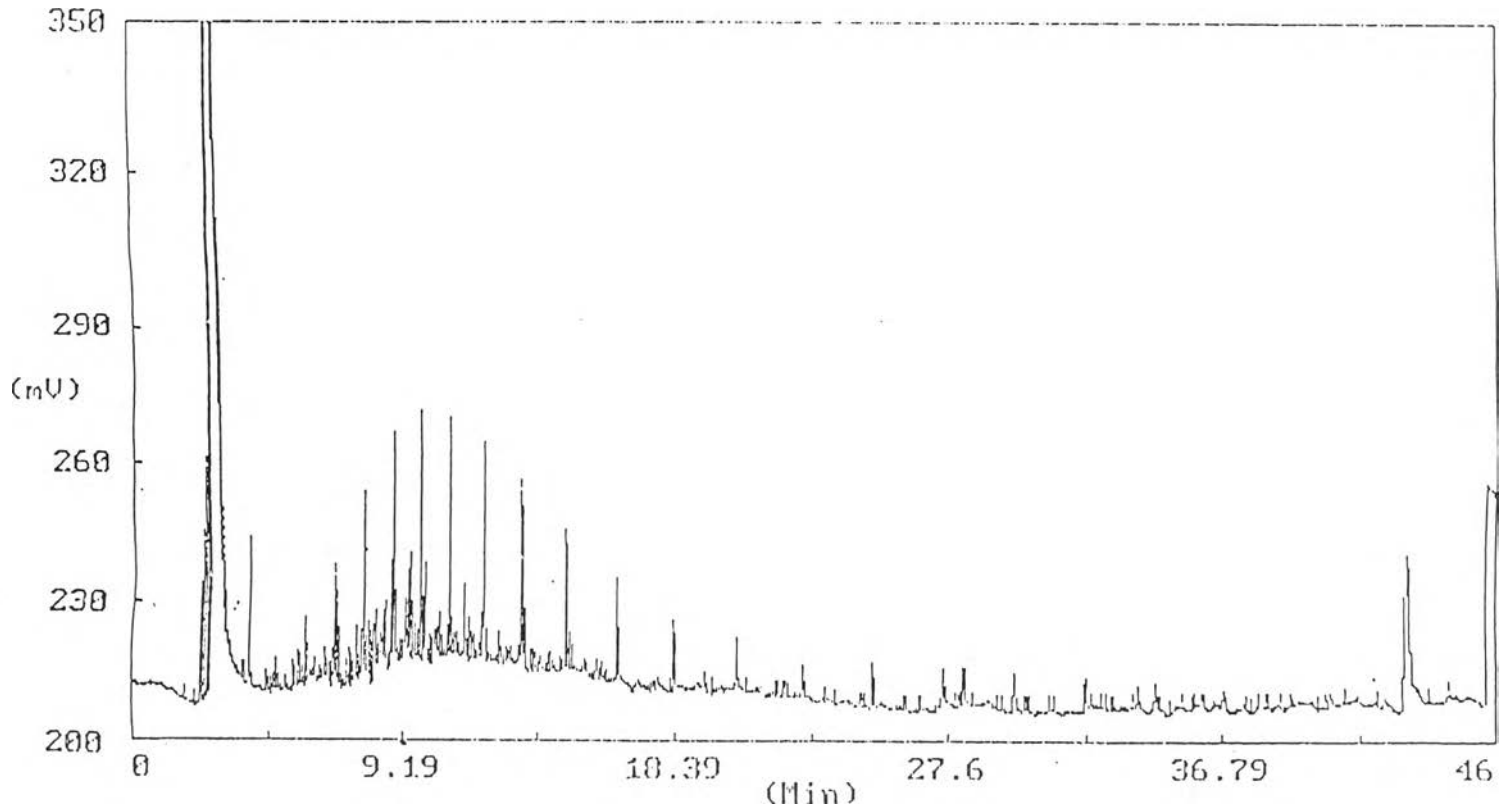

Figure B-8 The chromatogram of exhaust emission of B20 Blend at 800 rpm

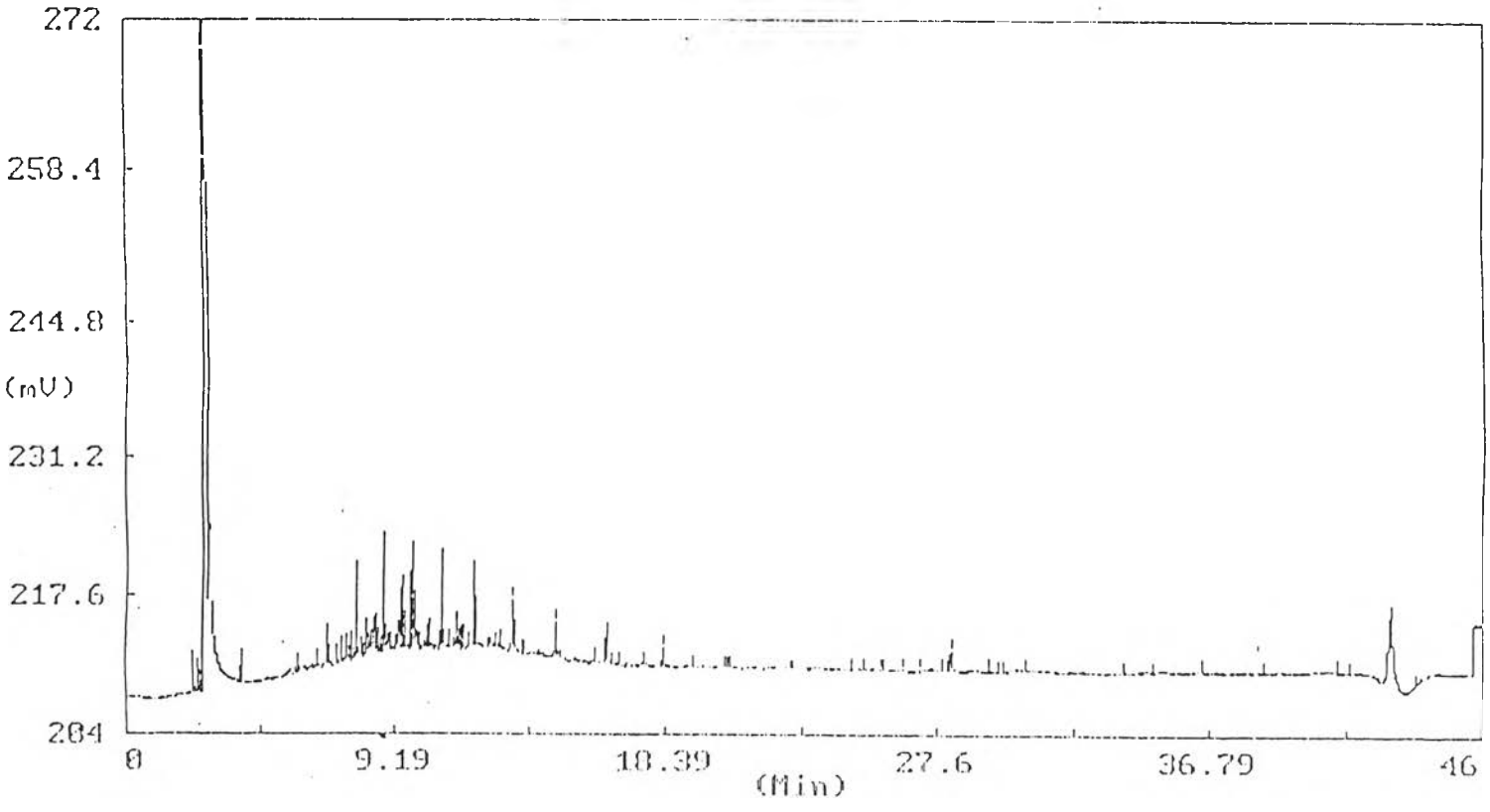

Figure B-9 The chromatogram of exhaust emission of B20 Blend at 1600 rpm

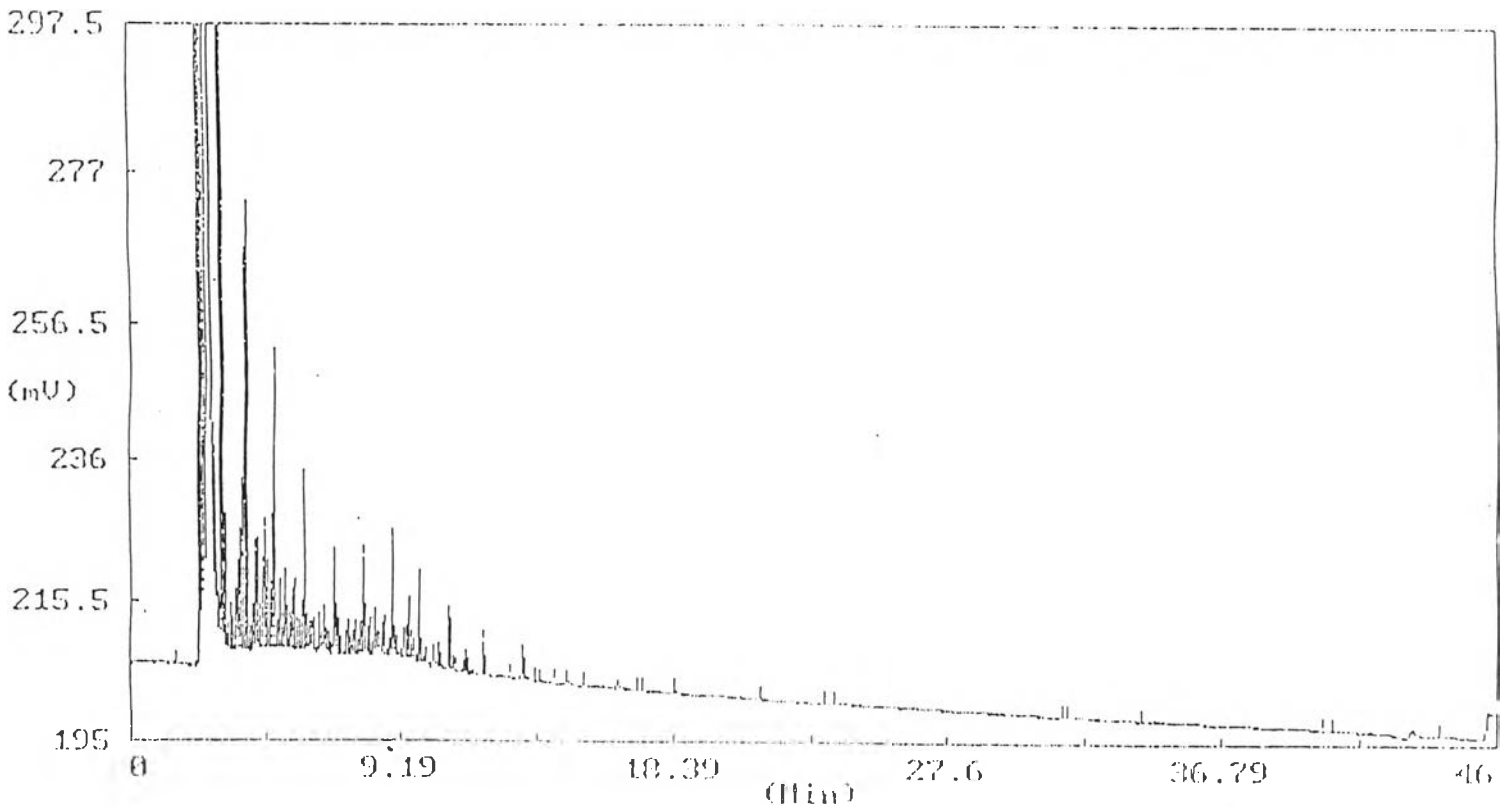

Figure B-10 The chromatogram of exhaust emission of B20 Blend at 2400 rpm

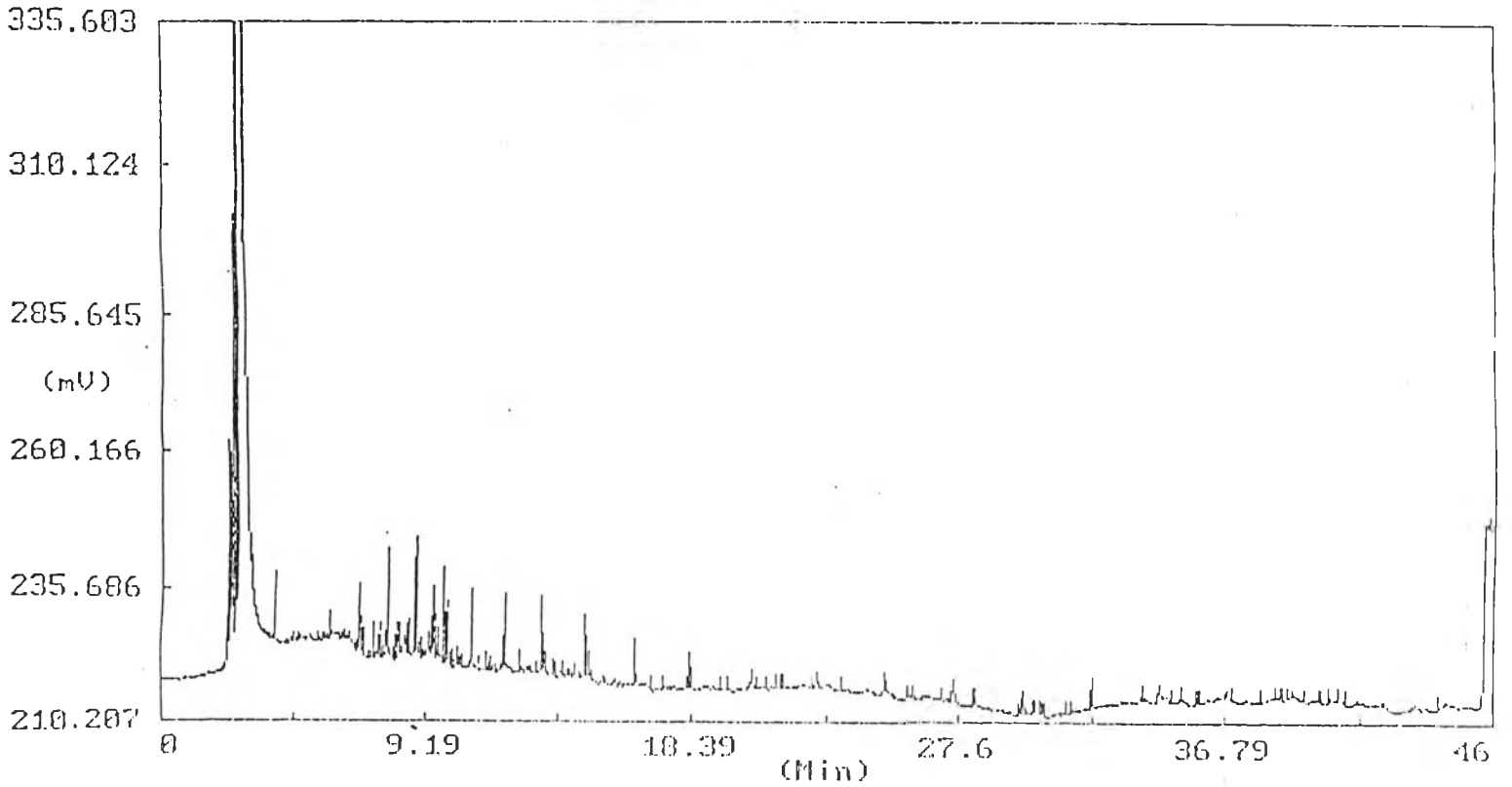

Figure B-11 The chromatogram of exhaust emission of B30 Blend at 800 rpm

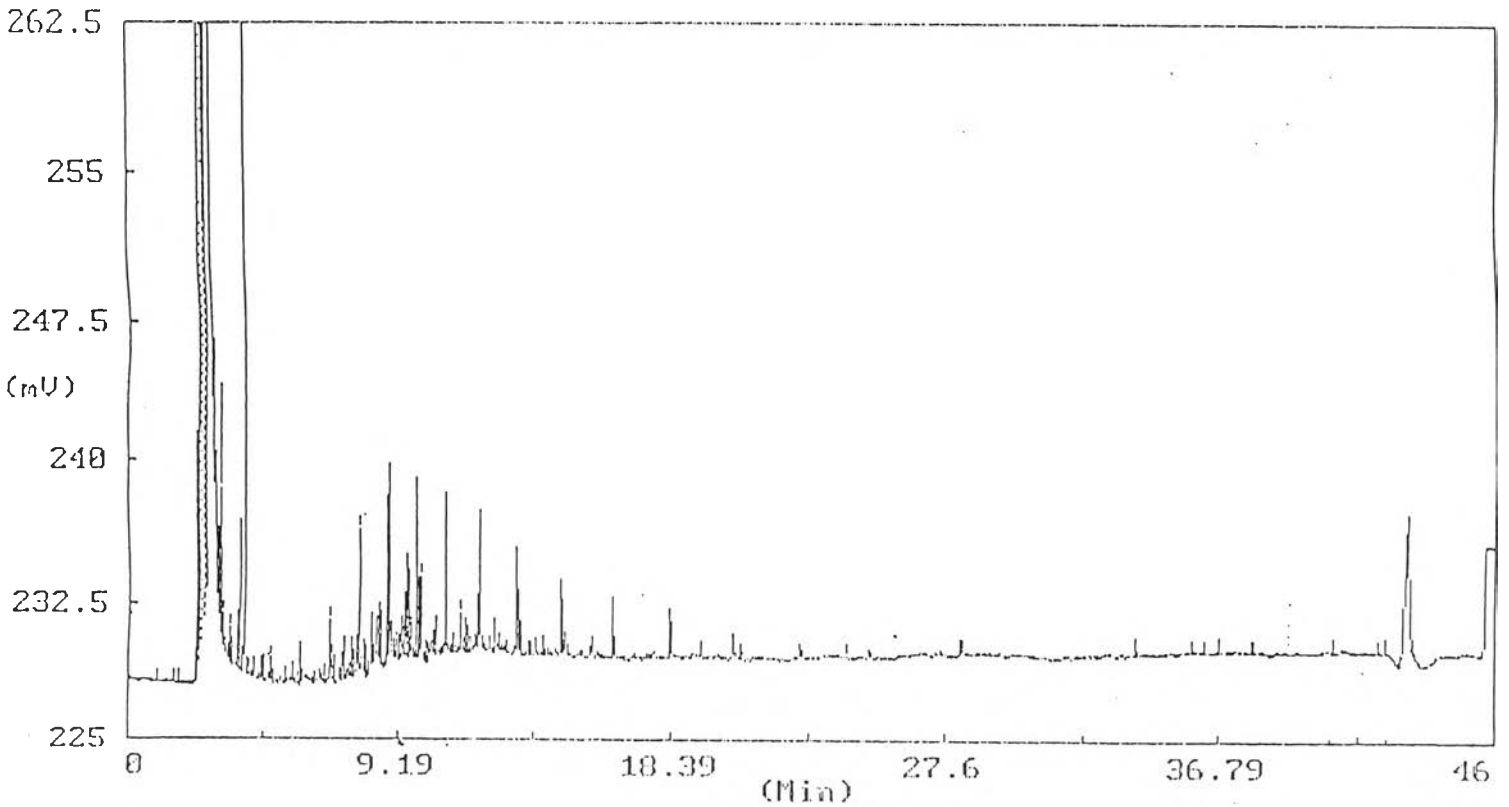

Figure B-12 The chromatogram of exhaust emission of B30 Blend at 1600 rpm

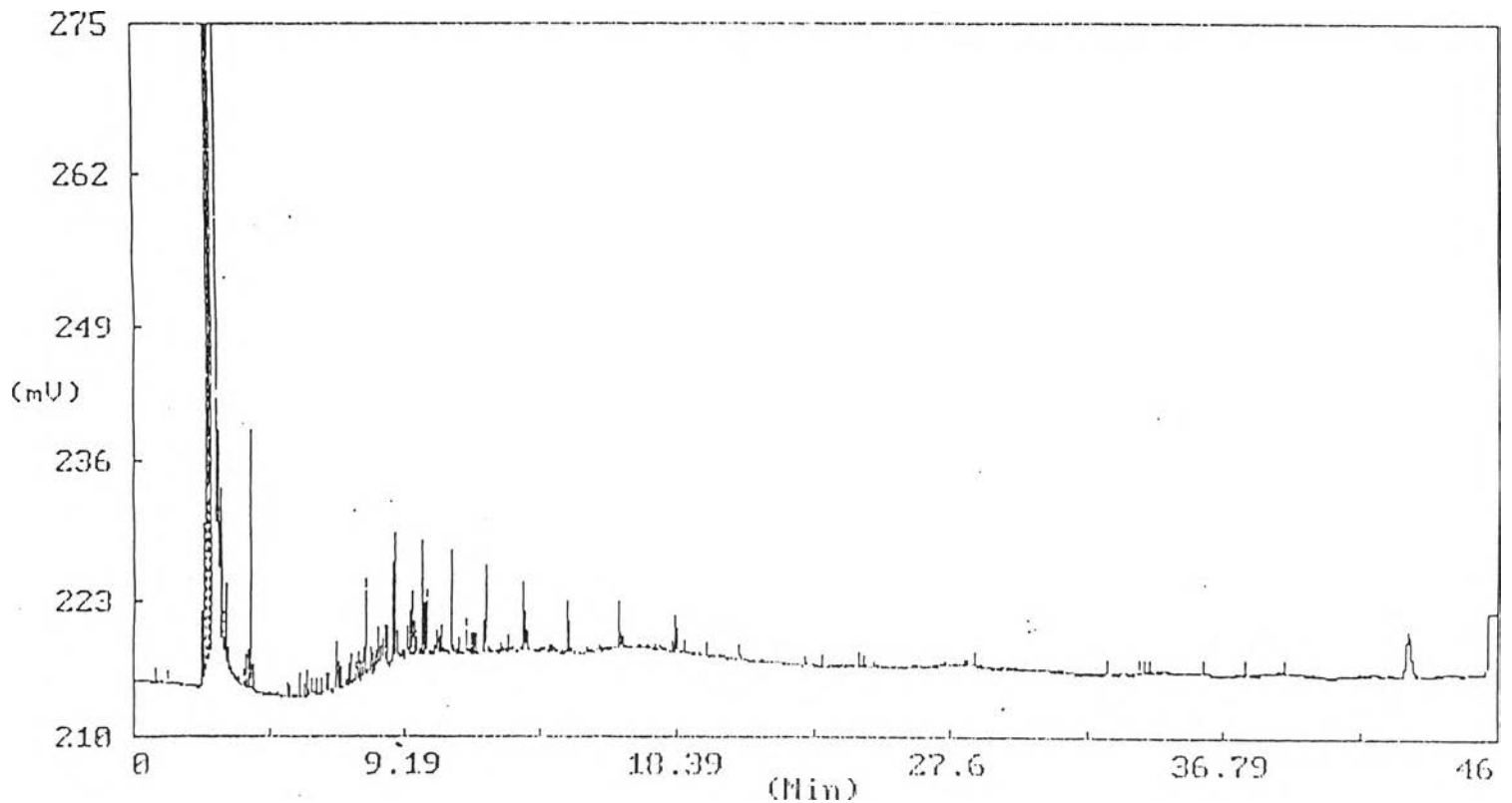

Figure B-13 The chromatogram of exhaust emission of B30 Blend at 2400 rpm

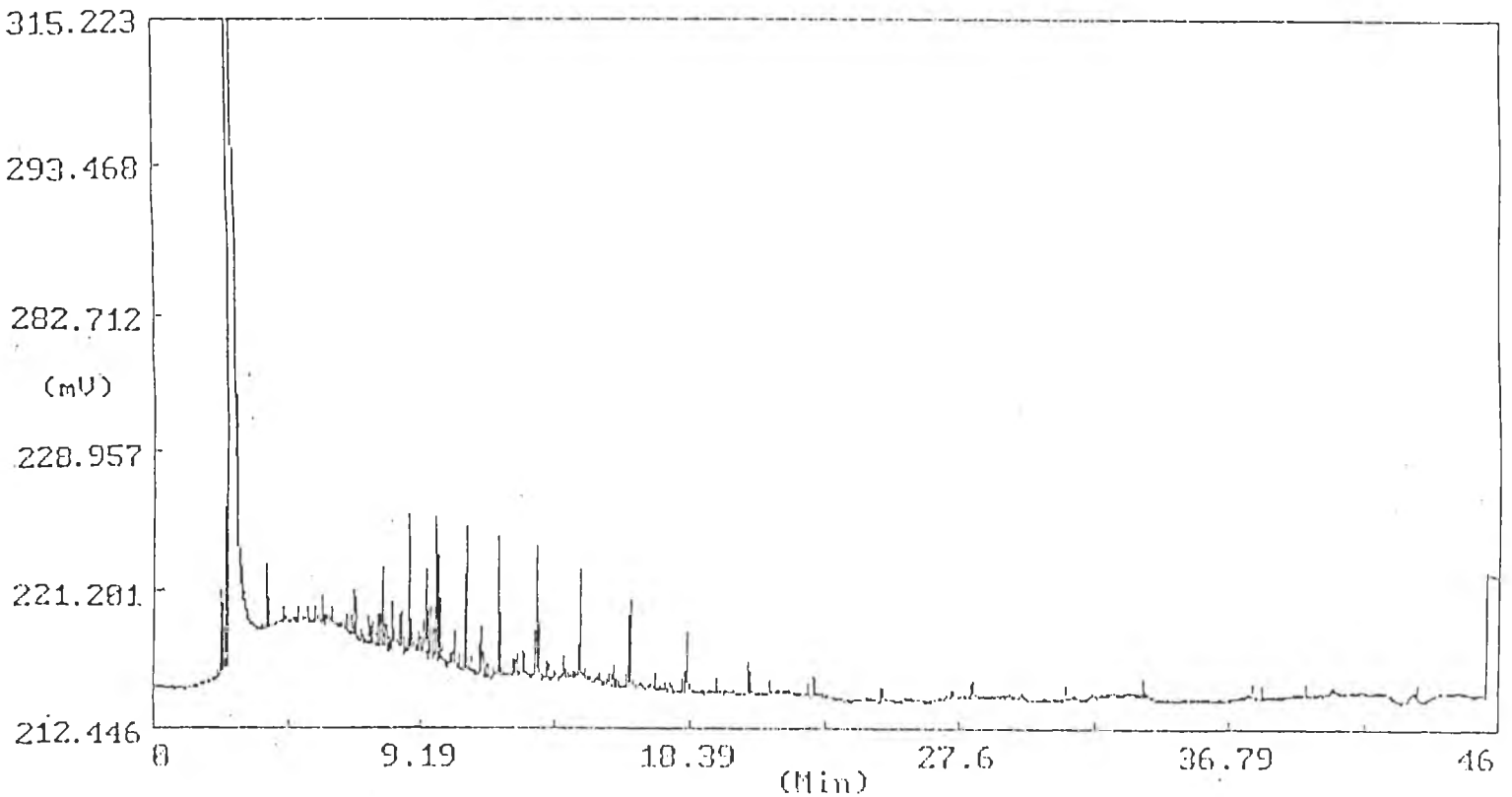

Figure B-14 The chromatogram of exhaust emission of RPO20 Blend at 800 rpm

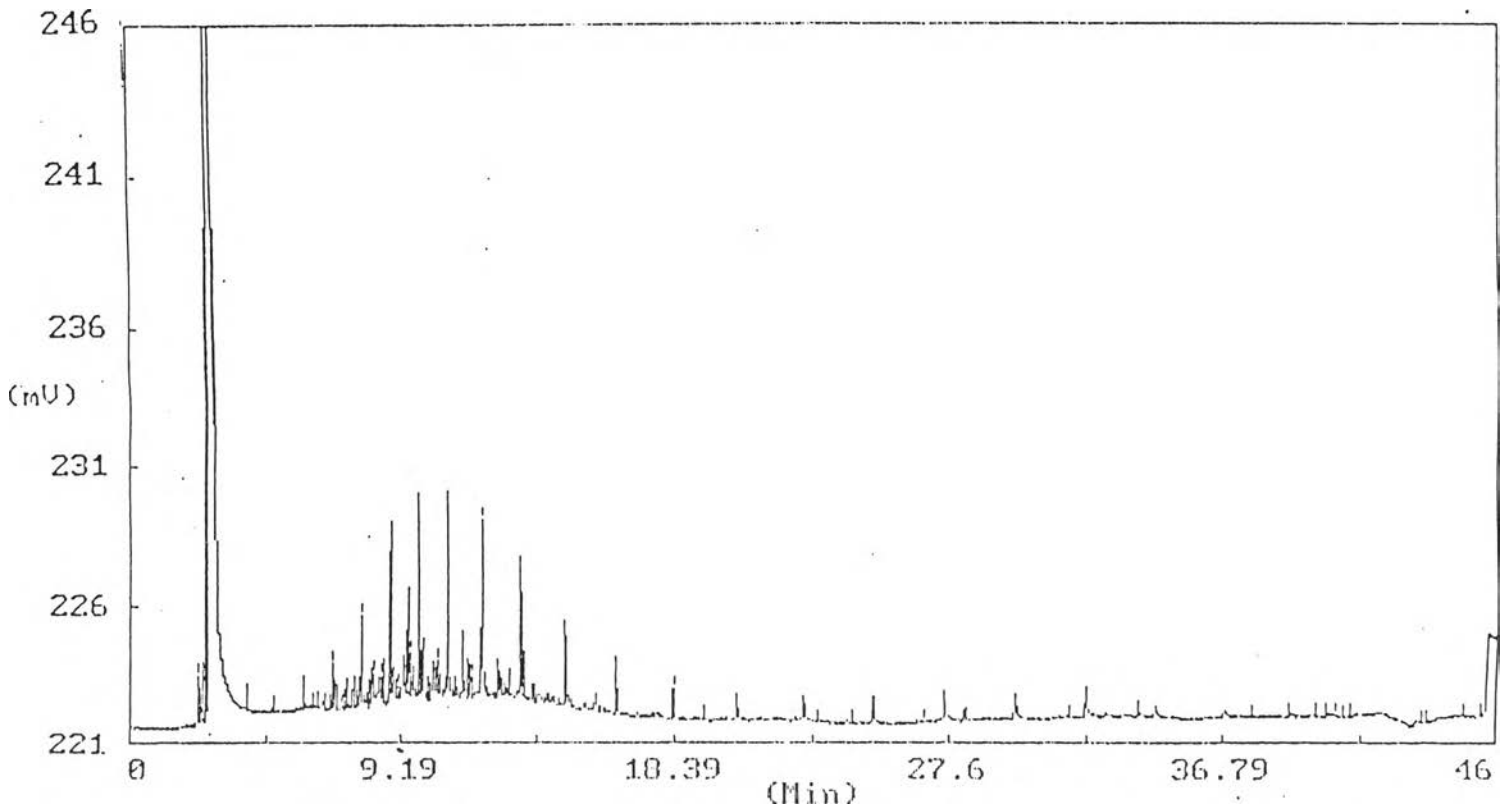

Figure B-15 The chromatogram of exhaust emission of RPO20 Blend at 1600 rpm

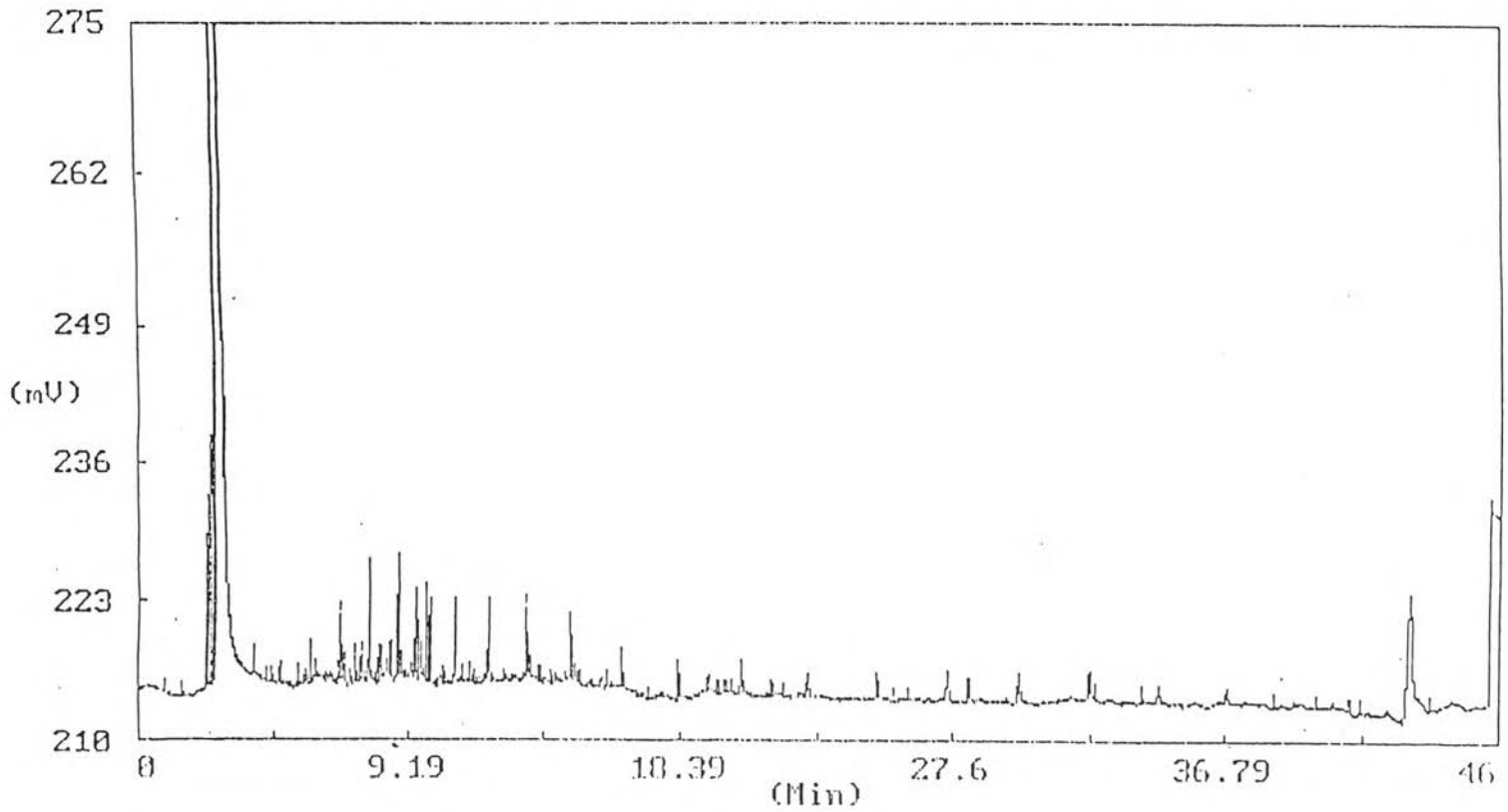

Figure B-16 The chromatogram of exhaust emission of RPO20 Blend at 2400 rpm

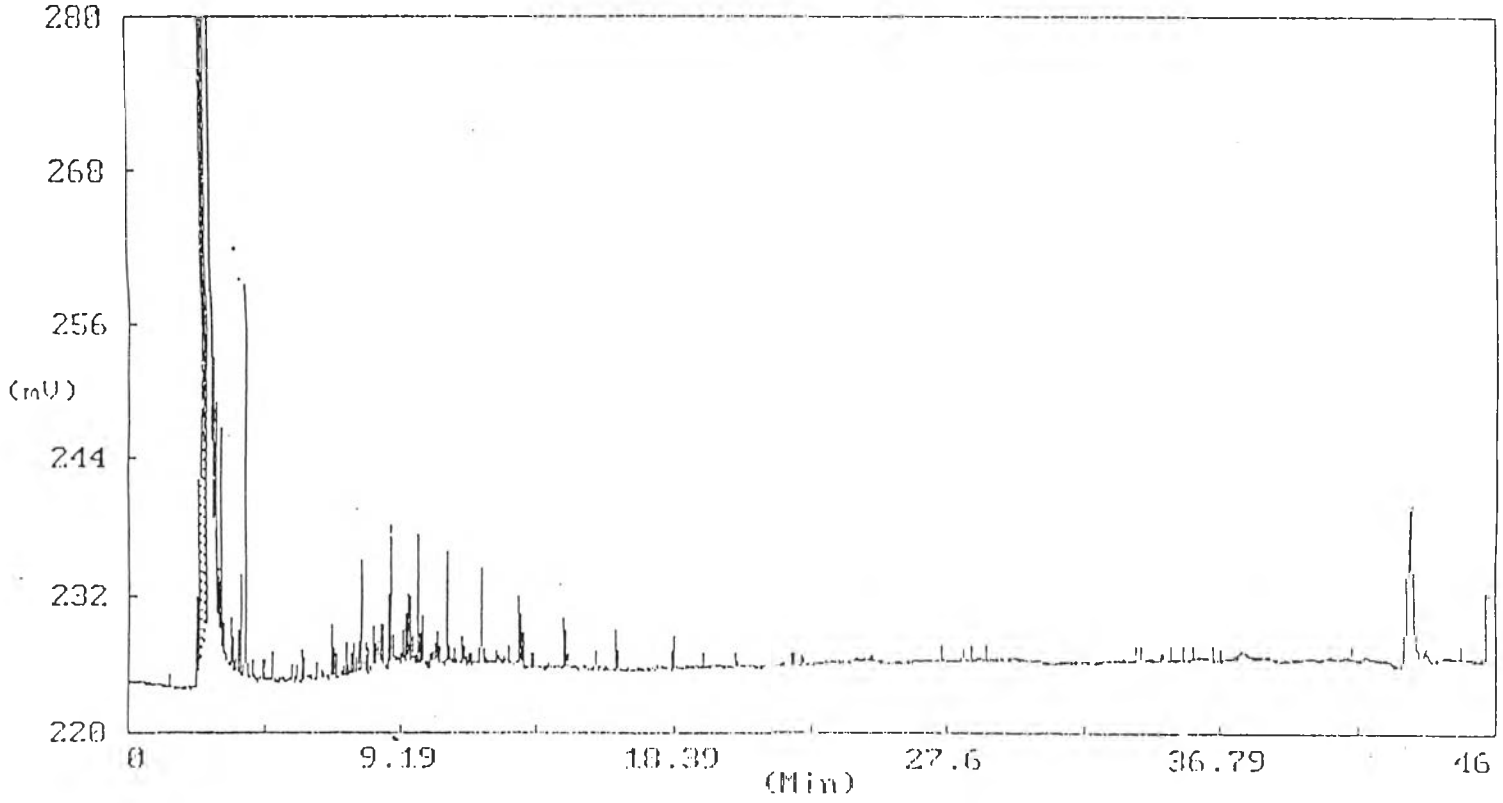

Figure B-17 The chromatogram of exhaust emission of CPO20 Blend at 800 rpm

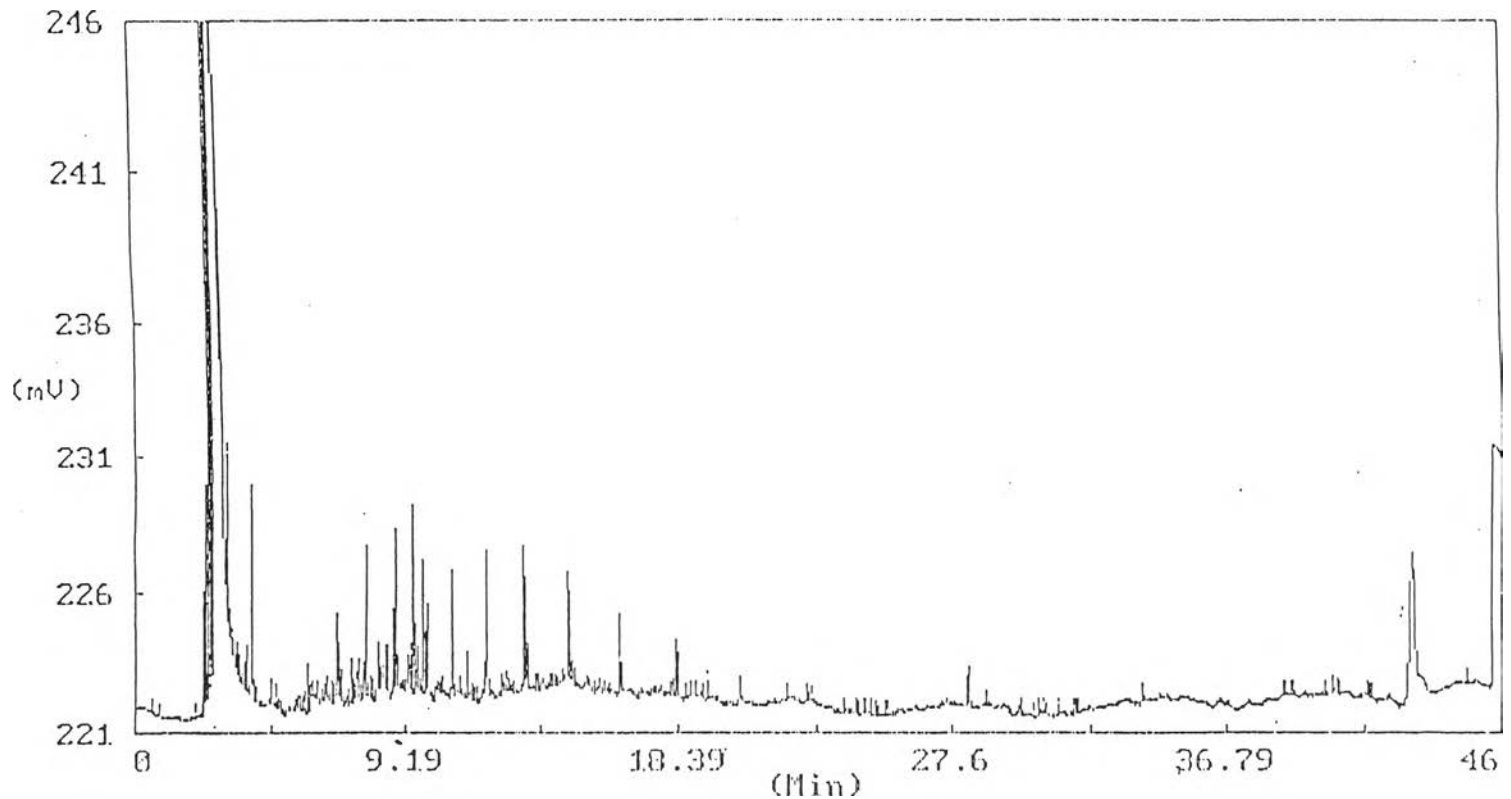

Figure B-18 The chromatogram of exhaust emission of CPO20 Blend at 1600 rpm

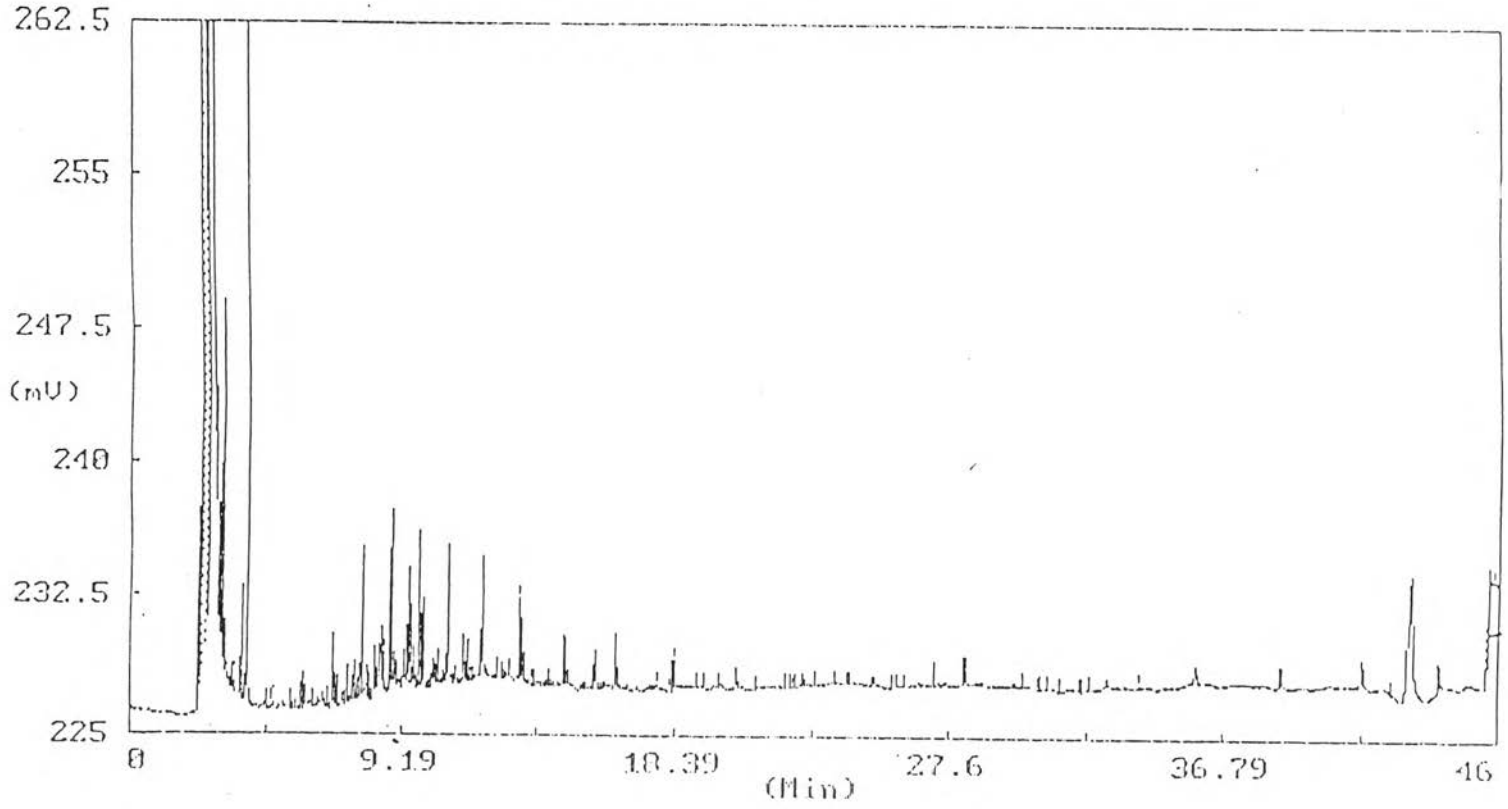

Figure B-19 The chromatogram of exhaust emission of CPO20 Blend at 2400 rpm

APPENDIX C

The ^{13}C-NMR, ^{1}H-NMR and FT-IR Spectrum of Palm Oil Methyl Ester

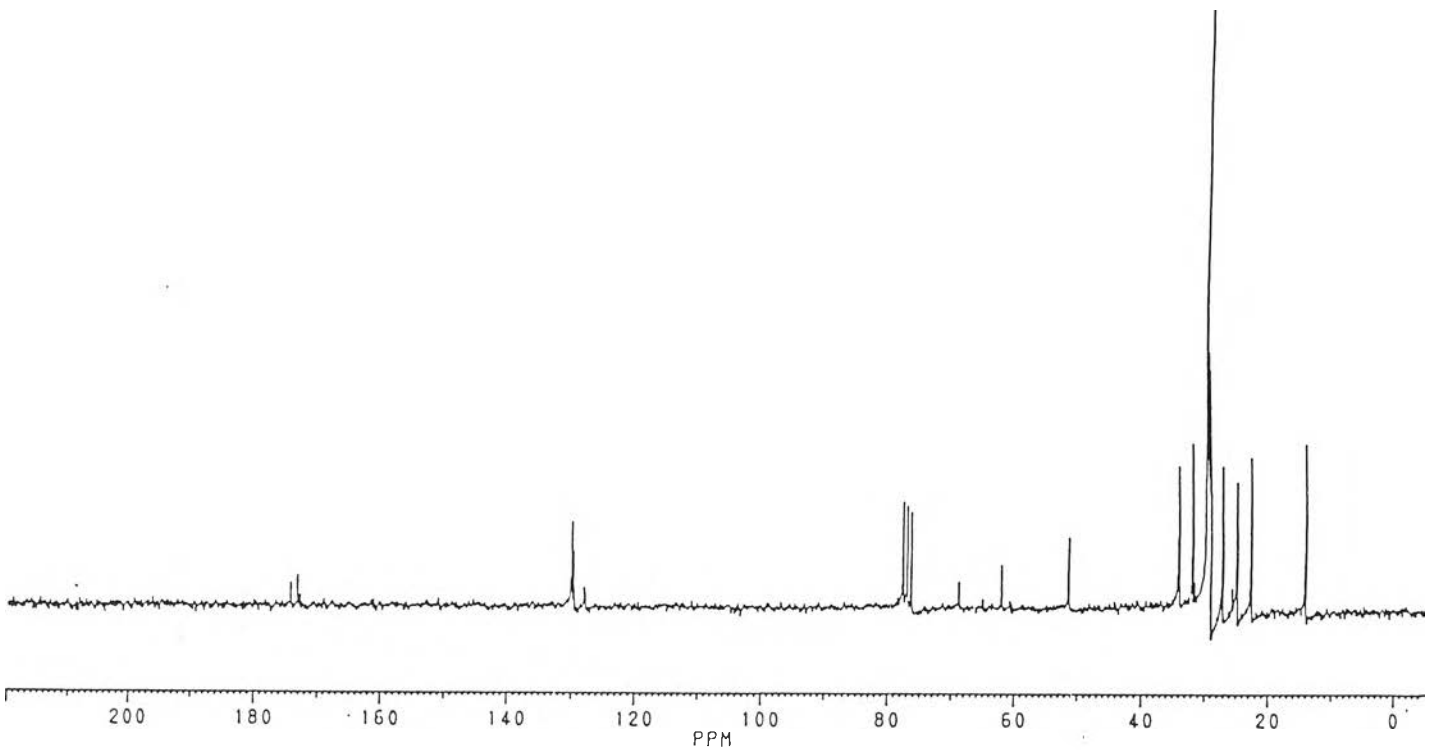

Figure C-1 The ^{13}C-NMR spectrum of palm oil methyl ester in $CDCl_3$

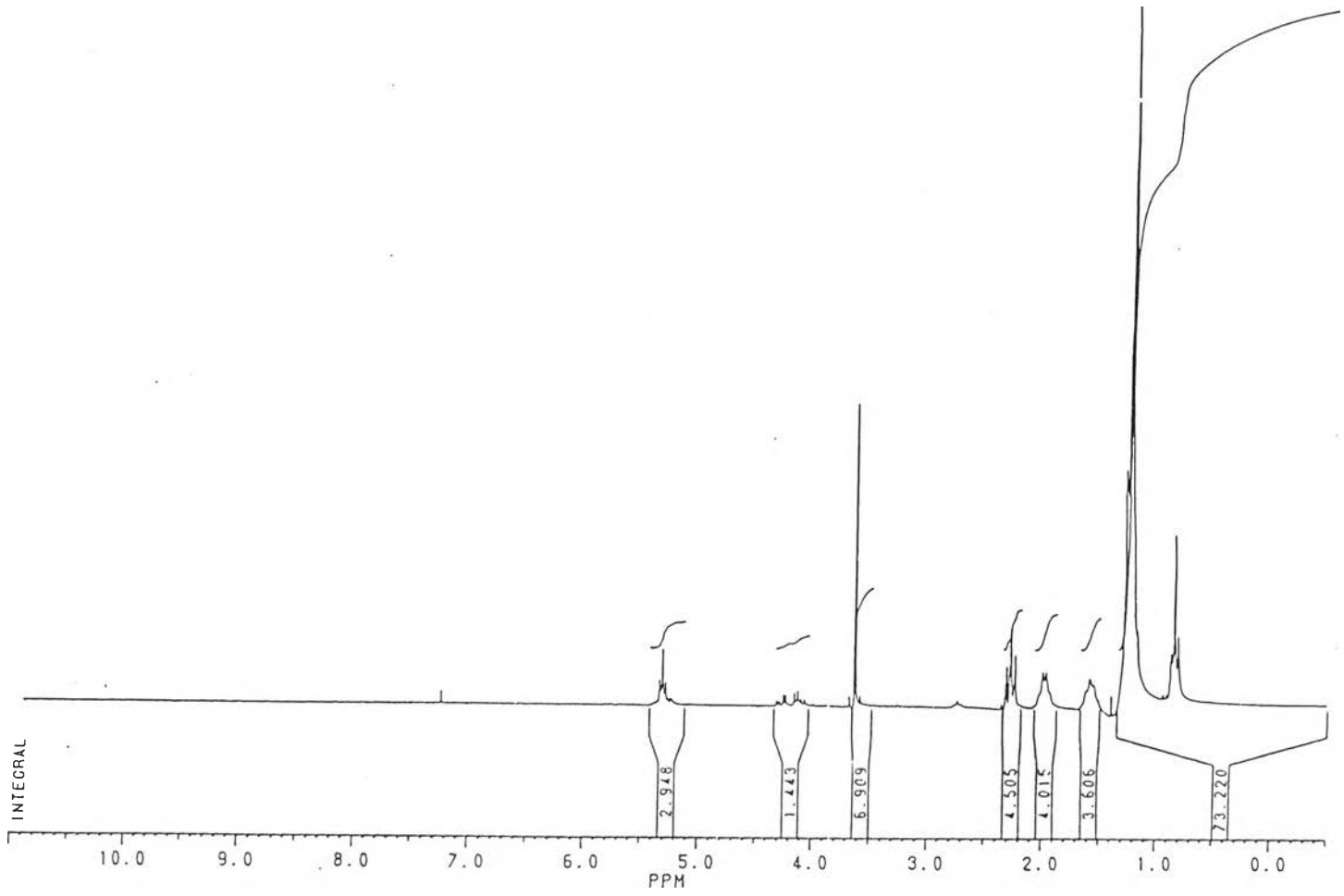

Figure C-2 The ^{1}H-NMR spectrum of palm oil methyl ester in $CDCl_3$

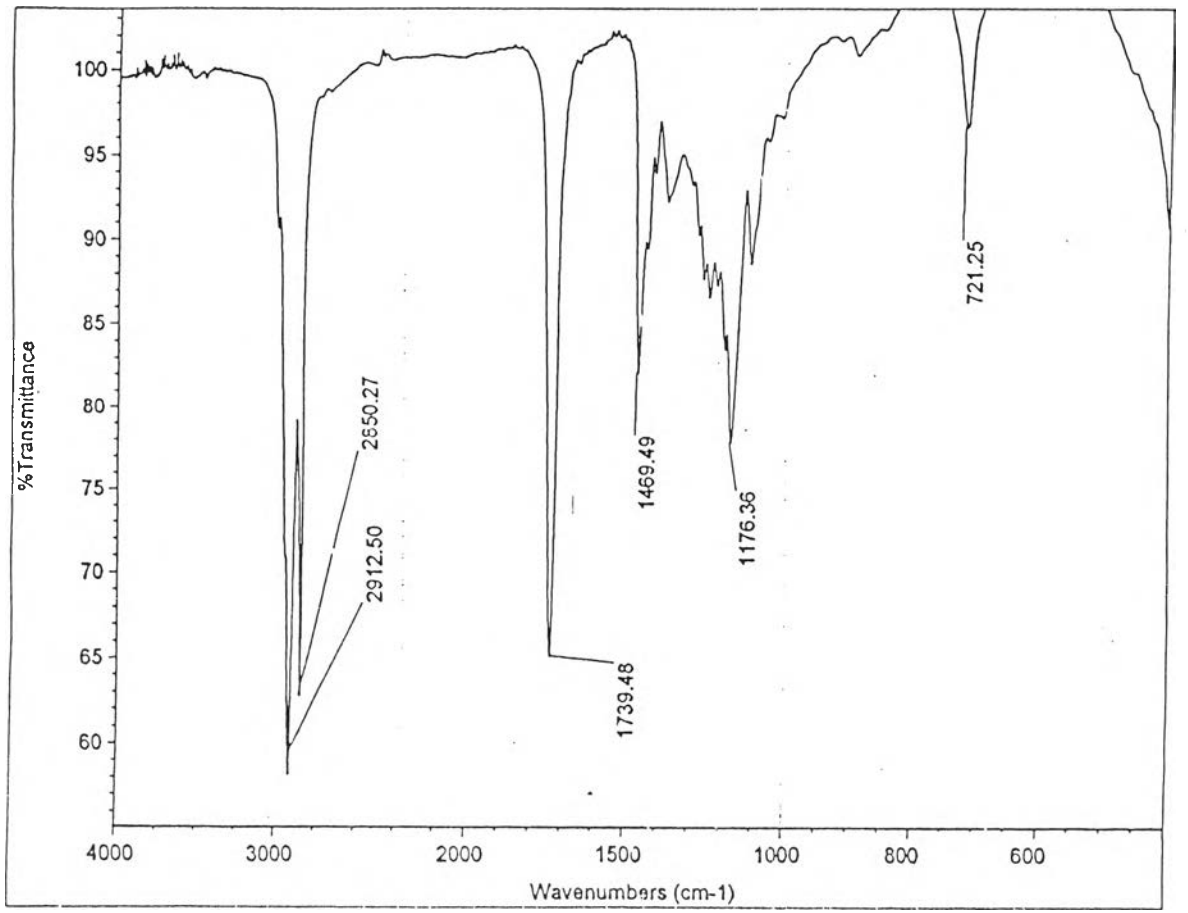

Figure C-3 The FT-IR spectrum of palm oil methyl ester

APPENDIX D

The Concentration of individual PAH in Diesel Exhaust

Table D-1 Concentration of PAHs in diesel test engine exhaust emission

Fuel	rpm	Concentration of PAHs in diesel test engine exhaust emission (μg/m^3 of exhaust)												
		Naph.	Ace.thyl.	Ace.thene	Fluorene	Phen.	Anthrac.	Fluoranth.	Pyrene	B[a]A	Chrys.	B[k]F	B[ghi]P	Total
Base Fuel	800	8.54	15.52	7.69	1.48	0.26	0.18	0.17	0.14	nd	0.35	nd	0.39	34.72
	1600	7.18	13.64	6.46	1.12	0.22	0.13	0.09	0.11	0.20	nd	nd	0.36	29.51
	2400	7.92	14.15	6.82	1.34	0.19	0.15	0.13	0.12	nd	0.17	nd	0.46	31.45
B10	800	7.67	13.67	6.92	1.24	0.23	0.16	0.14	0.13	0.48	0.18	nd	nd	30.82
	1600	6.46	12.28	5.81	1.01	0.18	0.12	0.08	0.10	0.18	0.06	0.26	nd	26.54
	2400	6.57	12.75	6.59	1.13	0 20	0.15	0.11	0.10	0.13	0.02	0.09	0.34	28.18
B20	800	7.66	11.57	6.15	1.18	0.21	0.14	0.14	0.11	0.18	nd	nd	0.41	27.76
	1600	6.44	10.16	3.94	0.89	0.10	0.07	0.06	0.06	nd	0.21	0.09	nd	22.02
	2400	6.57	11.74	5.66	1.11	0.16	0.12	0.11	0.10	0.52	nd	nd	nd	26.10
B30	800	5.97	10.64	5.38	0.96	0.18	0.12	0.11	0.10	0.51	nd	nd	nd	23.98
	1600	5.81	9.16	3.55	0.80	0.09	0.06	0.05	0.05	0.11	nd	0.06	0.26	20.02
	2400	5.66	10.12	4.88	0.96	0.14	0.11	0.09	0.09	0.37	0.08	nd	nd	22.49
RPO20	800	7.99	11.43	6.35	1.28	0.21	0.14	0.30	0.14	0.28	0.37	nd	0.30	28.77
	1600	6.18	10.07	5.87	0.96	0.17	0.05	0.24	0.04	nd	0.24	0.31	0.10	24.23
	2400	6.48	11.20	6.32	1.25	0.18	0.09	0.29	0.08	nd	0.44	nd	0.40	26.73
CPO20	800	7.08	13.11	6.25	1.33	0.36	0.29	0.14	0.11	0.16	0.32	nd	0.36	29.51
	1600	4.91	11.52	5.69	1.28	0.26	0.18	0.15	0.04	0.46	nd	0.31	nd	24.49
	2400	5.89	12.30	6.22	0.71	0.2	0.25	0.13	0.09	0.09	nd	nd	nd	26.02

VITA

Miss Umaporn Phongsataya was born on January 3, 1979 in Singburi. She received her Bachelor's degree of Science in Chemistry from the Department of Chemistry, Faculty of Science and Technology, Thammasat University in 2000. She began her studies in the Multidisciplinary program of Petrochemistry and Polymer Science, Faculty of Science, Chulalongkorn University in 2000 and completed the program in 2002.