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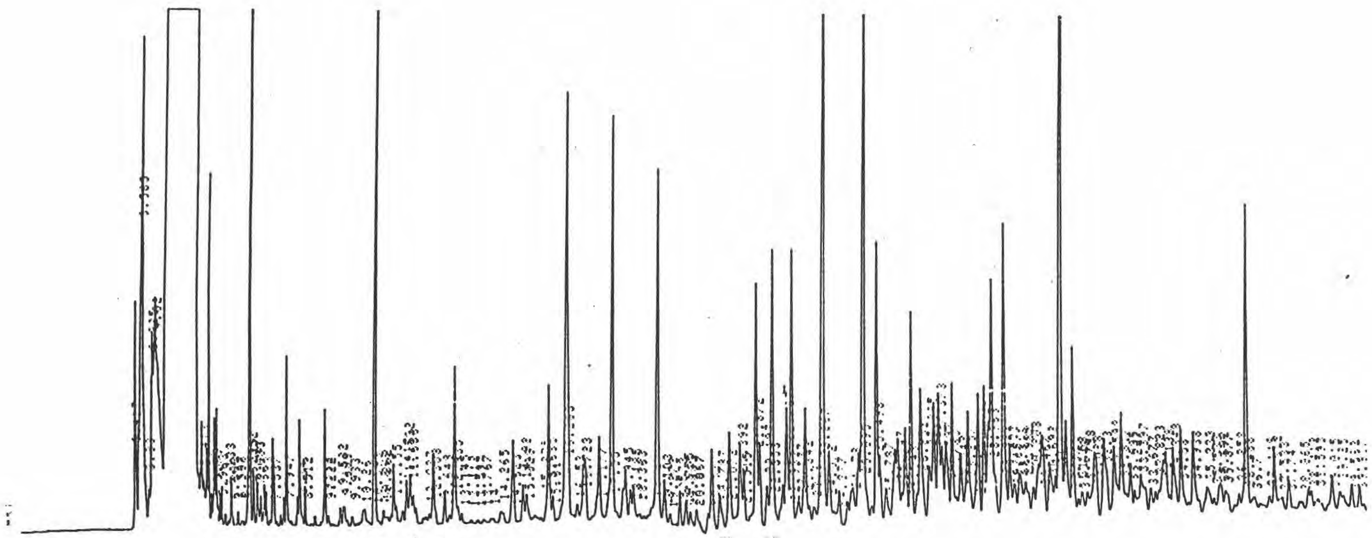
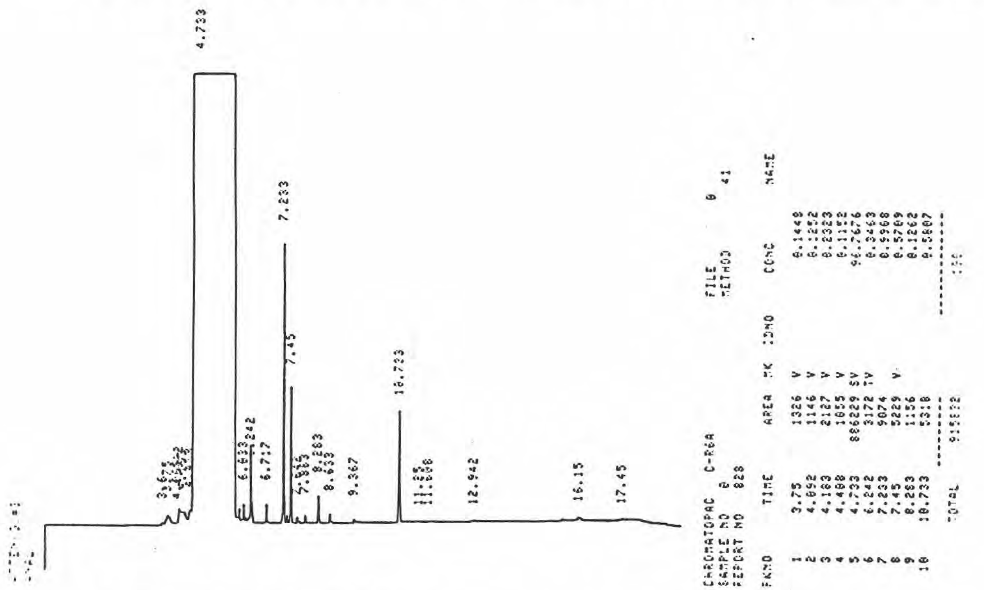
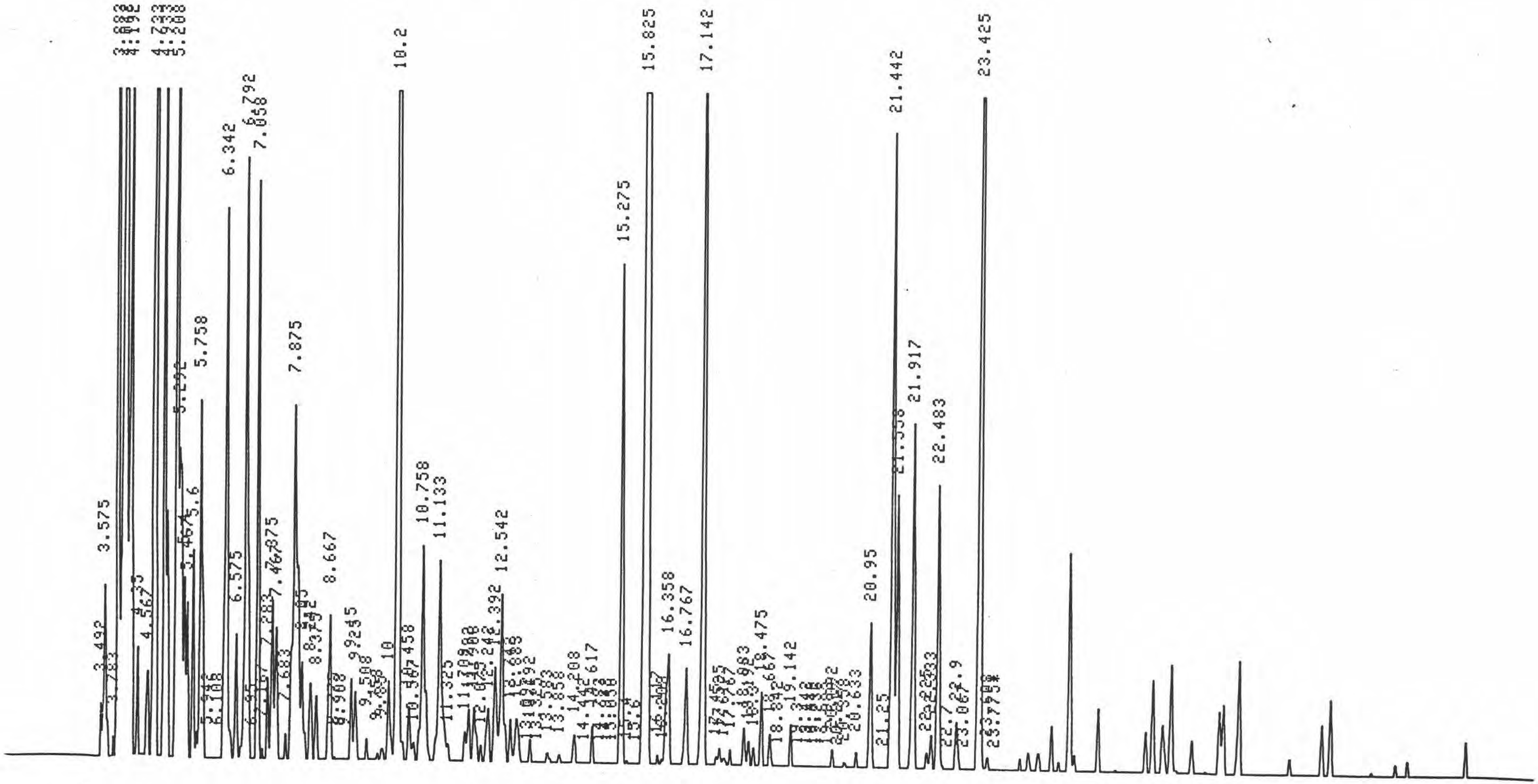
APPENDIX A



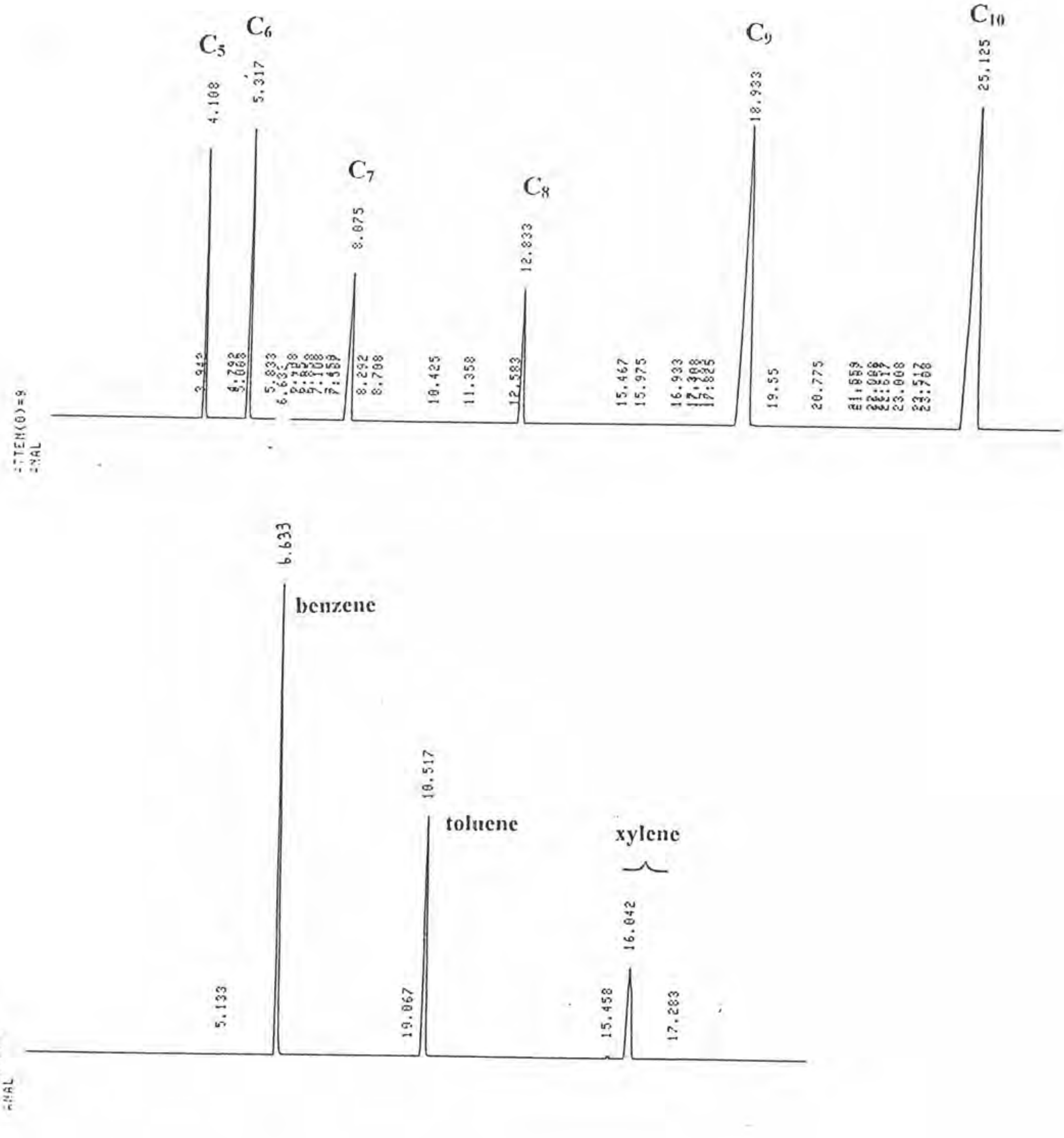
A1 Chromatogram of Hydrocarbon composition from front section of charcoal sorbent tube



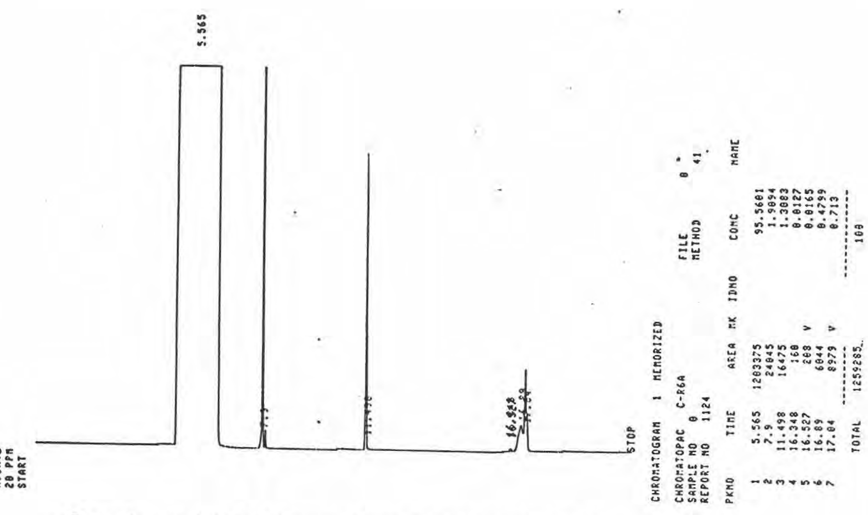
A2 Chromatogram of Hydrocarbon composition from back section of charcoal sorbent tube



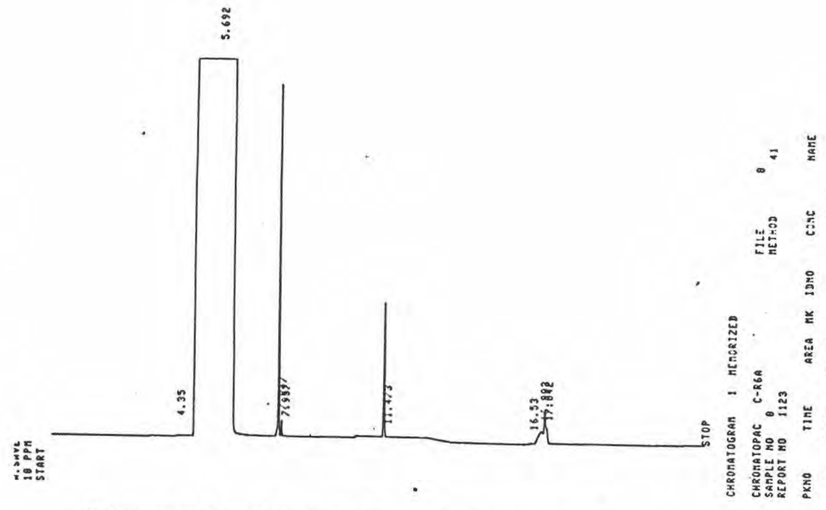
A3 Chromatogram of Gasoline was used for the pattern to identified the hydrocarbon composition



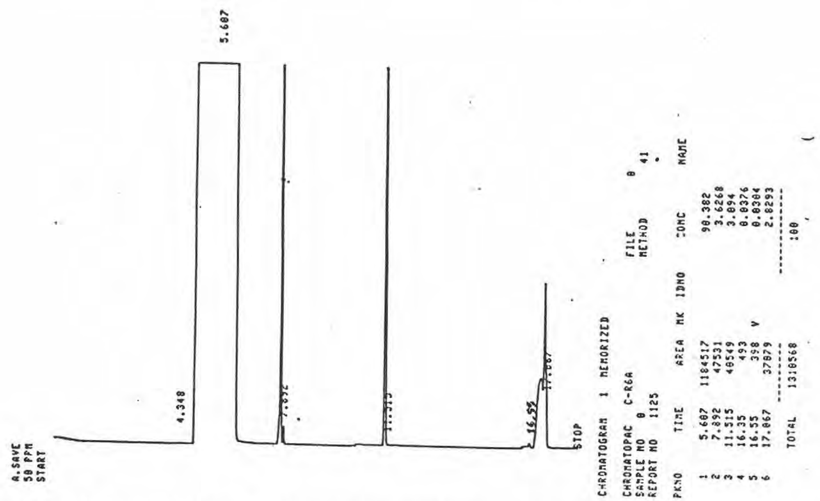
A4 Chromatogram of standard Paraffins and Aromatic groups



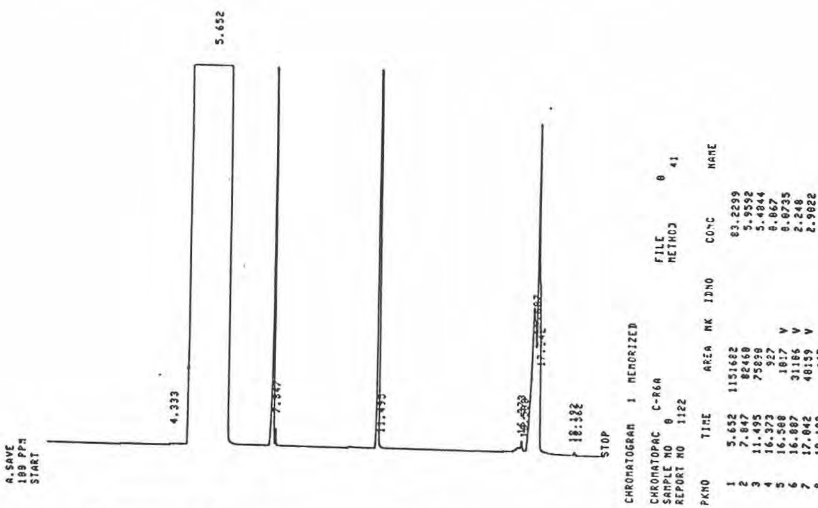
Chromatogram of standard (benzene, toluene, xylene) concentration 20 ppm



Chromatogram of standard (benzene, toluene, xylene) concentration 10 ppm

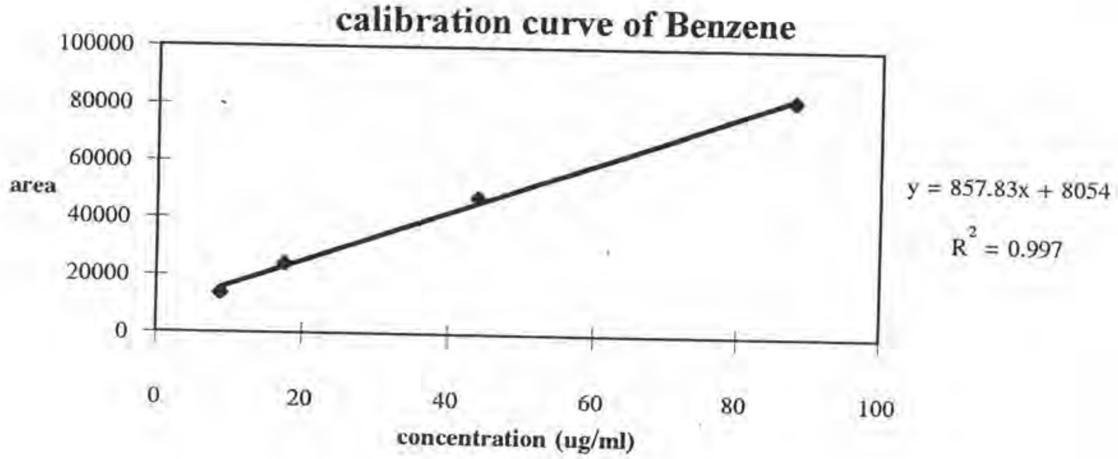


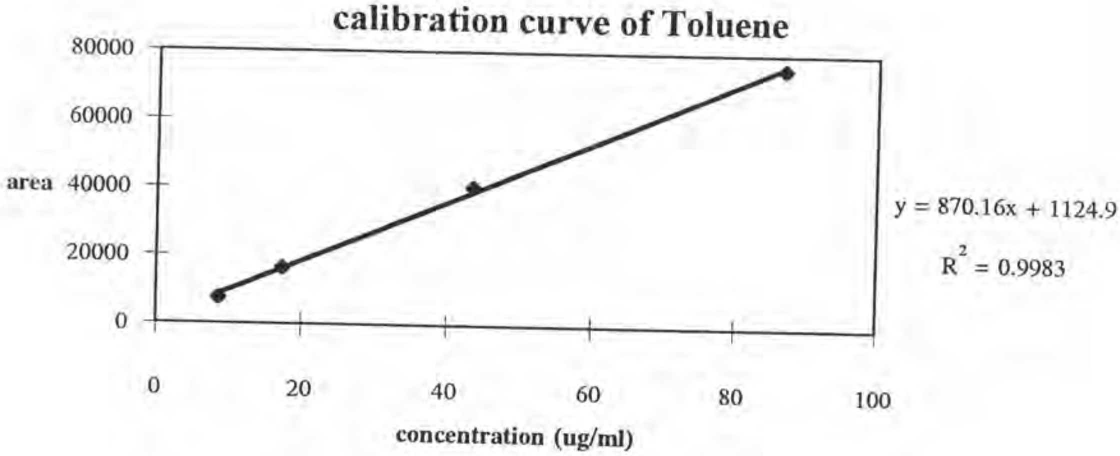
Chromatogram of standard (benzene, toluene, xylene) concentration 50 ppm

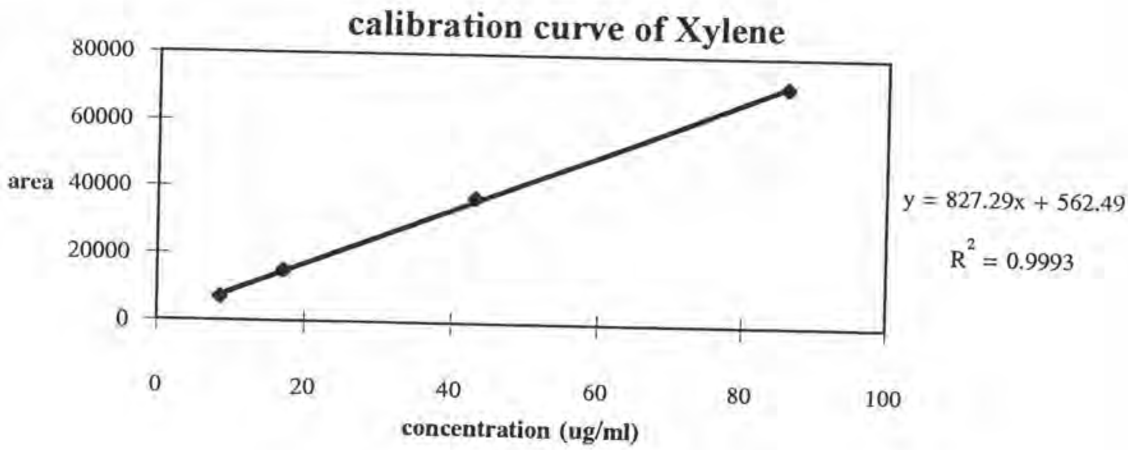


Chromatogram of standard (benzene, toluene, xylene) concentration 100 ppm

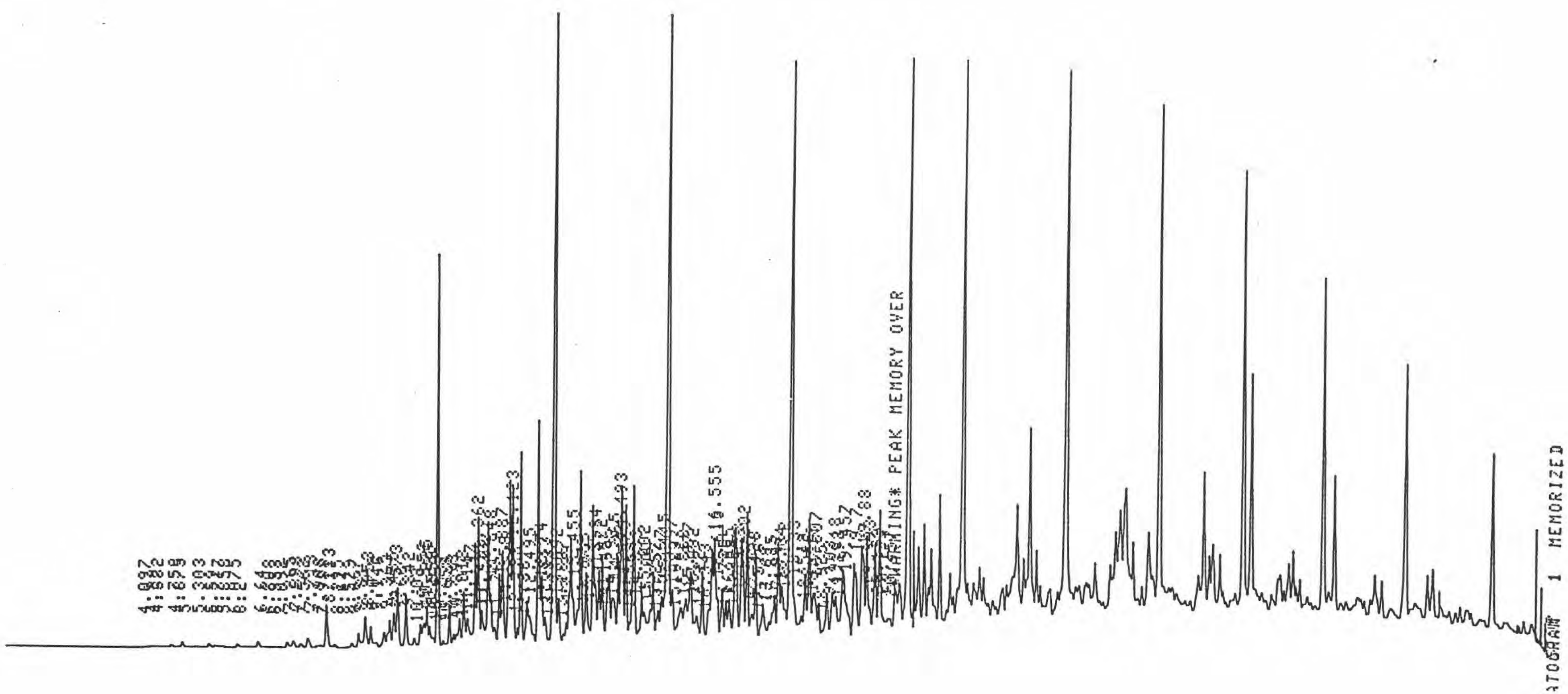
A5 Chromatogram of standard Benzene, Toluene, and Xylene at various concentrations







A6 The calibration curves of Benzene, Toluene, and Xylene



A7 Chromatogram of Diesel Fuel

APPENDIX B

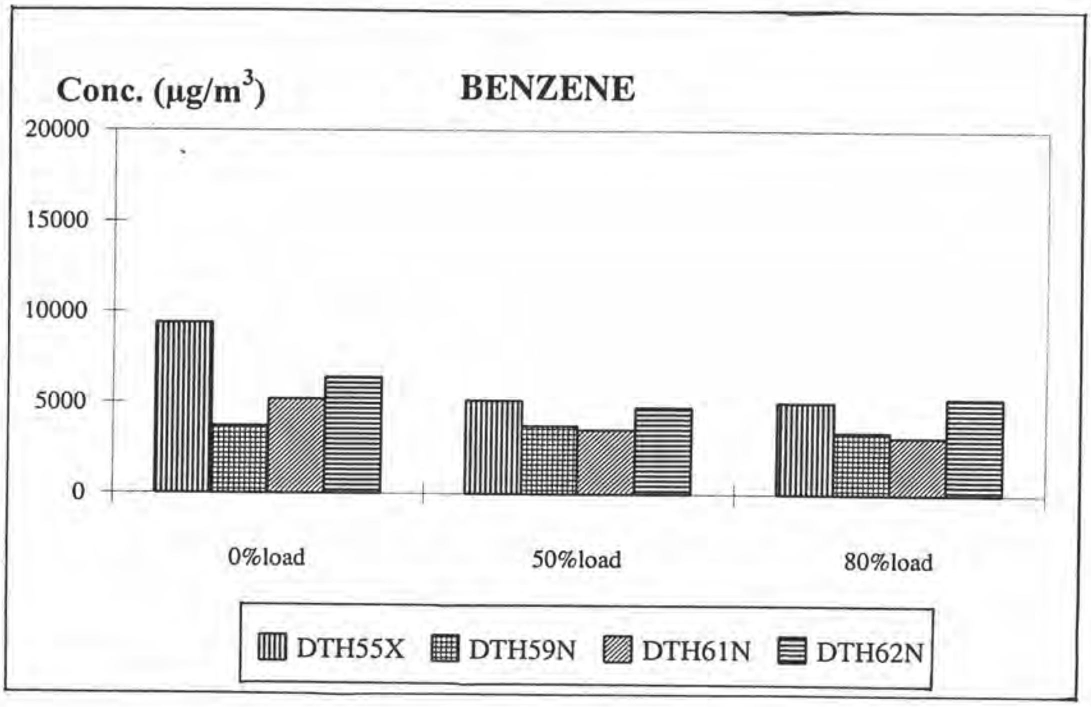


Figure B1 Effect of load on Benzene emissions

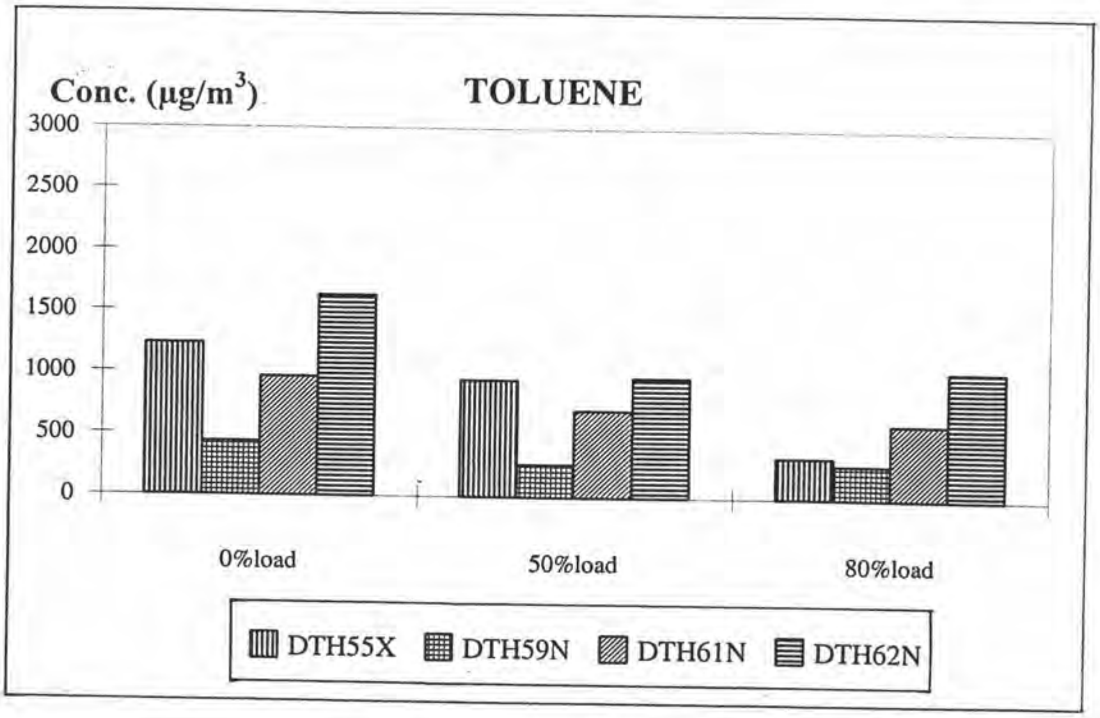


Figure B2 Effect of load on Toluene emissions

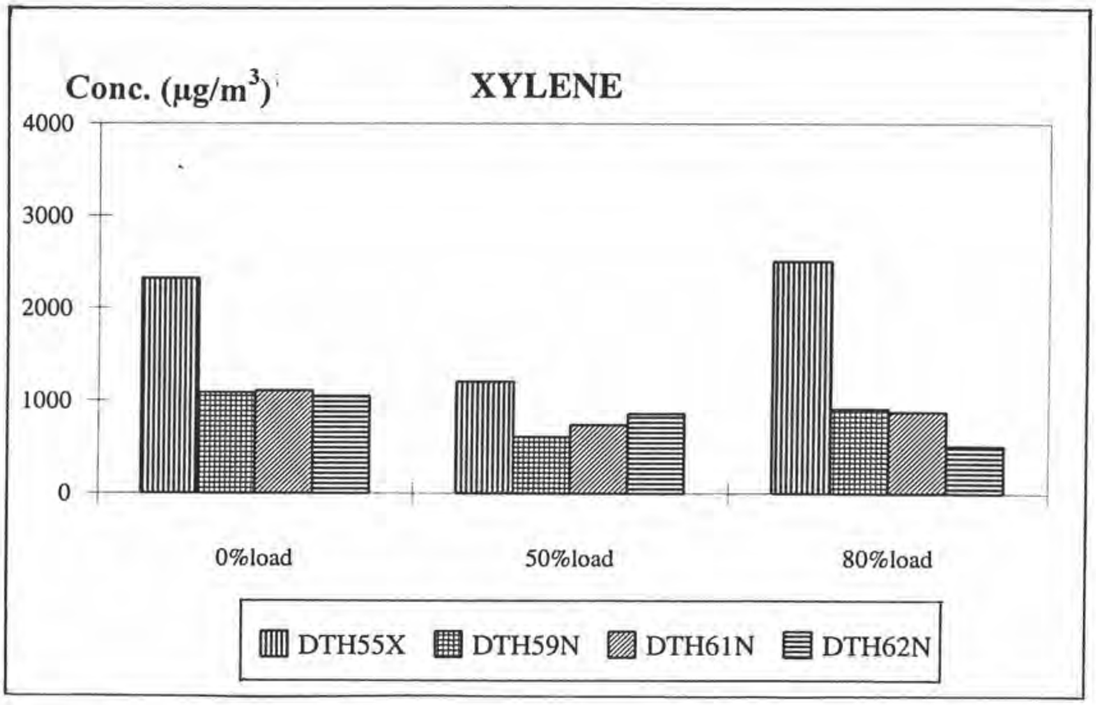


Figure B3 Effect of load on Xylene emissions

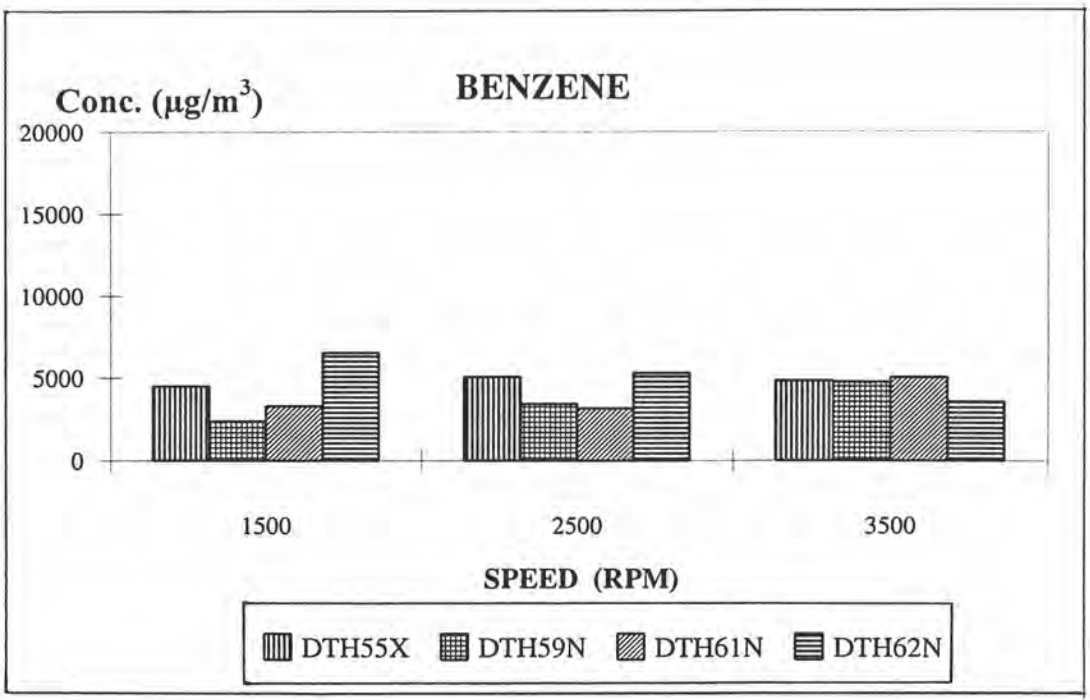


Figure B4 Effect of speed on Benzene emissions

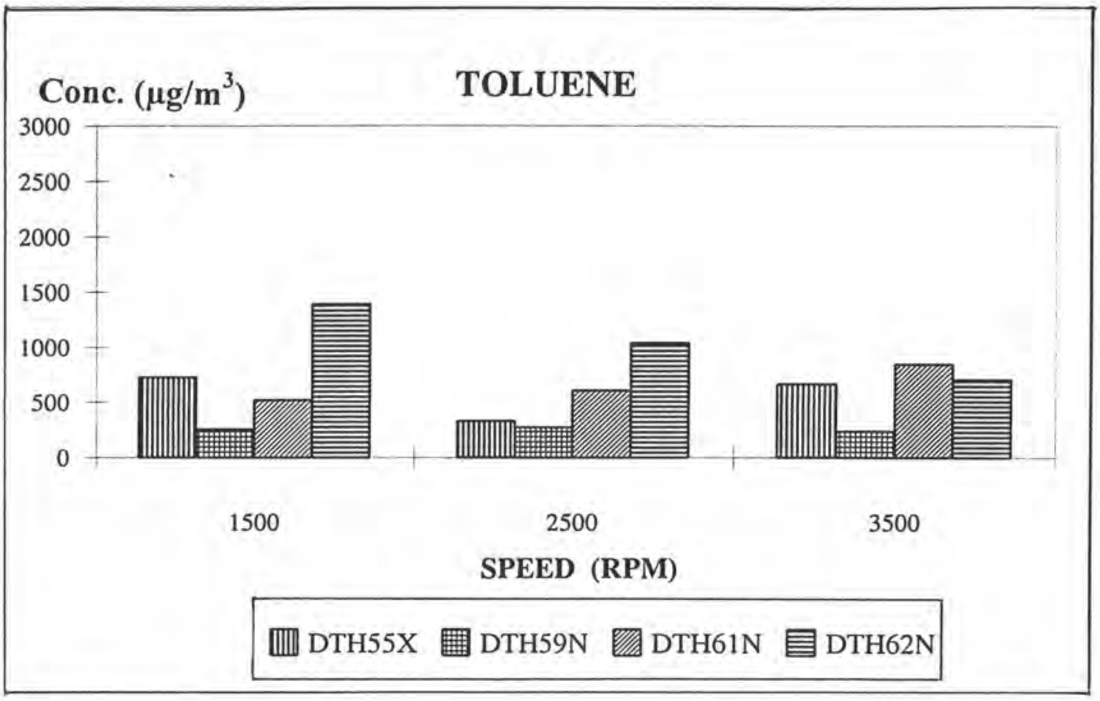


Figure B5 Effect of speed on Toluene emissions

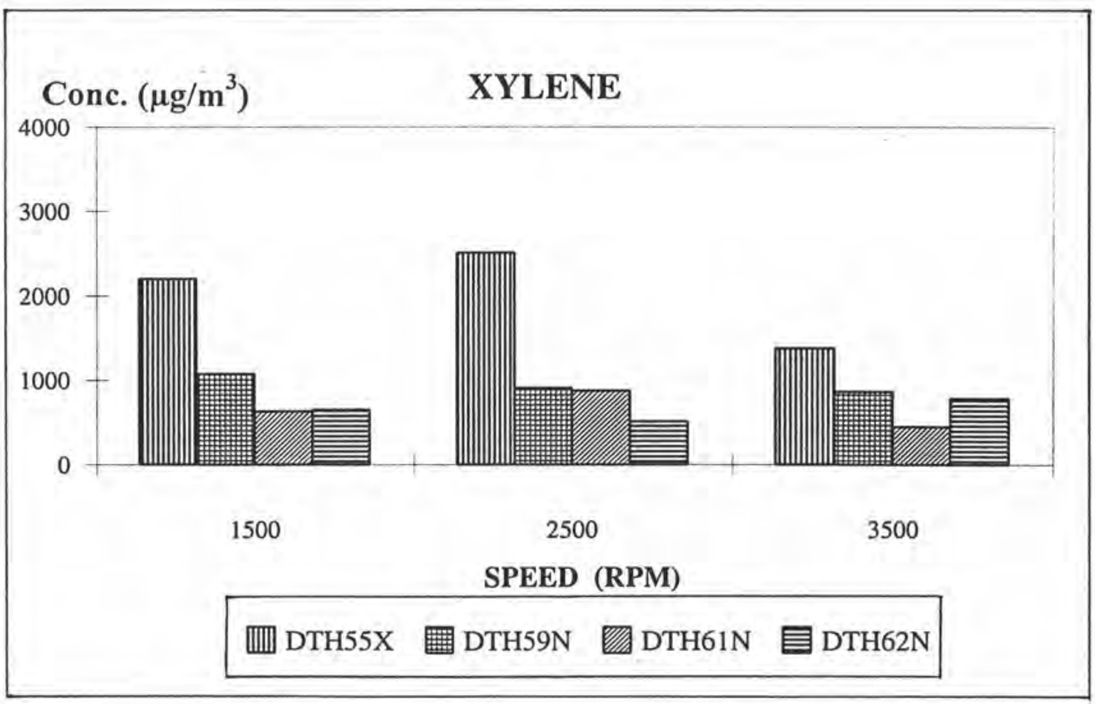


Figure B6 Effect of speed on Xylene emissions

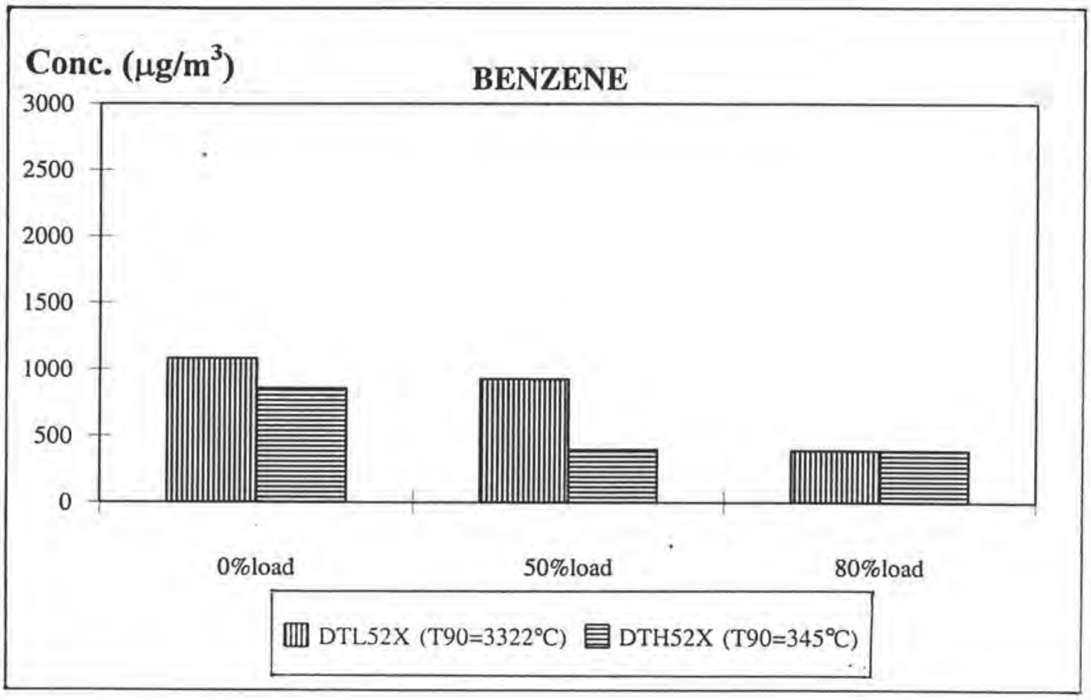


Figure B7 Effect of T90 on Benzene emissions

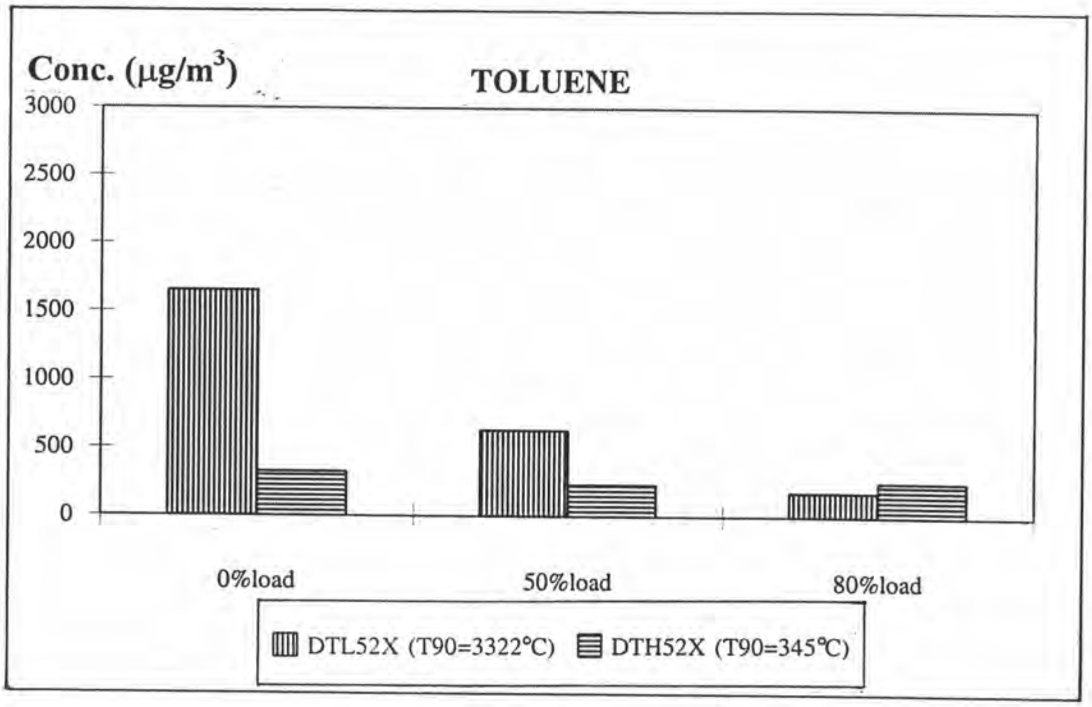


Figure B8 Effect of T90 on Toluene emissions

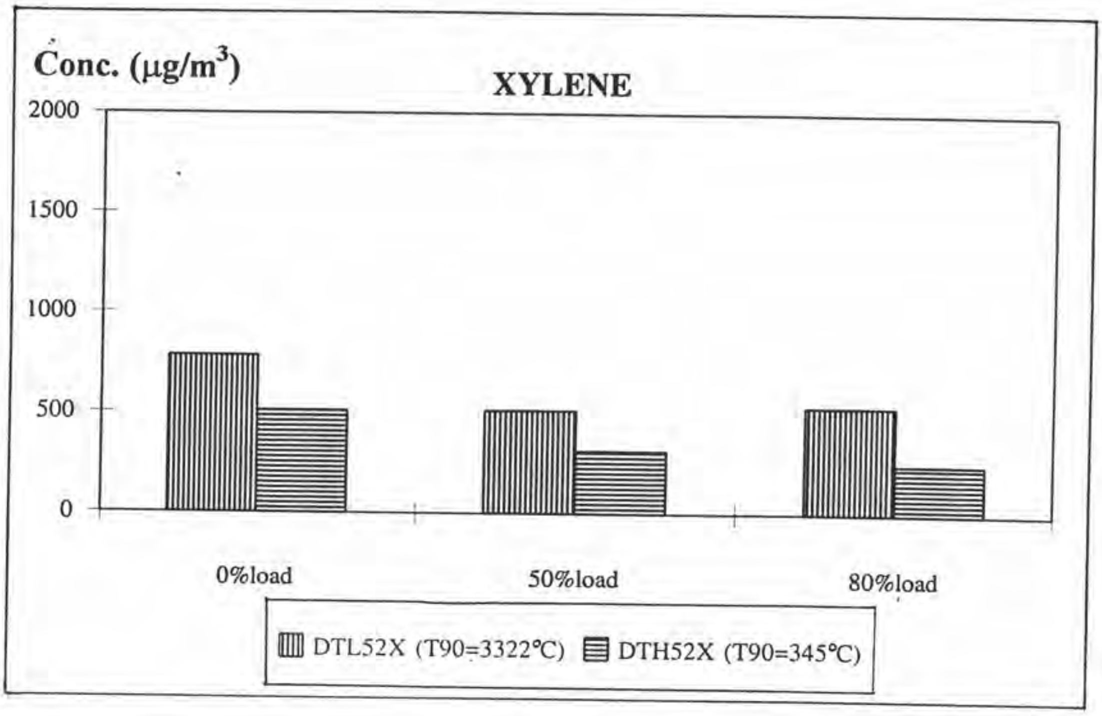


Figure B9 Effect of T90 on Xylene emissions

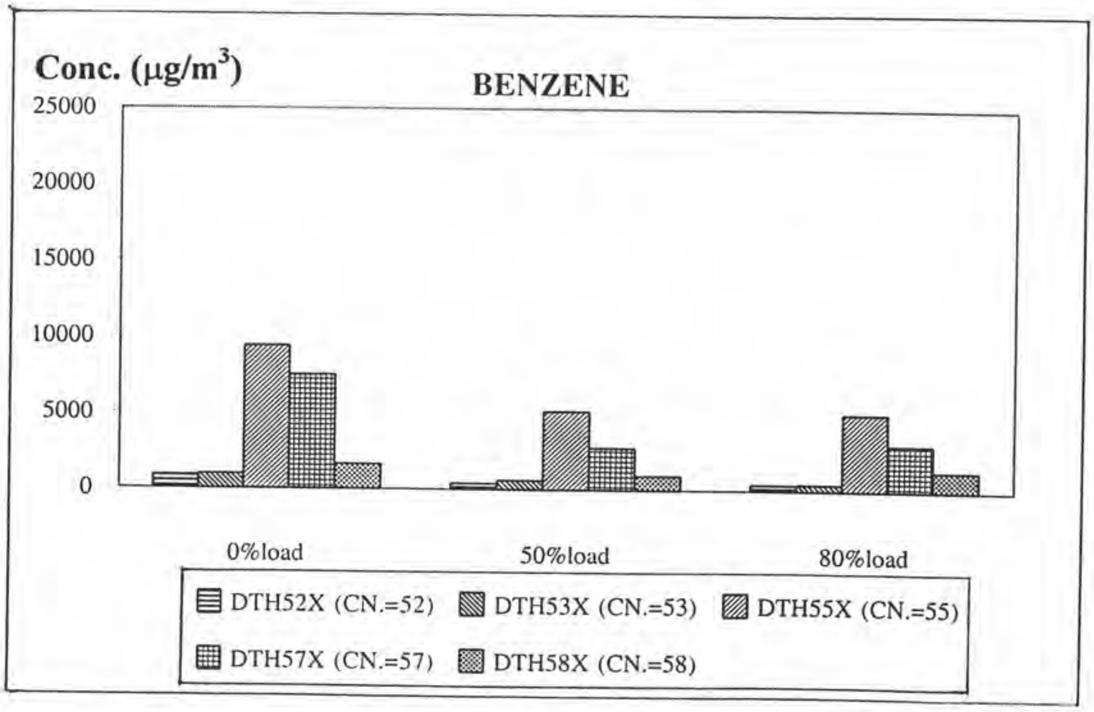


Figure B10 Effect of Cetane number on Benzene emissions

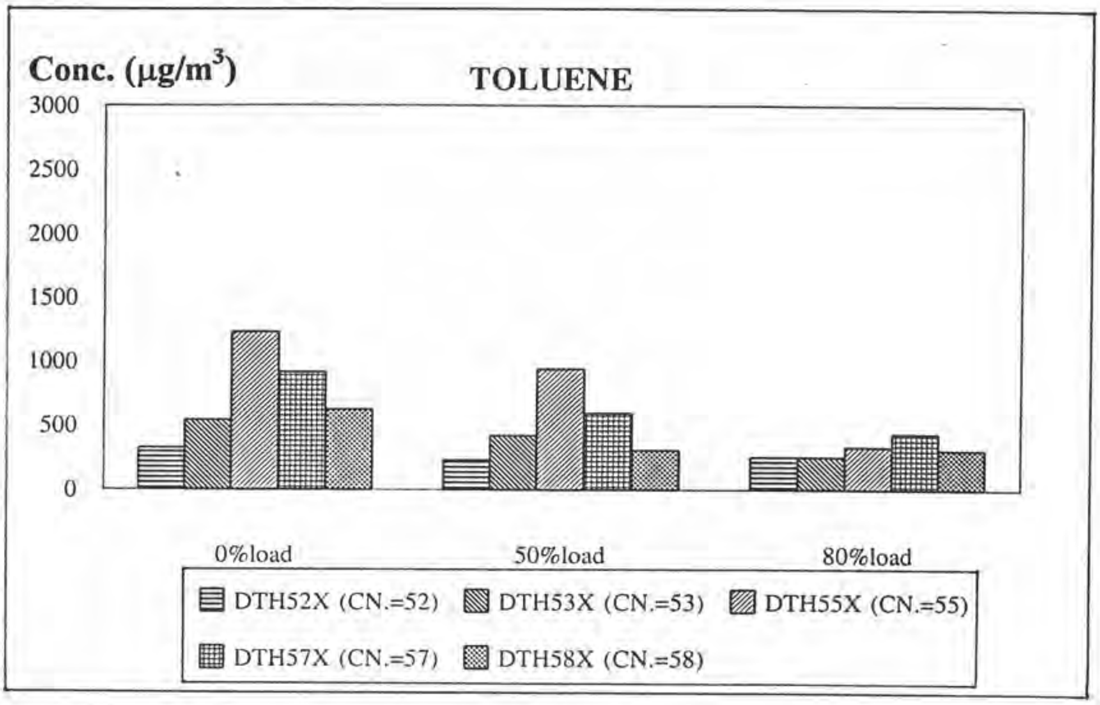


Figure B11 Effect of Cetane number on Toluene emissions

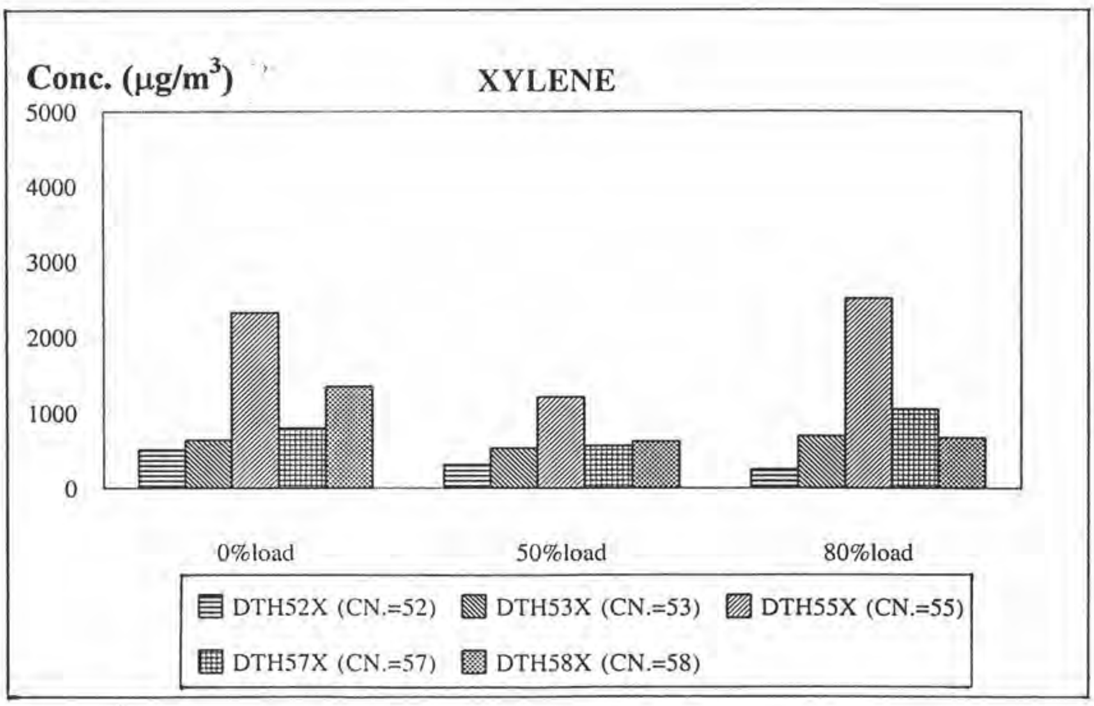


Figure B12 Effect of Cetane number on Xylene emissions

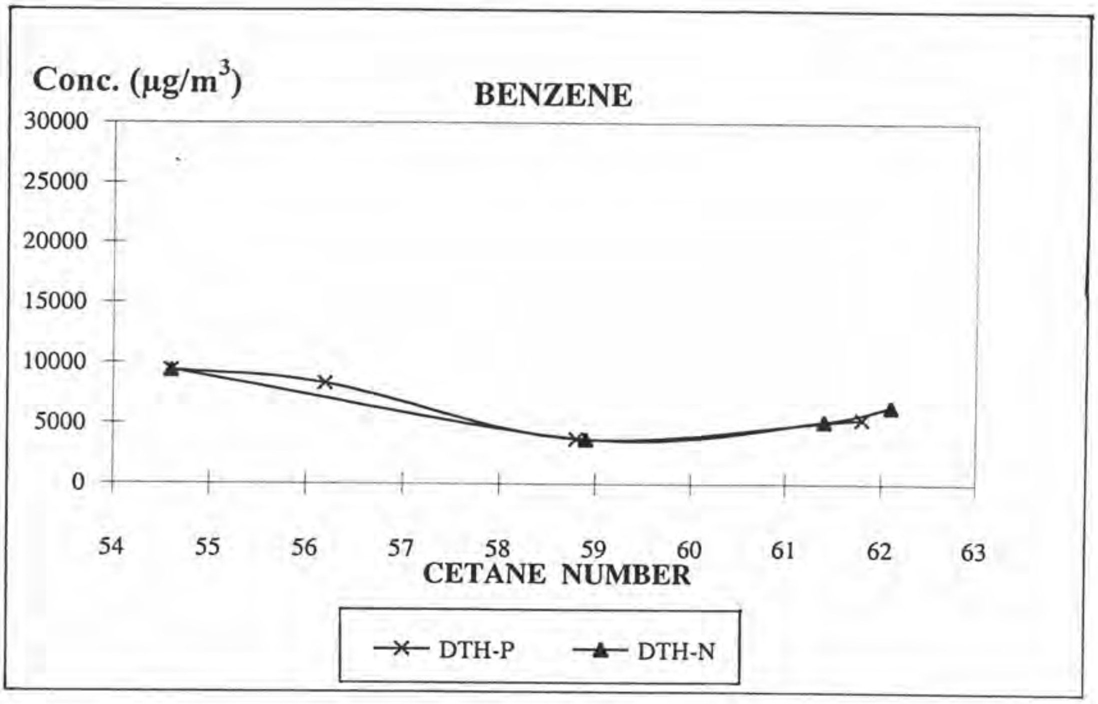


Figure B13 Effect of Cetane improver on Benzene emissions

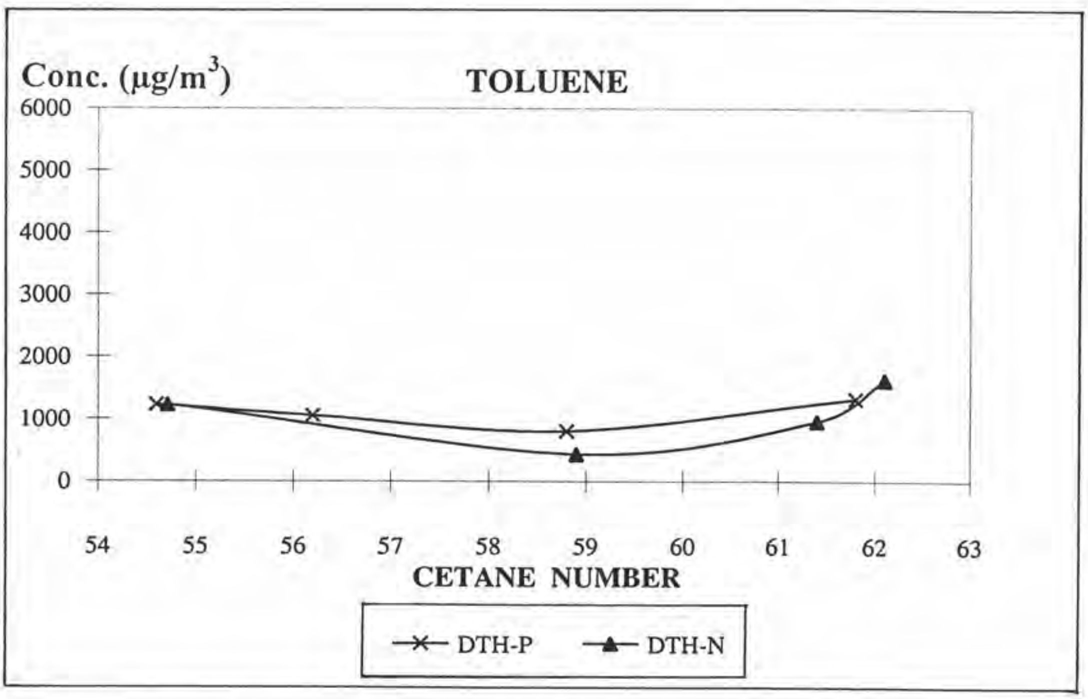


Figure B14 Effect of Cetane improver on Toluene emissions

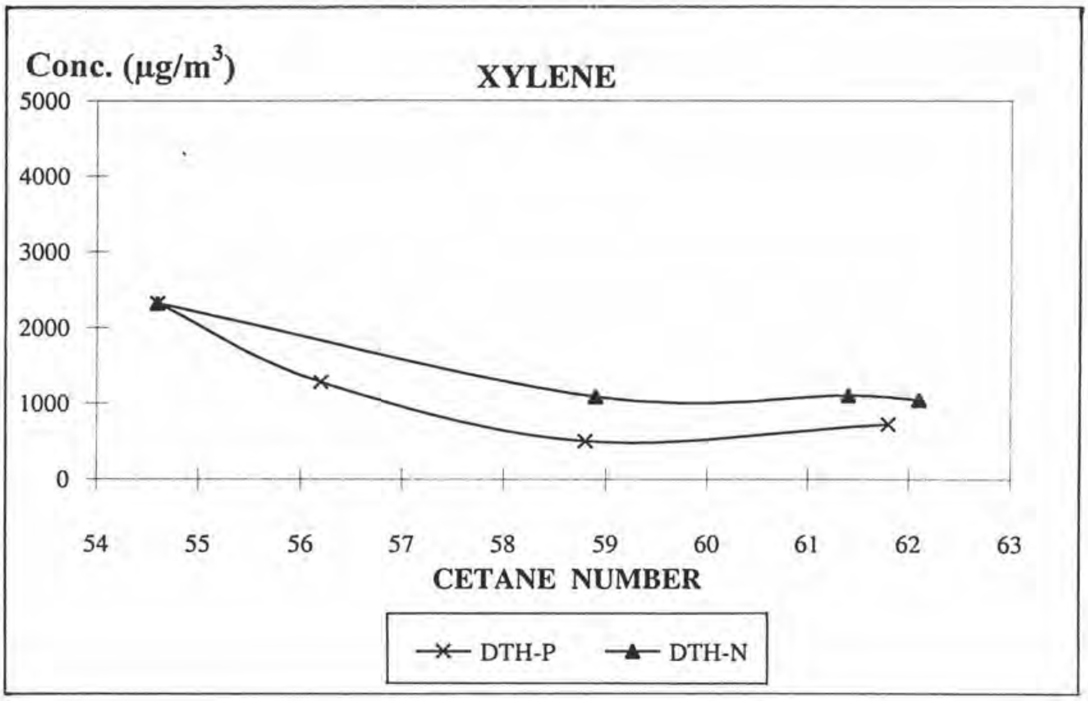


Figure B15 Effect of Cetane improver on Xylene emissions

APPENDIX C

Table C1 %compositions of hydrocarbons exhaust emission obtained from using DTH 55X fuel

Run No.	1	2	3	4	5	6	7	8	9
speed (rpm)	1500	1500	1500	2500	2500	2500	3500	3500	3500
%load	0	50	80	0	50	80	0	50	80
Composition, %									
total paraffins	22.87	16.67	19.73	21.18	20.27	24.65	25.47	20.21	16.73
total olefins	0.99	2.28	1.54	4.21	1.91	1.47	5.04	3.15	4.20
total napthtenes	2.81	2.89	1.56	3.85	3.00	1.80	3.98	1.23	4.38
total aromatics	73.33	78.15	77.18	70.76	74.82	72.07	65.51	75.41	70.51
C4	5.50	4.33	3.41	7.10	3.82	2.74	9.47	6.42	4.04
C6	3.90	4.24	3.12	5.95	4.69	3.21	7.48	5.00	17.24
C7	5.32	5.20	3.37	7.76	8.02	4.71	7.94	4.61	5.99
C8	9.23	9.58	8.17	12.27	8.60	10.35	8.31	6.23	7.71
C9	28.54	25.58	25.49	26.70	25.80	26.18	22.27	23.93	24.00
C10	34.99	36.46	42.46	29.35	34.45	39.34	30.77	37.15	29.62
C11	9.45	12.97	13.97	9.53	12.76	11.88	11.93	14.88	10.24

Table C2 %compositions of hydrocarbons exhaust emission obtained from using DTL 52X fuel

Run No.	1	2	3	4	5	6	7	8	9
speed (rpm)	1500	1500	1500	2500	2500	2500	3500	3500	3500
%load	0	50	80	0	50	80	0	50	80
Composition, %									
total paraffins	28.16	21.55	22.31	21.15	16.93	16.27	15.97	13.37	14.00
total olefins	2.09	1.12	0.75	1.44	1.42	1.76	2.41	7.70	1.47
total napthtenes	1.21	1.65	0.80	2.02	1.01	0.52	1.92	0.71	0.00
total aromatics	68.54	75.67	76.14	75.09	80.63	81.45	79.70	84.22	83.74
C4	0.23	1.59	1.08	2.22	2.01	1.63	2.97	2.00	1.39
C6	11.61	4.13	3.09	4.82	5.25	5.79	4.78	5.05	6.05
C7	0.81	1.93	1.16	2.86	3.06	1.50	4.46	1.61	1.80
C8	1.90	2.74	1.77	3.42	2.88	1.29	3.09	1.52	1.08
C9	22.42	23.97	20.26	15.78	21.57	23.25	20.33	21.09	22.12
C10	41.64	49.66	56.43	48.09	45.24	45.12	44.25	50.01	45.64
C11	16.75	12.61	12.90	20.21	17.17	18.22	17.69	16.08	17.62

Table C3 %compositions of hydrocarbons exhaust emission obtained from using DTH 58X fuel

Run No.	1	2	3	4	5	6	7	8	9
speed (rpm)	1500	1500	1500	2500	2500	2500	3500	3500	3500
%load	0	50	80	0	50	80	0	50	80
Composition, %									
total paraffins	20.81	14.72	18.13	21.82	13.60	20.27	22.84	13.27	21.08
total olefins	1.02	3.40	1.62	2.49	2.72	2.48	4.23	2.96	1.45
total napthtenes	1.63	2.84	1.24	3.00	1.70	1.52	3.41	1.79	1.62
total aromatics	76.55	79.00	79.02	72.70	81.99	75.74	69.33	81.98	75.85
C4	1.51	2.25	1.17	3.54	1.82	1.28	5.40	1.79	1.71
C6	2.52	7.89	3.01	5.64	4.91	7.09	7.55	6.95	5.96
C7	1.81	3.17	1.26	3.36	2.13	2.12	4.79	2.35	3.30
C8	3.42	5.31	2.34	5.02	3.58	3.19	6.57	3.60	3.94
C9	23.64	25.18	20.64	24.35	21.23	25.14	19.64	23.23	16.58
C10	47.23	38.57	56.32	42.23	51.48	43.58	39.02	46.67	51.73
C11	16.12	17.15	15.00	15.14	14.66	17.28	16.51	15.07	16.78

Table C4 %compositions of hydrocarbons exhaust emission obtained from using DTH 57X fuel

Run No.	1	2	3	4	5	6	7	8	9
speed (rpm)	1500	1500	1500	2500	2500	2500	3500	3500	3500
%load	0	50	80	0	50	80	0	50	80
Composition, %									
total paraffins	25.57	26.69	17.34	18.59	20.30	14.92	24.01	15.84	16.84
total olefins	5.63	3.91	4.44	13.58	4.67	6.49	4.47	1.88	0.89
total napthtenes	3.61	3.89	1.91	15.12	9.17	5.83	2.99	1.38	1.37
total aromatics	67.20	69.52	76.32	52.72	65.87	72.76	68.53	80.98	80.89
C4	3.78	3.28	2.23	2.95	1.17	1.71	4.43	2.66	0.89
C6	7.42	9.59	7.91	26.22	9.19	12.55	6.70	5.96	6.31
C7	4.05	4.26	2.70	15.18	9.18	5.78	3.30	2.08	2.28
C8	5.40	5.26	3.02	4.45	2.59	2.91	4.83	3.27	4.77
C9	22.06	21.80	17.19	14.92	17.26	20.93	21.16	24.98	23.25
C10	41.29	42.08	54.36	25.84	48.12	40.22	43.55	46.19	34.76
C11	15.39	13.09	12.30	9.81	12.18	15.66	15.51	14.51	27.28

APPENDIX D

Table D1 Concentration of exhaust emissions obtained from using DTH52X fuel

Condition No.	3	4	5	6	9
speed (rpm)	1500	2500	2500	2500	3500
%load	80	0	50	80	80
emissions					
NO_X (ppm)	497	126	357	649	880
Total HC (ppm)	109.5	132.7	104.7	109.3	125
%CO	0.02	0.04	0.02	0.02	0.02
Benzene(μg/m3)	649	857	397	390	1179
Toluene(μg/m3)	354	325	230	252	312
m,p-Xylene(μg/m3)	596	278	189	96	490
o-Xylene(μg/m3)	269	231	123	152	169

Table D2 Concentration of exhaust emissions obtained from using DTH53X fuel

condition No.	3	4	5	6	9
speed (rpm)	1500	2500	2500	2500	3500
%load	80	0	50	80	80
emissions					
NO_X (ppm)	492	138	428	584	920
Total HC (ppm)	99.2	125.4	100.1	101.6	109.5
%CO	0.02	0.045	0.02	0.02	0.02
Benzene(μg/m3)	440	956	597	434	363
Toluene(μg/m3)	308	542	421	252	286
m,p-Xylene(μg/m3)	534	325	396	546	435
o-Xylene(μg/m3)	244	315	133	146	191

Table D3 Concentration of exhaust emissions obtained from using DTH55X fuel

Condition No.	1	2	3	4	5	6	7	8	9
speed (rpm)	1500	1500	1500	2500	2500	2500	3500	3500	3500
%load	0	50	80	0	50	80	0	50	80
emissions									
NO_X (ppm)	128	424	570	150	554	754	168	562	1090
Total HC (ppm)	119.8	106.6	99.5	125.4	99.0	96.3	130.8	101.2	111.1
%CO	0.03	0.03	0.02	0.045	0.02	0.02	0.06	0.03	0.03
Benzene(μg/m3)	3494	1650	4500	9390	5140	5050	2493	3272	4818
Toluene(μg/m3)	905	794	727	1231	944	330	493	474	663
m,p-Xylene(μg/m3)	1133	1252	790	1367	682	1357	597	316	791
o-Xylene(μg/m3)	1097	1014	1411	953	527	1150	824	247	588

Table D4 Concentration of exhaust emissions obtained from using DTH58X fuel

Condition No.	1	2	3	4	5	6	7	8	9
speed (rpm)	1500	1500	1500	2500	2500	2500	3500	3500	3500
%load	0	50	80	0	50	80	0	50	80
emissions									
NO_X (ppm)	127	327	512	150	311	521	197	511	1010
Total HC (ppm)	141.0	121.7	118.4	171.3	111.1	121.4	182.1	141.6	145.2
%CO	0.02	0.01	0.02	0.03	0.015	0.015	0.05	0.01	0.02
Benzene(µg/m3)	7892	1662	1352	1626	929	1311	1753	1650	1418
Toluene(µg/m3)	444	442	376	624	308	306	763	368	419
m,p-Xylene(µg/m3)	837	655	812	937	421	513	770	476	337
o-Xylene(µg/m3)	426	287	379	415	203	151	328	219	81

Table D5 Concentration of exhaust emissions obtained from using DTH57X fuel

Condition No.	1	2	3	4	5	6	7	8	9
speed (rpm)	1500	1500	1500	2500	2500	2500	3500	3500	3500
%load	0	50	80	0	50	80	0	50	80
emissions									
NO_X (ppm)	140	309	526	155	299	485	170	309	880
Total HC (ppm)	123.0	114.0	111.0	135.0	92.0	94.0	129.0	114.0	125.0
%CO	0.01	0.02	0.01	0.035	0.01	0.015	0.04	0.02	0.02
Benzene(µg/m3)	1254	1352	1391	7501	2743	2999	1889	7801	1179
Toluene(µg/m3)	462	297	273	919	596	433	563	202	312
m,p-Xylene(µg/m3)	448	239	596	567	471	709	992	305	490
o-Xylene(µg/m3)	177	247	97	233	92	337	412	135	169

Table D6 Concentration of exhaust emissions obtained from using DTL52X fuel

Condition No.	1	2	3	4	5	6	7	8	9
speed (rpm)	1500	1500	1500	2500	2500	2500	3500	3500	3500
%load	0	50	80	0	50	80	0	50	80
emissions									
NO_X (ppm)	127	333	524	178	392	743	186	526	980
Total HC (ppm)	114.8	111.0	115.0	124.8	94.2	98.2	148.5	109.3	124.4
%CO	0.03	0.02	0.02	0.04	0.01	0.01	0.06	0.02	0.02
Benzene(µg/m3)	4530	885	480	1083	928	390	1528	1593	1011
Toluene(µg/m3)	419	347	259	1650	629	177	287	251	326
m,p-Xylene(µg/m3)	753	394	375	473	340	162	200	228	176
o-Xylene(µg/m3)	393	208	197	310	172	369	193	109	210

Table D7 Concentration of exhaust emissions obtained from using DTL56N fuel

Condition No.	1	2	3	4	5	6	7	8	9
speed (rpm)	1500	1500	1500	2500	2500	2500	3500	3500	3500
%load	0	50	80	0	50	80	0	50	80
emissions									
NO_X (ppm)	116	322	517	155	478	719	187	544	1010
Total HC (ppm)	128.5	110.8	110.0	116.3	101.2	114.1	125.2	105.2	118.8
%CO	0.02	0.02	0.01	0.04	0.02	0.02	0.04	0.01	0.02
Benzene(μg/m3)	3600	555	531	787	412	592	1590	1431	640
Toluene(μg/m3)	1021	688	728	981	610	692	940	496	690
m,p-Xylene(μg/m3)	1750	1946	2914	835	1801	1312	1315	1542	1506
o-Xylene(μg/m3)	2711	1505	2580	584	1587	1879	1078	807	1254

Table D8 Concentration of exhaust emissions obtained from using DTL58N fuel

Condition No.	1	2	3	4	5	6	7	8	9
speed (rpm)	1500	1500	1500	2500	2500	2500	3500	3500	3500
%load	0	50	80	0	50	80	0	50	80
emissions									
NO_X (ppm)	115	323	531	162	440	712	175	473	970
Total HC (ppm)	123.3	102.9	97.5	112.5	96.4	99.4	151.5	117.2	139.3
%CO	0.02	0.02	0.01	0.03	0.02	0.02	0.05	0.03	0.03
Benzene(μg/m3)	3229	687	482	618	817	400	1575	2959	669
Toluene(μg/m3)	3320	2695	3323	2255	1939	1833	2531	1574	2103
m,p-Xylene(μg/m3)	9784	3609	4843	846	2442	5031	5006	3652	2675
o-Xylene(μg/m3)	4420	3423	6315	521	1666	3552	3466	1703	1874

Table D9 Concentration of exhaust emissions obtained from using DTL60N fuel

Condition No.	1	2	3	4	5	6	7	8	9
speed (rpm)	1500	1500	1500	2500	2500	2500	3500	3500	3500
%load	0	50	80	0	50	80	0	50	80
emissions									
NO_X (ppm)	115	336	543	165	462	751	183	480	950
Total HC (ppm)	115.6	107.4	99.2	111.4	93.3	95.2	127.3	112.5	1350
%CO	0.01	0.01	0.01	0.03	0.01	0.02	0.03	0.02	0.02
Benzene(μg/m3)	4763	597	622	521	519	589	1450	117.4	782
Toluene(μg/m3)	1145	1110	948	1253	1190	1060	1058	693	1451
m,p-Xylene(μg/m3)	3177	2590	1467	785	2565	3501	2800	1938	613
o-Xylene(μg/m3)	2535	1364	1107	456	1359	2853	1895	1102	544

Table D10 Concentration of exhaust emissions obtained from using DTH59N fuel

Condition No.	3	4	5	6	9
speed (rpm)	1500	2500	2500	2500	3500
%load	80	0	50	80	80
emissions					
NO_X (ppm)	500	135	446	725	1020
Total HC (ppm)	140.1	128.1	103.5	103.5	135.4
%CO	0.02	0.04	0.02	0.02	0.02
Benzene(μg/m3)	2399	3705	3755	3424	4737
Toluene(μg/m3)	256	434	264	273	234
m,p-Xylene(μg/m3)	665	682	451	560	551
o-Xylene(μg/m3)	412	405	160	351	315

Table D11 Concentration of exhaust emissions obtained from using DTH61N fuel

Condition No.	3	4	5	6	9
speed (rpm)	1500	2500	2500	2500	3500
%load	80	0	50	80	80
emissions					
NO_X (ppm)	472	145	405	700	990
Total HC (ppm)	97.0	118.7	95.0	96.3	126.0
%CO	0.01	0.04	0.02	0.02	0.03
Benzene(μg/m3)	3300	5190	3541	3161	5040
Toluene(μg/m3)	512	961	704	606	842
m,p-Xylene(μg/m3)	467	779	495	591	306
o-Xylene(μg/m3)	167	328	246	285	145

Table D12 Concentration of exhaust emissions obtained from using DTH62N fuel

Condition No.	3	4	5	6	9
speed (rpm)	1500	2500	2500	2500	3500
%load	80	0	50	80	80
emissions					
NO_X (ppm)	501	170	444	720	1030
Total HC (ppm)	113.0	117.0	97.3	99.3	123.3
%CO	0.02	0.03	0.02	0.02	0.03
Benzene(μg/m3)	6519	6393	4760	5283	3561
Toluene(μg/m3)	1390	1630	969	1035	703
m,p-Xylene(μg/m3)	437	877	587	368	540
o-Xylene(μg/m3)	216	170	272	144	248

Table D13 Concentration of exhaust emissions obtained from using DTH56P fuel

Condition No.	3	4	5	6	9
speed (rpm)	1500	2500	2500	2500	3500
%load	80	0	50	80	80
emissions					
NO_X (ppm)	502	147	438	800	1030
Total HC (ppm)	97.5	120.1	97.5	94.2	110.6
%CO	0.02	0.05	0.03	0.03	0.03
Benzene(µg/m3)	7513	8312	8117	5890	6918
Toluene(µg/m3)	1758	1053	1715	1494	1581
m,p-Xylene(µg/m3)	755	860	605	667	764
o-Xylene(µg/m3)	352	422	242	271	287

Table D14 Concentration of exhaust emissions obtained from using DTH59P fuel

Condition No.	3	4	5	6	9
speed (rpm)	1500	2500	2500	2500	3500
%load	80	0	50	80	80
emissions					
NO_X (ppm)	478	144	420	663	835
Total HC (ppm)	104.5	121.0	100.0	67.2	144.0
%CO	0.01	0.04	0.02	0.02	0.03
Benzene(µg/m3)	963	3747	1929	2916	2553
Toluene(µg/m3)	286	800	403	528	496
m,p-Xylene(µg/m3)	535	353	217	358	259
o-Xylene(µg/m3)	1135	149	103	156	140

Table D15 Concentration of exhaust emissions obtained from using DTH62P fuel

Condition No.	3	4	5	6	9
speed (rpm)	1500	2500	2500	2500	3500
%load	80	0	50	80	80
emissions					
NO_X (ppm)	492	139	422	680	887
Total HC (ppm)	101.1	117.4	98.8	98.3	157.2
%CO	0.02	0.04	0.02	0.02	0.03
Benzene(µg/m3)	5760	5351	6078	5624	5330
Toluene(µg/m3)	1259	1319	1329	1180	1109
m,p-Xylene(µg/m3)	604	494	543	573	544
o-Xylene(µg/m3)	131	229	262	273	290

VITA

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