

LAMPIRAN

Lampiran 1. Kuantitas *Bio Oil*.

Persentase Katalis	CaO 0%	CaO 5%	CaO 10%	CaO 20%	CaO 30%
Cairan (g)	299,3	307	345,6	323	293
Arang (g)	264	266	262	292	258
Gas	436,7	427	392,4	385	449
Persentase (%)					
Cairan	29,93	30,7	34,56	32,3	29,3
Arang	26,4	26,6	26,2	29,2	25,8
Gas	43,67	42,7	39,24	38,5	44,9

Lampiran 2. Nilai densitas *Bio Oil*.

Persentase Katalis	CaO 0%	CaO 5%	CaO 10%	CaO 20%	CaO 30%
Massa (g)	302	310	347	326	291
	298	307	346	322	293
	298	304	344	321	295
Rata-rata berat (g)	299,3	307	345,6	323	293
Volume (ml)	400	375	400	370	330
Massa(kg)	0,2993	0,307	0,3456	0,323	0,293
Volume (m ³)	0,0004	0,000375	0,0004	0,00037	0,00033
Nilai densitas (kg/m ³)	748,25	818,7	864	873	887,9

Lampiran 3. Nilai pH *Bio Oil*.

Persentase Katalis	CaO 0%	CaO 5%	CaO 10%	CaO 20%	CaO 30%
Nilai pH	3,9	4,0	4,9	4,7	4,5
	3,3	3,8	3,7	4,1	4,8
	3,7	3,9	3,7	4,3	4,8
Rata-rata nilai pH	3,6	3,9	4,1	4,3	4,7

Lampiran 4. Nilai kalor *Bio Oil*.

No	Persentase Campuran	Massa Wadah ke-1 (Gram)	Massa Spesimen ke-1 (Gram)	Massa Wadah ke-2 (Gram)	Massa Spesimen ke-2 (Gram)
1	CaO 0%	13,4310	0,7191	13,4857	0,7230
2	CaO 5%	13,1934	0,7570	13,1874	0,7553
3	CaO 10%	13,4104	0,7213	13,5109	0,7312
4	CaO 20%	13,1852	0,7350	13,1962	0,7134
5	CaO 30%	13,1976	0,7305	13,2185	0,7275

Lampiran 5. Data Uji GCMS CaO 0%.

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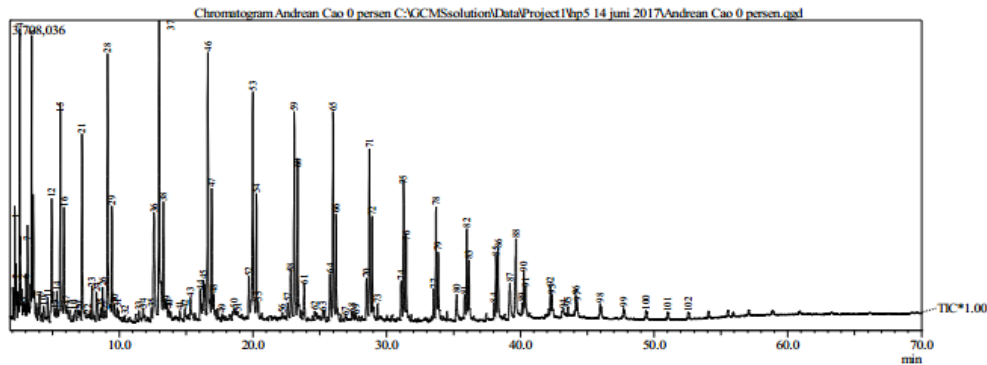
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Lab. Kimia Organik FMIPA - UGM

Sample Information

Analyzed by : Admin
 Sample Name : Andreas Cao 0 persen
 Sample ID : 08.17.04.04-01
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 Method File : C:\GCMSsolution\Data\Project1\Wp5 14 juni 2017\pyrolysis.qgm
 Tuning File : C:\GCMSsolution\System1\Tune1\juni 21 2017.qgt



Peak#	R. Time	L. Time	F. Time	Area	Area%	Height	Name
1	2.193	2.142	2.258	4067545	1.12	1282654	Pentane
2	2.292	2.258	2.375	1905315	0.52	579841	CH3C(O)O(CH2)3CH=CH2
3	2.406	2.375	2.475	1124597	0.31	291250	Cyclopentene
4	2.554	2.475	2.758	11220880	3.08	2965288	Cyclopropane, propyl- (CAS) Propylcyclopropane
5	2.831	2.758	2.942	1573575	0.43	198908	Cyclopentane, methyl- (CAS) Methylcyclopentane
6	3.029	2.942	3.092	2058868	0.56	526647	Cyclopentane, methylene- (CAS) Methylene-cyclopentane
7	3.138	3.092	3.208	3304716	0.91	1046922	Benzene (CAS) Phen
8	3.444	3.258	3.892	16918911	4.64	3276034	1-Heptane
9	4.042	3.892	4.175	1785997	0.49	312980	Cyclohexane, methyl-
10	4.345	4.275	4.508	1111975	0.30	176253	1,4-Heptadiene
11	4.649	4.508	4.758	1305362	0.36	273094	4-Penten-1-ol, 3-methyl- (CAS) 1-PENTEN-5-OL, 3-METHYL-
12	4.945	4.758	5.142	7980191	2.19	1438190	Toluene
13	5.192	5.142	5.258	705947	0.19	153810	Cyclohexene (CAS) Cyclohex-1-ene
14	5.328	5.258	5.392	1449366	0.40	354069	1,7-Octadiene
15	5.589	5.392	5.792	11100362	3.04	2563683	1-Octene (CAS) Caprylene
16	5.859	5.792	6.008	5651722	1.55	1350919	Octane
17	6.042	6.008	6.208	1422176	0.39	194870	2-Octene, (E)-
18	6.298	6.208	6.392	724347	0.20	134152	2-Octene, (Z)-
19	6.707	6.392	6.808	1473411	0.40	144731	Cyclooctene
20	6.977	6.808	7.125	1746607	0.48	138923	Cyclohexane, 1,2,4-trimethyl-
21	7.218	7.125	7.508	9465959	2.59	2131197	2,4-Dimethyl-1-heptene
22	7.625	7.508	7.892	1596565	0.44	87476	Cyclohexane, ethenyl- (CAS) Ethenylcyclohexane
23	7.955	7.892	8.075	1919483	0.53	423025	Benzene, ethyl- (CAS) EB
24	8.292	8.208	8.475	2563386	0.70	358331	1,3-Cyclopentadiene, 5-(1-methylethenylidene)- (CAS) 6,6-Dimethylfulvene
25	8.608	8.475	8.692	1116234	0.31	166970	Cyclohexanemethanol (CAS) Cyclohexylmethanol
26	8.754	8.692	8.825	1527521	0.42	402963	Cyclopropane, 1,1'-(1,2-ethanediyl)bis- (CAS) Ethane, 1,2-dicyclopropyl-
27	8.906	8.825	8.958	789969	0.22	133451	4-Nonene
28	9.127	8.958	9.308	14875564	4.08	3142063	1-Nonene (CAS) n-Non-1-ene
29	9.452	9.308	9.592	6439353	1.77	1313618	Nonane
30	9.642	9.592	9.708	946771	0.26	213485	4-Nonene
31	9.855	9.708	10.008	1721166	0.47	168996	Cyclohexane, 2-propenyl-
32	10.422	10.008	10.558	1087956	0.30	80859	Cyclopropane, 1,1'-(1,2-ethanediyl)bis- (CAS) Ethane, 1,2-dicyclopropyl-
33	11.475	11.375	11.642	773636	0.21	131014	Benzene, propyl-
34	11.781	11.642	11.975	1272892	0.35	151559	Benzene, 1-ethyl-2-methyl- (CAS) o-Ethyltoluene
35	12.408	12.308	12.475	831071	0.23	155890	Benzene, 1,2,3-trimethyl-
36	12.597	12.475	12.825	9748696	2.67	1283395	Phenol (CAS) lnal
37	12.985	12.825	13.225	19068592	5.23	3451605	1-Decene
38	13.299	13.225	13.392	5681524	1.56	1351203	Decane
39	13.558	13.392	13.642	2178826	0.60	192367	Octadecane, 1-chloro-
40	13.708	13.642	13.808	833955	0.23	126639	Heptane, 5-ethyl-2-methyl-
41	14.533	14.425	14.792	767805	0.21	118693	Benzene, 1-propenyl- (CAS) Propenylbenzene
42	14.898	14.792	15.075	1079050	0.30	143922	Indene
43	15.326	15.208	15.592	2292549	0.63	285918	3-Octen-1-yne, (E)-
44	16.056	15.792	16.158	2214646	0.61	371718	1-Octanol, 3,7-dimethyl- (CAS) 3,7-Dimethyl-1-octanol
45	16.299	16.158	16.492	5174260	1.42	469836	1,9-Decadiene
46	16.628	16.492	16.842	15264714	4.18	3084893	1-Decene (CAS) Deco-1-ene
47	16.919	16.842	17.008	6274002	1.72	1530085	Octane, 2,4,6-trimethyl-
48	17.058	17.008	17.142	1439014	0.39	312838	5-Undecene, (E)-
49	17.697	17.458	18.042	825278	0.23	78129	Octadecane, 1-chloro-
50	18.595	18.392	18.725	1635378	0.45	128339	Benzene, (1-methyl-2-cyclopropen-1-yl)- (CAS) CYCLOPROPENE, 3-METHYL-3-PHENYL-
51	18.842	18.725	18.942	945072	0.26	93096	1H-Indene, 1-methyl- (CAS) 1-Methylindene
52	19.689	19.592	19.792	2504326	0.69	508952	1,9-Decadiene
53	19.984	19.792	20.175	14317768	3.93	2605836	1-Decene
54	20.250	20.175	20.342	5833975	1.60	1413723	Octane, 2,4,6-trimethyl-
55	20.392	20.342	20.492	850979	0.23	213671	5-Dodecene, (E)- (CAS)
56	22.158	22.025	22.508	839873	0.23	58742	Bicyclo 3.1.1 heptan-3-ol, 6,6-dimethyl-2-methylene-, 1S-(1.alpha.,3.alpha.,5.alpha.)
57	22.592	22.508	22.725	1142752	0.31	204102	Benzene, 1,4-dimethoxy-2-methyl-
58	22.829	22.725	22.958	3027409	0.83	578139	1,13-Tetradecadiene
59	23.092	22.958	23.258	11196281	3.07	2436776	1-Tridecanol

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Peak#	R.Time	LTime	F.Time	Area	Area%	Height	Name
60	23.339	23.258	23.525	8355898	2.29	1874192	Heptadecane, 2,6-dimethyl-
61	23.832	23.658	23.975	2273405	0.62	422738	1-Hexadecene (CAS) Cetene
62	24.610	24.525	24.808	1150415	0.32	116954	1-Undecene, 7-methyl- (CAS)
63	25.227	25.042	25.292	1000804	0.27	118718	3,5-Octadiene, 2,2,4,5,7,7-hexamethyl-, (E,Z)- (CAS) CIS, TRANS-2,2,4,5,7,7-HEXAMETHYLOCTA-3
64	25.753	25.658	25.892	3000265	0.82	558198	1,13-Tetradecadiene
65	25.993	25.892	26.125	11037470	3.03	2493369	1-Tridecanol
66	26.209	26.125	26.508	6006881	1.65	1284824	Octane, 2,4,6-trimethyl- (CAS)
67	26.892	26.692	27.342	969900	0.27	60145	7-Tetradecene
68	27.391	27.342	27.542	716415	0.20	99770	2-Cyclohexen-1-one, 2-hydroxy-6-methyl-3-(1-methylethyl)-
69	27.725	27.542	27.808	707539	0.19	72801	1-Tetradecanol (CAS) Alfol 14
70	28.493	28.408	28.608	2386998	0.65	501226	11-dodecanol
71	28.711	28.608	28.842	9265676	2.54	2011063	1-Pentadecene (CAS) Pentadec-1-ene
72	28.909	28.842	29.175	5126103	1.41	1213612	Octane, 2,4,6-trimethyl-
73	29.314	29.175	29.408	763394	0.21	184437	2-Hexyl-1-decanol
74	31.077	30.992	31.175	2196672	0.60	462550	1,15-Pentadecanediol
75	31.271	31.175	31.392	7159053	1.96	1647042	1-Tridecanol
76	31.458	31.392	31.608	4218446	1.16	990841	Octane, 2,4,6-trimethyl- (CAS)
77	33.516	33.425	33.608	1737770	0.48	367592	1,15-Pentadecanediol
78	33.694	33.608	33.775	5645610	1.55	1330163	1-Tetradecene
79	33.859	33.775	34.025	3986056	1.09	817586	Tridecane
80	35.240	35.075	35.425	2251260	0.62	314697	Tetradecanoic acid
81	35.831	35.708	35.908	1292970	0.35	274937	1,15-Pentadecanediol
82	35.994	35.908	36.075	4485196	1.23	1069283	1-Octadecene
83	36.145	36.075	36.325	3188696	0.87	685904	PENTADECANE, 2,6,10-TRIMETHYL-
84	38.033	37.908	38.108	836417	0.23	189144	1,15-Pentadecanediol
85	38.180	38.108	38.258	3132604	0.86	735336	1-Docosene
86	38.328	38.258	38.525	3819552	1.05	837034	Dodecane, 2-methyl-
87	39.219	39.075	39.475	3756420	1.03	435352	Oleic Acid
88	39.673	39.475	39.875	6808738	1.87	953827	Hexadecanoic acid (CAS) Palmitic acid
89	40.129	39.875	40.192	1226912	0.34	175957	1,15-Pentadecanediol
90	40.263	40.192	40.325	2385649	0.65	549865	1-Docosene
91	40.389	40.325	40.558	1764864	0.48	359110	Decane, 6-ethyl-2-methyl-
92	42.250	42.008	42.308	1896929	0.52	348080	1-Docosene
93	42.364	42.308	42.575	1472685	0.40	264463	Heptadecane (CAS) n-Heptadecane
94	43.196	42.992	43.308	934400	0.26	98696	9-Octadecenoic acid (Z)- (CAS) Oleic acid
95	43.559	43.308	43.742	800794	0.22	113071	Nonadecanoic acid (CAS)
96	44.148	44.092	44.208	883027	0.24	222202	1-Docosene
97	44.258	44.208	44.425	689704	0.19	164187	Hexadecane (CAS) n-Hexadecane
98	45.970	45.842	46.208	1151710	0.32	156873	CYCLOEICOSANE
99	47.716	47.542	47.908	1136874	0.31	127975	1-Docosene
100	49.392	49.225	49.625	917716	0.25	108942	5-Eicosene, (E)- (CAS)
101	51.005	50.842	51.225	831172	0.23	93627	1-Heptacosanol
102	52.548	52.408	52.758	713733	0.20	81430	Nonacosanol
				364778312	100.00	72494545	

Lampiran 6. Data Uji GCMS CaO 30%.

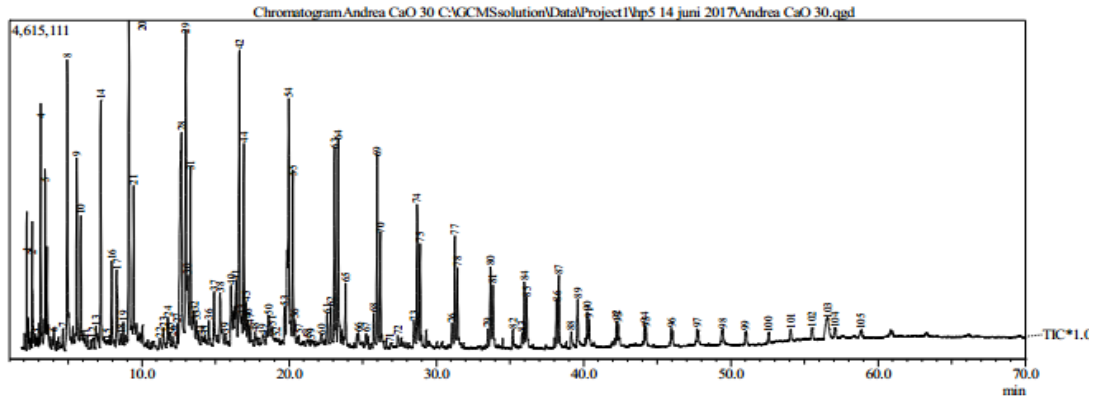
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Lab. Kimia Organik FMIPA - UGM

Sample Information

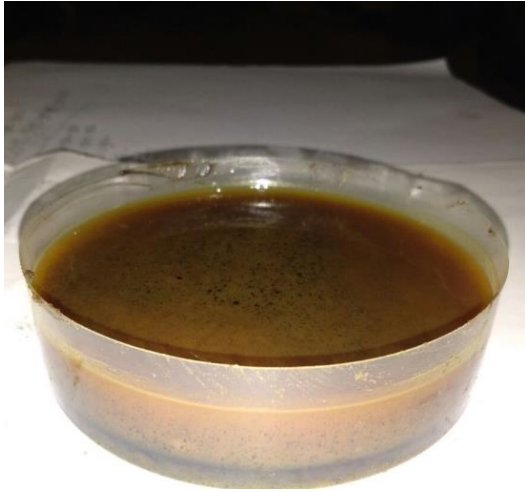
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 Tuning File : C:\GCMSsolution\System1\Tune1\juni 21 2017.qqs



Peak#	R.Time	L.Time	F.Time	Area	Area%	Height	Name
1	2.188	2.125	2.258	4177465	0.86	1601626	2-Propanone (CAS) Acetone
2	2.558	2.508	2.758	6607885	1.35	1512972	1-Hexanol (CAS) n-Hexanol
3	2.785	2.758	2.858	881047	0.18	199813	CHLOROFORM
4	3.131	2.925	3.325	11131551	2.28	3004048	1,3-Hexadien-5-yne
5	3.441	3.325	3.875	12850084	2.63	2371115	1-Heptene
6	4.042	3.875	4.158	1579563	0.32	262197	Cyclohexane, methyl-
7	4.642	4.442	4.758	1489875	0.31	295742	1-Decyne
8	4.944	4.758	5.392	19881091	4.08	3880572	Toluene
9	5.579	5.392	5.708	10772323	2.21	2530353	1-Octene (CAS) Caprylene
10	5.853	5.708	6.008	7795910	1.60	1742758	Octane
11	6.125	6.008	6.208	1469296	0.30	1465777	1,10-Undecadiene
12	6.698	6.592	6.792	1054186	0.22	143121	Cyclooctene (CAS)
13	6.889	6.792	7.125	2763243	0.57	305904	2-Furancarboxaldehyde (CAS) Furfural
14	7.216	7.125	7.442	13384468	2.74	3182225	2,4-Dimethyl-1-heptene
15	7.642	7.442	7.892	2062482	0.42	97238	Cyclohexane, ethylidene-
16	7.954	7.892	8.075	4588084	0.94	1131311	Ethylbenzene
17	8.293	8.208	8.475	6361465	1.30	1042897	Benzene, 1,3-dimethyl- (CAS) m-Xylene
18	8.607	8.475	8.692	980159	0.20	153180	Cyclohexanemethanol (CAS) Cyclohexylmethanol
19	8.751	8.692	8.825	976324	0.20	291941	Cyclopropane, 1,1'-(1,2-ethanediy)bis- (CAS) Ethane, 1,2-dicyclopropyl-
20	9.131	8.958	9.375	21498124	4.41	4233767	1-Nonene
21	9.452	9.375	9.708	8857069	1.82	2021056	Dodecane (CAS) n-Dodecane
22	11.224	11.125	11.358	911402	0.19	140958	Cyclopropene, 1-butyl-2-ethyl-
23	11.476	11.358	11.625	1450923	0.30	276377	Benzene, propyl-
24	11.776	11.625	11.842	2269509	0.47	423049	Benzene, 1-ethyl-2-methyl- (CAS) o-Ethyltoluene
25	11.892	11.842	11.975	908007	0.19	209888	Benzene, 1-ethyl-2-methyl-
26	12.108	11.975	12.308	1097792	0.23	160583	Benzene, 1,2,3-trimethyl-
27	12.424	12.308	12.475	1478279	0.30	329608	Benzene, 1-ethyl-2-methyl-
28	12.688	12.475	12.892	29142802	5.97	2917619	Benzenesulfonic acid, 4-hydroxy-
29	12.988	12.892	13.042	19358555	3.97	4306147	1-Decene (CAS) Dec-1-ene
30	13.110	13.042	13.225	7533985	1.54	985538	Benzene, 1-ethenyl-3-methyl-
31	13.305	13.225	13.392	10179105	2.09	2436245	Decane
32	13.549	13.392	13.642	4685802	0.96	484102	Decane, 4-methyl- (CAS) 4-METHYLDECANE
33	13.705	13.642	13.942	3039890	0.62	362002	Nonane, 2,6-dimethyl-
34	14.045	13.942	14.142	1193698	0.24	149756	1,3-Cyclopentadiene, 5-(1-methylpropylidene)- (CAS) 6-METHYL-6-ETHYLFI
35	14.292	14.142	14.458	1791855	0.37	154644	Benzene, 1-ethenyl-2-methyl-
36	14.551	14.458	14.792	2252708	0.46	358090	Benzene, 1-propenyl- (CAS) Propenylbenzene
37	14.911	14.792	15.075	4195010	0.86	740595	INDENE
38	15.321	15.208	15.592	6116215	1.25	738565	Phenol, 2-methyl- (CAS) o-Cresol
39	15.675	15.592	15.808	1259592	0.26	182463	Benzenecetaldehyde, .alpha.-methyl-
40	16.059	15.925	16.158	4826549	0.99	834403	1-Octanol, 3,7-dimethyl- (CAS) 3,7-Dimethyl-1-octanol
41	16.407	16.158	16.508	9289799	1.90	900627	Mequinol
42	16.633	16.508	16.725	18102201	3.71	3842619	1-Dodecene (CAS) Adacene 12
43	16.775	16.725	16.842	2267834	0.46	407951	3-Octen-1-ol, (Z)-
44	16.926	16.842	17.008	10493760	2.15	2690394	Undecane
45	17.066	17.008	17.142	2630648	0.54	566526	5-Undecene, (E)-
46	17.212	17.142	17.292	1815793	0.37	356312	Benzofuran, 2-methyl- (CAS) 2-Methylbenzofuran
47	17.360	17.292	17.458	1389508	0.28	287748	2-Undecene, (E)-
48	17.697	17.558	17.858	1288988	0.26	169556	1-Octadecanol (CAS) Stenol
49	18.211	18.025	18.392	1583833	0.32	142230	Phenol, 2-ethyl- (CAS) o-Ethylphenol
50	18.602	18.392	18.725	4164805	0.85	404405	Benzene, (1-methyl-2-cyclopropen-1-yl)- (CAS) CYCLOPROPENE, 3-METHY
51	18.845	18.725	19.025	2759813	0.57	258825	1H-Indene, 1-methyl- (CAS) 1-Methylindene
52	19.142	19.025	19.225	930489	0.19	104609	N-(2-Phenylethyl)undeca-(3E,5E)-diene-8,10-diyamide
53	19.693	19.375	19.775	3227373	0.66	520795	1,9-Decadiene
54	19.986	19.775	20.175	23390999	4.79	3270001	1-Dodecene (CAS) Adacene 12
55	20.256	20.175	20.342	9009178	1.85	2341015	Dodecane (CAS) n-Dodecane
56	20.392	20.342	20.475	1357361	0.28	345772	5-Dodecene, (E)-
57	20.658	20.475	20.758	963240	0.20	128186	4-Dodecene, (E)-
58	21.224	21.125	21.408	954040	0.20	96937	DECANE, 2,3,5,8-TETRAMETHYL-
59	21.491	21.408	21.758	1161155	0.24	89534	DECANE, 2,3,5,8-TETRAMETHYL-

Peak#	R.Time	I.Time	F.Time	Area	Area%	Height	Name
60	22.189	22.008	22.358	1089493	0.22	123274	DIHYDRO-CARVEOL, MAIN PEAK
61	22.590	22.508	22.725	2070890	0.42	420943	Benzene, 1,4-dimethoxy-2-methyl-
62	22.831	22.725	22.942	2627153	0.54	515197	1,13-Tetradecadiene
63	23.090	22.942	23.258	12048611	2.47	2689338	1-Pentadecene (CAS) Pentadec-1-ene
64	23.341	23.258	23.525	12488858	2.56	2800024	DECANE
65	23.835	23.658	23.975	4164969	0.85	827557	1-Heptadecene (CAS) Hexahydroplotaxene
66	24.713	24.658	24.808	1147747	0.24	201957	Phenol, 2,6-dimethoxy-
67	25.231	25.042	25.308	1581332	0.32	203323	3,4,5,6-TETRAMETHYL-2,5-OCTADIENE
68	25.751	25.658	25.892	2727030	0.56	468826	1,13-Tetradecadiene
69	25.988	25.892	26.125	11125273	2.28	2635486	1-Pentadecene (CAS) Pentadec-1-ene
70	26.207	26.125	26.508	7285796	1.49	1580173	DODECANE
71	26.875	26.675	27.325	1109090	0.23	61192	Undecane, 1,2-dibromo-2-methyl- (CAS) 1,2-DIBROMO-2-METHYLUNDECANE
72	27.386	27.325	27.542	1122291	0.23	164228	2-Cyclohexen-1-one, 2-hydroxy-6-methyl-3-(1-methylethyl)-
73	28.489	28.342	28.608	1960297	0.40	365756	1,13-Tetradecadiene
74	28.701	28.608	28.825	8697550	1.78	1864418	1-Pentadecene (CAS) Pentadec-1-ene
75	28.903	28.825	29.058	5648821	1.16	1354018	DODECANE
76	31.072	30.975	31.175	1789727	0.37	338461	1,15-Pentadecanediol
77	31.259	31.175	31.375	6342200	1.30	1496937	1-Tetradecene
78	31.445	31.375	31.608	4747594	0.97	1055950	Pentadecane (CAS) n-Pentadecane
79	33.510	33.408	33.592	1041215	0.21	247607	1,15-Pentadecanediol
80	33.686	33.592	33.758	4456150	0.91	1067005	1-Hexadecene
81	33.854	33.758	34.008	3887042	0.80	814696	Hexadecane (CAS) n-Hexadecane
82	35.203	35.092	35.292	1176895	0.24	235467	9-Octadecenoic acid (Z)- (CAS) Oleic acid
83	35.827	35.708	35.892	953895	0.20	198686	1,15-Pentadecanediol
84	35.986	35.892	36.058	3644142	0.75	863064	1-Octadecene
85	36.139	36.058	36.325	3299355	0.68	687141	Pentadecane (CAS) n-Pentadecane
86	38.173	38.092	38.242	2488259	0.51	627513	1-Docosene
87	38.326	38.242	38.525	4465950	0.92	975127	2-Heptadecanone (CAS)
88	39.167	39.058	39.425	1591975	0.33	221486	Oleic Acid
89	39.609	39.442	39.842	3562003	0.73	636616	Hexadecanoic acid (CAS) Palmitic acid
90	40.257	40.192	40.325	1745743	0.36	436528	1-Docosene
91	40.375	40.325	40.542	1484015	0.30	333682	Eicosane
92	42.243	42.008	42.308	1859545	0.38	335990	
93	42.358	42.308	42.558	1646945	0.34	301707	
94	44.144	44.075	44.192	995517	0.20	273337	
95	44.248	44.192	44.408	948355	0.19	225749	
96	45.965	45.908	46.225	1492106	0.31	205288	
97	47.711	47.592	47.992	1508496	0.31	192865	
98	49.461	49.192	49.642	1918814	0.39	204593	
99	51.001	50.825	51.208	1560346	0.32	170284	
100	52.550	52.408	52.758	1284848	0.26	140761	
101	54.089	53.858	54.258	1232576	0.25	150114	
102	55.511	55.375	55.692	1183565	0.24	157654	
103	56.571	56.242	56.842	4783571	0.98	291265	
104	57.076	56.842	57.275	1304371	0.27	141569	
105	58.840	58.675	59.042	934364	0.19	103338	
				487858969	100.00	92671277	

Lampiran 7. Tampilan *Bio Oil*.



CaO 0%



CaO 5%



CaO 10%



CaO 20%



CaO 30%