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APPENDICES

Appendix A Gas Chromatography

Table A1 Gas chromatography feed biodiesel

Peak	Retention Time	Type	Width	Area	Start Time	End Time	FAME	%
1	7.427	BH	0.033	2510321	7.353	7.452	Solvent	
2	7.477	HB	0.031	6485274	7.452	7.71		
3	12.834	BB	0.063	1156	12.71	12.94	C12:0	0.278
4	17.857	BB	0.084	6469	17.713	18.077	C14:0	1.556
5	26.403	BB	0.113	263233	26.053	26.743	C16:0	63.324
6	27.82	MM	0.079	66	27.695	27.942	*trans*-C16:1	0.016
7	28.486	MM	0.095	101	28.397	28.643	*cis*-C16:1	0.024
8	28.933	MM	0.099	499	28.764	29.077		0.120
9	29.579	MM	0.106	55	29.438	29.685	C17:0	0.013
10	30.75	BB	0.081	2315	30.63	30.94		0.557
11	31.484	MM	0.012	38	31.434	31.523		0.009
12	33.207	MM	0.095	77	33.116	33.313		0.019
13	33.432	MM	0.055	22	33.374	33.481		0.005
14	33.639	MM	0.048	21	33.53	33.655		0.005
15	35.201	BB	0.082	20132	35.03	35.377	C18:0	4.843
16	36.665	MM	0.172	529	36.428	36.998	*trans*-C18:1	0.127
17	37.431	BF	0.084	96246	37.183	37.6	*cis*-C18:1	23.153
18	37.727	FB	0.079	2008	37.6	37.853		0.483
19	39.945	MM	0.088	386	39.833	40.104	C18:2	0.093
20	40.274	MM	0.089	403	40.147	40.411		0.097
21	40.674	BB	0.077	18734	40.513	40.857		4.507
22	43.229	BB	0.079	1244	43.113	43.35	C20:0	0.299
23	44.349	MM	0.088	372	44.194	44.529	C18:3	0.089
24	45.163	MM	0.086	293	44.977	45.313	C20:1	0.070
25	50.213	MM	0.084	165	50.115	50.336	C22:0	0.040
26	56.339	MM	0.071	114	56.249	56.426	C24:0	0.027
				415693			Total	100.000
							%FAME	99.705

Table A2 SiO_2 (Q3) on FAME composition of biodiesel after partial hydrogenation reaction (Reaction condition: 120 °C, 4 bar, 50 ml/min of hydrogen flow rate, 500 rpm of stirring rate, and 1.5 wt.% of catalyst compared to starting oil)

Reaction time (h)	C18:0	*cis*-C18:1	*trans*-C18:1	C18:2	C18:3	Saturated hydrocarbon
0.00	4.843	0.127	23.636	4.696	0.089	66.312
0.50	4.996	0.297	24.009	4.745	0.094	65.557
1.00	4.960	0.264	24.267	4.756	0.088	65.339
1.50	4.898	0.252	24.143	4.777	0.092	65.493
2.00	4.994	0.241	24.498	4.855	0.093	64.984
3.00	5.031	0.277	24.408	4.817	0.087	65.025
4.00	5.042	0.021	24.628	4.785	0.096	65.097

Table A3 SiO_2 (Q10) on FAME composition of biodiesel after partial hydrogenation reaction (Reaction condition: 120 °C, 4 bar, 50 ml/min of hydrogen flow rate, 500 rpm of stirring rate, and 1.5 wt.% of catalyst compared to starting oil)

Reaction time (h)	C18:0	*cis*-C18:1	*trans*-C18:1	C18:2	C18:3	Saturated hydrocarbon
0.00	4.843	0.127	23.636	4.696	0.089	66.312
0.50	4.947	0.177	24.146	4.814	0.087	65.354
1.00	4.879	0.205	23.932	4.804	0.094	65.693
1.50	4.951	0.235	24.252	4.814	0.097	65.285
2.00	5.005	0.249	24.294	4.827	0.084	65.162
3.00	5.083	0.293	24.495	4.845	0.089	64.840
4.00	5.059	0.333	24.339	4.830	0.084	64.837

Table A4 SiO_2 (Q30) on FAME composition of biodiesel after partial hydrogenation reaction (Reaction condition: 120 °C, 4 bar, 50 ml/min of hydrogen flow rate, 500 rpm of stirring rate, and 1.5 wt.% of catalyst compared to starting oil)

Reaction time (h)	C18:0	*cis*-C18:1	*trans*-C18:1	C18:2	C18:3	Saturated hydrocarbon
0.00	4.843	0.127	23.636	4.696	0.089	66.312
0.50	4.968	0.156	24.433	4.832	0.090	65.141
1.00	4.894	0.196	24.006	4.800	0.085	65.610
1.50	4.987	0.205	24.314	4.821	0.091	65.154
2.00	4.978	0.219	24.299	4.824	0.094	65.156
3.00	4.992	0.254	24.249	4.715	0.086	65.321
4.00	5.047	0.149	25.094	4.744	0.085	64.177

Table A5 SiO_2 (Q50) on FAME composition of biodiesel after partial hydrogenation reaction (Reaction condition: 120 °C, 4 bar, 50 ml/min of hydrogen flow rate, 500 rpm of stirring rate, and 1.5 wt.% of catalyst compared to starting oil)

Reaction time (h)	C18:0	*cis*-C18:1	*trans*-C18:1	C18:2	C18:3	Saturated hydrocarbon
0.00	4.843	0.127	23.636	4.696	0.089	66.312
0.50	4.998	0.155	24.371	4.861	0.091	65.157
1.00	5.065	0.172	24.627	4.883	0.092	64.843
1.50	4.979	0.186	24.197	4.813	0.089	65.447
2.00	4.975	0.188	24.118	4.842	0.086	65.470
3.00	5.018	0.197	24.426	4.881	0.091	65.057
4.00	5.062	0.206	24.455	4.850	0.093	65.048

Table A6 2 wt.% Pd/SiO_2 (Q3) on FAME composition of biodiesel after partial hydrogenation reaction (Reaction condition: 120 °C, 4 bar, 50 ml/min of hydrogen flow rate, 500 rpm of stirring rate, and 1.5 wt.% of catalyst compared to starting oil)

Reaction time (h)	C18:0	*cis*-C18:1	*trans*-C18:1	C18:2	C18:3	Saturated hydrocarbon
0.00	4.843	0.127	23.636	4.696	0.089	66.312
0.50	6.584	4.881	19.522	2.505	0.024	66.196
1.00	7.449	7.776	17.436	1.650	0.015	65.328
1.50	9.318	9.802	14.401	0.909	0.013	65.315
2.00	11.579	10.920	11.449	0.486	0.010	65.318
3.00	14.599	10.740	8.807	0.259	0.007	65.348
4.00	18.395	10.078	4.813	0.160	0.000	66.265

Table A7 2 wt.% Pd/SiO_2 (Q10) on FAME composition of biodiesel after partial hydrogenation reaction (Reaction condition: 120 °C, 4 bar, 50 ml/min of hydrogen flow rate, 500 rpm of stirring rate, and 1.5 wt.% of catalyst compared to starting oil)

Reaction time (h)	C18:0	*cis*-C18:1	*trans*-C18:1	C18:2	C18:3	Saturated hydrocarbon
0.00	4.843	0.127	23.636	4.696	0.089	66.312
0.50	16.840	4.638	11.653	0.872	0.044	65.717
1.00	23.976	3.532	6.174	0.153	0.027	65.859
1.50	30.732	1.032	1.458	0.040	0.023	66.489
2.00	33.583	0.100	0.285	0.029	0.000	65.778
3.00	34.042	0.041	0.077	0.014	0.000	65.621
4.00	33.348	0.034	0.057	0.013	0.000	66.324

Table A8 2 wt.% Pd/SiO_2 (Q30) on FAME composition of biodiesel after partial hydrogenation reaction (Reaction condition: 120 °C, 4 bar, 50 ml/min of hydrogen flow rate, 500 rpm of stirring rate, and 1.5 wt.% of catalyst compared to starting oil)

Reaction time (h)	C18:0	*cis*-C18:1	*trans*-C18:1	C18:2	C18:3	Saturated hydrocarbon
0.00	4.843	0.127	23.636	4.696	0.089	66.312
0.50	18.895	5.145	8.839	0.887	0.032	65.933
1.00	27.563	2.734	3.546	0.087	0.019	65.793
1.50	32.601	0.276	0.885	0.091	0.009	65.739
2.00	33.832	0.097	0.124	0.017	0.000	65.740
3.00	33.595	0.043	0.066	0.016	0.000	66.078
4.00	34.003	0.019	0.039	0.006	0.000	65.707

Table A9 2 wt.% Pd/SiO_2 (Q50) on FAME composition of biodiesel after partial hydrogenation reaction (Reaction condition: 120 °C, 4 bar, 50 ml/min of hydrogen flow rate, 500 rpm of stirring rate, and 1.5 wt.% of catalyst compared to starting oil)

Reaction time (h)	C18:0	*cis*-C18:1	*trans*-C18:1	C18:2	C18:3	Saturated hydrocarbon
0.00	4.843	0.127	23.636	4.696	0.089	66.312
0.50	16.738	8.796	7.723	0.486	0.033	65.953
1.00	22.610	6.996	5.064	0.126	0.025	64.896
1.50	28.966	2.745	2.191	0.053	0.013	65.814
2.00	32.469	0.463	0.519	0.033	0.003	66.347
3.00	34.184	0.084	0.159	0.011	0.000	65.370
4.00	34.895	0.035	0.056	0.000	0.000	64.828

Table A10 1 wt.% Pd/SiO_2 (Q10) on FAME composition of biodiesel after partial hydrogenation reaction (Reaction condition: 120 °C, 4 bar, 50 ml/min of hydrogen flow rate, 500 rpm of stirring rate, and 1.5 wt.% of catalyst compared to starting oil)

Reaction time (h)	C18:0	*cis*-C18:1	*trans*-C18:1	C18:2	C18:3	Saturated hydrocarbon
0.00	4.843	0.127	23.636	4.696	0.089	66.312
0.50	11.068	9.398	13.030	1.186	0.054	65.046
1.00	16.120	10.144	8.433	0.118	0.032	64.967
1.50	21.761	6.456	6.046	0.080	0.021	65.401
2.00	28.401	2.970	3.219	0.065	0.014	65.116
3.00	29.881	1.951	1.786	0.090	0.000	65.985
4.00	33.426	0.245	0.568	0.017	0.000	65.530

Table A11 1 wt.% Pd/SiO_2 (Q30) on FAME composition of biodiesel after partial hydrogenation reaction (Reaction condition: 120 °C, 4 bar, 50 ml/min of hydrogen flow rate, 500 rpm of stirring rate, and 1.5 wt.% of catalyst compared to starting oil)

Reaction time (h)	C18:0	*cis*-C18:1	*trans*-C18:1	C18:2	C18:3	Saturated hydrocarbon
0.00	4.843	0.127	23.636	4.696	0.089	66.312
0.50	12.914	9.349	11.663	0.999	0.043	64.399
1.00	18.322	9.159	7.225	0.157	0.035	64.846
1.50	24.080	5.604	4.726	0.093	0.022	65.248
2.00	27.254	3.175	2.848	0.066	0.006	66.425
3.00	31.039	1.321	1.162	0.034	0.000	66.236
4.00	33.836	0.151	0.233	0.015	0.000	65.545

Table A12 1 wt.% Pd/SiO_2 (Q50) on FAME composition of biodiesel after partial hydrogenation reaction (Reaction condition: 120 °C, 4 bar, 50 ml/min of hydrogen flow rate, 500 rpm of stirring rate, and 1.5 wt.% of catalyst compared to starting oil)

Reaction time (h)	C18:0	*cis*-C18:1	*trans*-C18:1	C18:2	C18:3	Saturated hydrocarbon
0.00	4.843	0.127	23.636	4.696	0.089	66.312
0.50	11.005	9.617	13.062	1.270	0.053	64.770
1.00	16.364	10.026	7.721	0.146	0.049	65.451
1.50	22.905	5.857	3.715	0.087	0.041	67.069
2.00	27.579	3.434	3.234	0.069	0.019	65.451
3.00	32.054	1.090	0.990	0.033	0.000	65.643
4.00	33.528	0.190	0.250	0.020	0.000	65.825

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1. Simakul, K.; Luengnaruemitchai, A. (2011, December 4-8) Partial Hydrogenation of Polyunsaturated Fatty Acid Methyl Ester for Biodiesel Upgrading Using Palladium supported on silica. Poster presented at Catalysis and Fine Chemicals 2011, Nara, Japan.