SUPPORTING INFORMATION

Prediction of Viscosity for Characterized Oils and Their Fractions Using the Expanded Fluid Model

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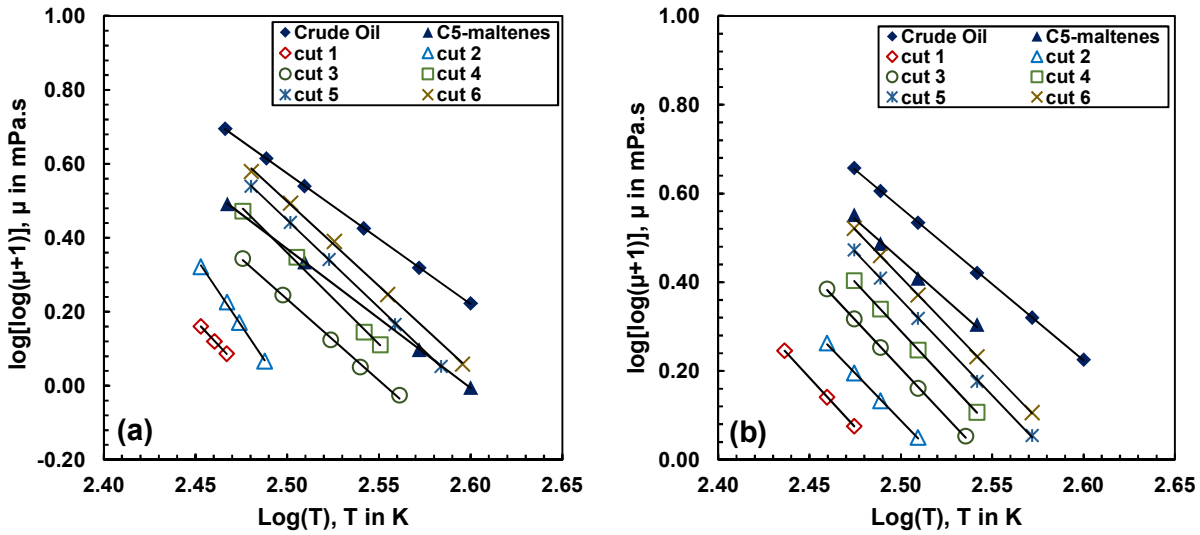

Figure S1. Walther plot at 0.1 MPa of whole crude oil, maltenes and distillation cuts of samples: a) WC-B-B1 and, b) WC-B-A1.

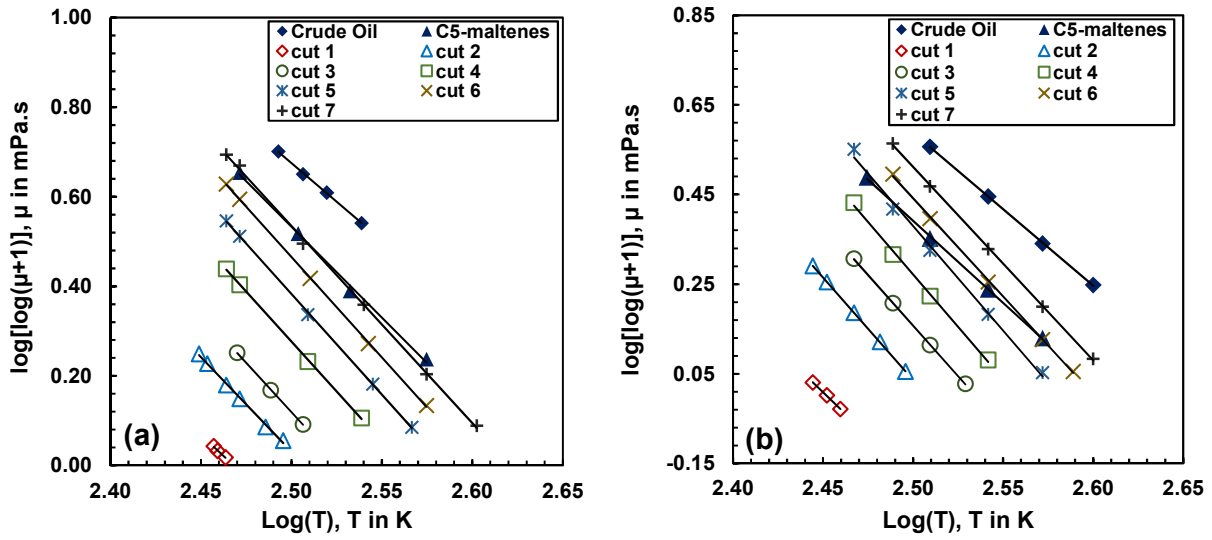

Figure S2. Walther plot at 0.1 MPa of whole crude oil, maltenes and distillation cuts of samples: a) CO-B-A1 and, b) CO-B-B1.

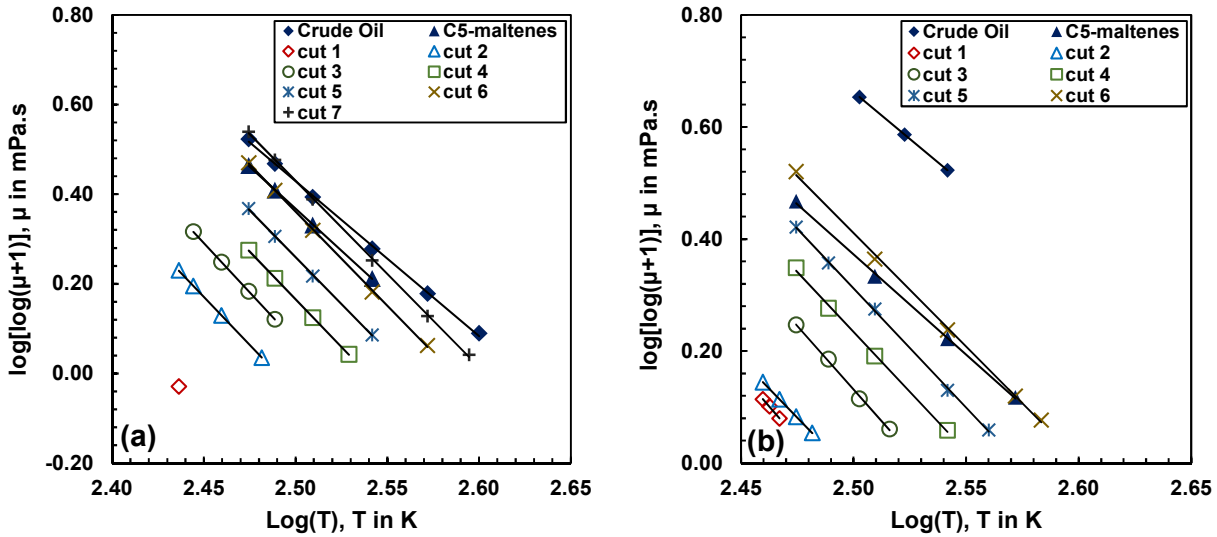

Figure S3. Walther plot at 0.1 MPa of whole crude oil, maltenes and distillation cuts of samples: a) US-HO-A1 and, b) MX-HO-A1.

Table S1. EF fluid-specific parameters for the *n*-alkanes in Development Dataset 1.

Compound	c_2	ρ_s^o, **kg/m^3**
n-Alkanes		
methane	0.1000	540.0
ethane	0.1560	724.0
propane	0.1740	778.0
n-butane	0.1900	813.0
n-pentane	0.1980	837.0
n-hexane	0.2050	849.1
n-heptane	0.2130	857.8
n-octane	0.2210	862.7
n-nonane	0.2304	865.9
n-decane	0.2360	868.1
n-dodecane	0.2490	871.4
n-tridecane	0.2538	877.8
n-tetradecane	0.2650	875.5
n-pentadecane	0.2698	878.4
n-hexadecane	0.2780	878.6
n-heptadecane	0.2878	881.3
n-octadecane	0.2974	885.1
n-eicosane	0.3060	885.5
n-docosane	0.3100	885.2
n-tricosane	0.3310	891.4
n-tetracosane	0.3350	893.2
n-hexacosane	0.3727	903.9
n-octacosane	0.3788	903.2
n-dotriacontane	0.4082	908.6
n-pentatriacontane	0.4493	919.9
n-hexatriacontane	0.4397	914.9
n-tetratetracontane	0.5071	926.9

Table S2. EF fluid-specific parameters for the branched alkanes in Development Dataset 1.

Compound	c_2	ρ_s^o, kg/m^3
7-methyltridecane	0.2418	868.1
2,2,3,3,5,6,6-heptamethylheptane	0.2751	899.3
2-methylpentadecane	0.2737	873.8
7-n-propyltridecane	0.2324	866.6
7-n-hexyltridecane	0.2619	874.5
2,6,10,14-tetramethylpentadecane	0.2656	868.1
2,6,11,15-tetramethylhexadecane	0.2813	875.1
8-hexylpentadecane	0.2729	877.2
9-hexylheptadecane	0.2890	881.8
9-octylheptadecane	0.3055	887.2
11-butyldocosane	0.3195	890.0
6,11-dipentylhexadecane	0.3092	887.3
9-ethyl-9-heptyloctadecane	0.3211	891.5
2,2,4,10,12,12-hexamethyl-7-(3,5,5-trimethylhexyl) tridecane	0.3010	868.8
11-n-decyldocosane	0.3575	900.4
13-n-dodecylhexacosane	0.3856	905.0

Table S3. EF fluid-specific parameters for the mono-aromatics in Development Dataset 1.

Compound	c_2	ρ_s^o, kg/m^3
benzene	0.2260	1066.4
toluene	0.2155	1049.6
o-xylene	0.2320	1052.9
p-xylene	0.2260	1045.5
ethylbenzene	0.2222	1042.4
propylbenzene	0.2214	1017.8
n-butylbenzene	0.2247	1005.8
n-pentylbenzene	0.2026	976.5
n-hexylbenzene	0.2159	975.2
n-heptylbenzene	0.2270	968.7
n-octylbenzene	0.2437	967.7
n-nonylbenzene	0.2505	963.6
n-decylbenzene	0.2661	963.4
n-undecylbenzene	0.2857	965.0
n-dodecylbenzene	0.2973	963.8
n-tridecylbenzene	0.3068	962.0
n-tetradecylbenzene	0.3164	960.7
n-pentadecylbenzene	0.3258	959.5

n-hexadecylbenzene	0.3361	958.8

Table S4. Fitted EF fluid-specific parameters for the cyclics in Development Dataset 1.

Compound	c_2	ρ_s^o, kg/m^3
cyclohexane	0.2370	922.1
cycloheptane	0.2310	933.7
cyclooctane	0.2541	950.7
methylcyclopentane	0.2464	944.5
ethylcyclopentane	0.2630	966.8
propylcyclopentane	0.2483	950.5
n-butylcyclopentane	0.2440	939.0
n-pentylcyclopentane	0.2550	937.2
n-hexylcyclopentane	0.2700	937.7
n-heptylcyclopentane	0.2858	938.9
n-octylcyclopentane	0.3002	939.6
n-nonylcyclopentane	0.3145	940.7
n-decylcyclopentane	0.3309	942.8
n-undecylcyclopentane	0.3293	937.5
n-dodecylcyclopentane	0.3276	932.7
n-tridecylcyclopentane	0.3314	930.4
n-tetradecylcyclopentane	0.3424	931.4
n-pentadecylcyclopentane	0.3443	929.0
n-hexadecylcyclopentane	0.3461	926.7
methylcyclohexane	0.2505	937.9
ethylcyclohexane	0.2495	950.1
propylcyclohexane	0.2472	941.7
n-butylcyclohexane	0.2447	933.7
n-pentylcyclohexane	0.2345	920.6
n-hexylcyclohexane	0.2464	920.7
n-heptylcyclohexane	0.2574	920.8
n-octylcyclohexane	0.2660	921.0
n-nonylcyclohexane	0.2794	921.9
n-decylcyclohexane	0.2783	917.8
n-undecylcyclohexane	0.2852	917.0
n-dodecylcyclohexane	0.2867	914.6
n-tridecylcyclohexane	0.2916	913.6
n-tetradecylcyclohexane	0.3005	914.6
n-pentadecylcyclohexane	0.3095	915.4
n-hexadecylcyclohexane	0.3060	911.7

Table S5. Fitted EF fluid-specific parameters for the aromatics in Development Dataset 1.

Compound	c_2	ρ_s^o, kg/m^3
Non-Fused Aromatics		
Diphenyl methane	0.2485	1132.6
1,1-diphenylethane	0.2359	1106.2
1-phenyl-2-cyclohexilethane	0.2418	1027.8
1-phenyl-3-cyclopentylpropane	0.2564	1031.1
1-cyclohexyl-1-phenylethane	0.2300	1022.5
1,3-diphenylbenzene	0.2464	1155.6
1,2-diphenylbenzene	0.2219	1120.6
1,1-diphenylheptane	0.2389	1024.4
1,5-diphenyl-3-(2-phenylethyl)pentane	0.2569	1072.2
1-phenyl-3-(2-phenylethyl)hendecane	0.2717	997.3
1,1diphenyltetradecane	0.2957	994.6
Fused Aromatics		
naphthalene	0.3054	1212.5
1-methylnaphthalene	0.2250	1138
2-n-butylnaphtalene	0.2204	1060.2
1-tert-butylnaphtalene	0.2086	1061.8
4,5-dimethylphenantrene	0.2366	1154.1
4,5-dimethyl-9,10-dihydrophenantrene	0.2447	1121.3
1,2,3,4,4a,7,8,9,10,11,12,12a-Dodecahydrochrysene	0.2392	1024.2
1,4-dimethyl-5-octylnaphthalene	0.2532	1020.6
2-butyl-3-hexylnaphthalene	0.2656	1008.5
7-butyl-1-hexylnaphthalene	0.2724	1007.4
2-octyltriphenylene	0.2757	1107.0

Table S6. Fitted EF fluid-specific parameters for the naphthenes in Development Dataset 1.

Compound	c_2	ρ_s^o, kg/m^3
Non-Fused Naphthenes		
bicyclopentyl	0.2640	1015.3
bicyclohexyl	0.2527	990.8
1,1-dicyclopentylethane	0.2611	1005.3
1,1-dicyclohexylethane	0.2608	982.2
1-cyclohexyl-3-cyclopentylpropane	0.2637	967.6
tricyclopentyl methane	0.2444	1020.6
1,2-dicyclohexyl cyclohexane	0.2345	987.7
7-cyclopentylmethyl tridecane	0.2608	908.8
7-cyclohexyltridecane	0.2612	909.1
1-cyclopentyl-4-(3-cyclopentylpropyl) dodecane	0.3196	939.4
1-cyclohexyl-3-(2-cyclohexylethyl) undecane	0.3239	936.6
9-(3-cyclopentylpropyl) heptadecane	0.3142	913.4
9-(2-cyclohexylethyl)heptadecane	0.3163	913.0
Fused Naphthenes		
decalin	0.2700	1010.0
2-n-butyldecalin	0.2486	969.5
2-butyl-1-hexylhexahydroindan	0.2535	937.6
5-butyl-6-hexylhexahydroindan	0.2597	944.7
1,4-dimethyl-5-octyldecalin	0.2703	951.2
7-butyl-1-hexyldecalin	0.2772	945.1
perhydrodibenzo[a,i]fluorene	0.2345	1033.2
1-alpha-decalylhendecane	0.2948	953.0
1,2-bis(decahydro-1-naphthyl)ethane	0.2742	1006.8
1-n-hexadecylindan	0.3315	973.6
6-n-octylperhydrobenz[de]anthracene	0.3004	1000.5
phenanthrene, 2-dodecyl-9,10-dihydro-	0.3089	1027.4
2-decylperhydroindeno-(2,1-a)indene	0.3513	989.9
3-decylperhydropyrene	0.2916	991.6
2-n-dodecylperhydrophenanthrene	0.3377	976.6
9-n-Dodecylperhydrophenanthrene	0.3116	972.7
7-Hexadecylspiro[4.5]decane	0.3528	948.0
cholestane	0.2784	982.5
9(4-as-perhydroindacenyl)heptadecane	0.3449	991.6

Table S7. Maltene characterization of WC-B-B1 oil from Test Dataset 4.

I	Wt	T_b, K	SG	Tc, K	Pc, kPa	Z_{RA}	H/C	$\rho_{37.7°C}$ kg/m^3	$\mu_{37.7°C}$ mPa.s	c_2	ρ_s^o, kg/m^3	c_3 x10^7, kPa-1
1	0.1608	557.9	0.914	759.1	2223.7	0.3437	1.673	913.9	6.8	0.2220	996.2	2.72
2	0.0577	606.4	0.937	804.4	1934.4	0.3373	1.627	937.3	17	0.2370	1010.0	2.77
3	0.0692	635.2	0.950	830.3	1776.8	0.3322	1.603	949.7	32	0.2485	1017.7	2.78
4	0.0797	664.1	0.961	855.8	1630.7	0.3265	1.581	961.5	68	0.2621	1025.3	2.79
5	0.0883	692.9	0.973	880.8	1495.3	0.3204	1.559	972.7	160	0.2784	1032.6	2.80
6	0.0939	721.8	0.983	905.3	1369.8	0.3138	1.538	983.3	460	0.2978	1039.7	2.80
7	0.0960	750.6	0.994	929.5	1253.6	0.3066	1.519	993.6	1600	0.3209	1046.6	2.80
8	0.0943	779.5	1.003	953.4	1146.0	0.2991	1.499	1003.4	7300	0.3482	1053.3	2.80
9	0.0890	808.3	1.013	977.1	1046.4	0.2911	1.481	1013.0	46000	0.3806	1059.9	2.80
10	0.0807	837.2	1.022	1000.5	954.5	0.2827	1.463	1022.3	$4.5\ 10^5$	0.4192	1066.5	2.80
11	0.0703	866.0	1.031	1023.7	869.6	0.2740	1.445	1031.4	$7.6\ 10^6$	0.4649	1073.0	2.80
12	0.0202	885.4	1.038	1039.2	816.2	0.2680	1.434	1037.5	$7.3\ 10^7$	0.5004	1077.4	2.80

Table S8. Maltene characterization of CO-B-A1 oil from Test Dataset 4.

i	Wt	T_b, K	SG	Tc, K	Pc, kPa	Z_{RA}	H/C	$\rho_{37.7°C}$ kg/m^3	$\mu_{37.7°C}$ mPa.s	c_2	ρ_s^o, kg/m^3	c_3 x10^7, kPa-1
1	0.1493	546.4	0.880	738.8	2120.4	0.3453	1.739	614.7	4.1	0.2220	970.4	2.49
2	0.0515	597.8	0.904	786.2	1820.5	0.3377	1.691	631.7	8.9	0.2380	985.5	2.64
3	0.0623	638.2	0.921	822.0	1610.6	0.3302	1.659	643.6	18	0.2545	996.9	2.71
4	0.0730	678.6	0.937	856.8	1422.6	0.3219	1.628	654.6	41	0.2753	1007.8	2.75
5	0.0827	719.0	0.951	890.8	1254.2	0.3126	1.600	664.8	120	0.3015	1018.1	2.78
6	0.0908	759.4	0.965	924.1	1103.4	0.3024	1.573	674.5	420	0.3346	1028.0	2.79
7	0.0965	799.8	0.978	956.8	968.7	0.2914	1.548	683.7	2300	0.3765	1037.4	2.79
8	0.0994	840.1	0.991	989.1	848.5	0.2797	1.523	692.5	20000	0.4295	1046.6	2.80
9	0.0990	880.5	1.003	1021.0	741.5	0.2673	1.499	701.2	$3.6\ 10^5$	0.4968	1055.6	2.80
10	0.0955	920.9	1.016	1052.7	646.7	0.2544	1.476	709.7	$1.7\ 10^7$	0.5822	1064.7	2.80
11	0.0892	961.3	1.028	1084.4	563.4	0.2413	1.452	718.4	$3.5\ 10^9$	0.6905	1073.8	2.80
12	0.0107	984.3	1.036	1102.5	520.7	0.2338	1.437	723.6	$1.8\ 10^{11}$	0.7648	1079.2	2.80

Table S9. Maltene characterization of US-HO-A1 oil from Test Dataset 4.

I	Wt	T_b, K	SG	Tc, K	Pc, kPa	Z_{RA}	H/C	$\rho_{37.7°C}$ kg/m^3	$\mu_{37.7°C}$ mPa.s	c_2	ρ_s^o, kg/m^3	c_3 x10^7, kPa-1
1	0.0048	319.7	0.739	498.6	4266.4	0.4095	2.011	738.9	0.3	0.2018	937.3	1.86
2	0.0086	378.0	0.795	569.9	3656.7	0.4114	1.903	794.7	0.5	0.1999	956.4	2.29
3	0.0198	427.2	0.833	625.5	3190.8	0.4047	1.829	832.7	1.0	0.2014	962.4	2.53
4	0.0397	476.4	0.865	677.6	2777.1	0.3965	1.767	865.0	1.9	0.2062	971.7	2.68
5	0.0695	525.7	0.893	726.8	2412.3	0.3884	1.713	893.1	3.9	0.2146	984.1	2.75
6	0.1062	574.9	0.918	773.6	2091.5	0.3800	1.665	917.9	8.6	0.2271	997.6	2.78
7	0.1418	624.1	0.940	818.6	1809.6	0.3707	1.622	940.0	22	0.2443	1011.1	2.79
8	0.1653	673.4	0.960	861.9	1562.2	0.3600	1.583	960.1	74	0.2677	1024.1	2.80
9	0.1684	722.6	0.978	903.9	1344.9	0.3477	1.548	978.4	370	0.2991	1036.4	2.80
10	0.1498	771.8	0.996	945.0	1154.4	0.3339	1.515	995.5	3200	0.3412	1048.0	2.80
11	0.1163	821.0	1.012	985.1	987.7	0.3187	1.483	1011.7	68000	0.3975	1059.2	2.80
12	0.0103	849.9	1.021	1008.5	900.0	0.3094	1.466	1021.0	7.1 10^5	0.4391	1065.9	2.80

Table S10. Maltene characterization of CO-B-B1 oil from Test Dataset 4.

I	Wt	T_b, K	SG	Tc, K	Pc, kPa	Z_{RA}	H/C	$\rho_{37.7°C}$ kg/m^3	$\mu_{37.7°C}$ mPa.s	c_2	ρ_s^o, kg/m^3	c_3 x10^7, kPa-1
1	0.0049	340.6	0.771	526.9	4153.0	0.3775	1.949	770.9	0.4	0.2028	956.1	1.43
2	0.0079	391.8	0.817	588.6	3623.3	0.3757	1.860	817.1	0.7	0.2015	971.0	1.72
3	0.0173	434.6	0.849	636.7	3221.2	0.3700	1.797	849.4	1.1	0.2028	974.6	1.95
4	0.0339	477.4	0.878	682.1	2858.6	0.3637	1.743	877.6	2.1	0.2067	982.5	2.17
5	0.0590	520.2	0.902	725.3	2533.2	0.3574	1.695	902.4	4.0	0.2134	992.8	2.37
6	0.0918	563.0	0.925	766.7	2241.7	0.3511	1.652	924.7	8.3	0.2230	1004.1	2.53
7	0.1272	605.8	0.945	806.6	1980.9	0.3441	1.613	944.8	20	0.2363	1015.7	2.64
8	0.1573	648.6	0.963	845.1	1747.5	0.3362	1.577	963.2	56	0.2538	1027.0	2.71
9	0.1734	691.4	0.980	882.6	1538.8	0.3272	1.544	980.2	210	0.2767	1037.9	2.75
10	0.1705	734.2	0.996	919.1	1352.1	0.3171	1.514	996.0	1200	0.3064	1048.3	2.78
11	0.1495	777.0	1.011	954.9	1185.4	0.3059	1.485	1011.0	12000	0.3447	1058.4	2.79
12	0.0074	800.4	1.019	974.2	1102.0	0.2995	1.470	1018.9	62000	0.3703	1063.8	2.79

Table S11. Maltene characterization of MX-HO-A1 oil from Test Dataset 4.

i	wt	T_b, K	SG	Tc, K	Pc, kPa	Z_{RA}	H/C	$\rho_{37.7°C}$ kg/m^3	$\mu_{37.7°C}$ mPa.s	c_2	ρ_s^o, kg/m^3	c_3 x10^7, kPa-1
1	0.0172	293.8	0.717	465.6	4641.4	0.3933	2.054	716.6	0.3	0.2056	918.1	1.57
2	0.0184	364.7	0.791	556.1	3872.4	0.3986	1.909	791.4	0.5	0.2014	961.5	2.12
3	0.0325	421.7	0.838	621.8	3315.5	0.3924	1.820	837.5	1.0	0.2019	970.3	2.44
4	0.0525	478.7	0.876	682.7	2828.2	0.3836	1.746	875.7	2.1	0.2068	980.4	2.64
5	0.0776	535.7	0.908	739.6	2406.2	0.3748	1.684	908.0	5.0	0.2165	994.6	2.74
6	0.1048	592.7	0.936	793.5	2041.9	0.3654	1.630	936.0	14	0.2319	1010.0	2.78
7	0.1295	649.7	0.961	845.0	1727.9	0.3545	1.582	960.8	53	0.2545	1025.2	2.80
8	0.1463	706.7	0.983	894.6	1457.3	0.3416	1.539	983.1	330	0.2867	1039.6	2.80
9	0.1512	763.6	1.003	942.6	1224.4	0.3266	1.499	1003.4	4500	0.3320	1053.2	2.80
10	0.1429	820.6	1.023	989.4	1024.3	0.3097	1.463	1022.5	$2.2\ 10^5$	0.3957	1066.4	2.80
11	0.1235	877.6	1.041	1035.5	853.1	0.2913	1.427	1040.7	$7.8\ 10^7$	0.4850	1079.4	2.80
12	0.0035	908.1	1.050	1059.9	772.4	0.2812	1.409	1050.3	$6.3\ 10^9$	0.5468	1086.4	2.80

Table S12. Maltene characterization of WC-B-A1 oil from Test Dataset 4.

i	wt	T_b, K	SG	Tc, K	Pc, kPa	Z_{RA}	H/C	$\rho_{37.7°C}$ kg/m^3	$\mu_{37.7°C}$ mPa.s	c_2	ρ_s^o, kg/m^3	c_3 x10^7, kPa-1
1	0.0166	429.8	0.839	629.6	3207.4	0.3593	1.817	839.3	1.0	0.2019	967.4	2.31
2	0.0185	480.7	0.873	683.4	2781.1	0.3520	1.752	872.6	2.1	0.2069	977.1	2.53
3	0.0330	521.7	0.896	724.6	2474.2	0.3461	1.707	896.1	3.8	0.2137	987.3	2.65
4	0.0537	562.8	0.917	764.1	2198.3	0.3400	1.666	917.3	7.5	0.2233	998.3	2.72
5	0.0793	603.9	0.937	802.2	1950.6	0.3335	1.629	936.5	16	0.2361	1009.6	2.76
6	0.1066	645.0	0.954	839.1	1728.1	0.3261	1.595	954.1	41	0.2528	1020.6	2.78
7	0.1302	686.0	0.970	875.0	1528.5	0.3178	1.563	970.4	130	0.2742	1031.1	2.79
8	0.1445	727.1	0.986	910.0	1349.3	0.3085	1.534	985.7	580	0.3017	1041.2	2.80
9	0.1459	768.2	1.000	944.3	1188.6	0.2983	1.506	1000.0	4000	0.3369	1050.9	2.80
10	0.1338	809.3	1.014	978.0	1044.7	0.2872	1.480	1013.7	52000	0.3817	1060.4	2.80
11	0.1116	850.3	1.027	1011.3	916.1	0.2753	1.454	1026.9	$1.6\ 10^6$	0.4390	1069.7	2.80
12	0.0263	877.5	1.035	1033.1	838.9	0.2671	1.438	1035.5	$3.0\ 10^7$	0.4853	1075.9	2.80