

Homework #2

Imagine that you have been hired to work at a small refinery. You've been asked to evaluate the Cabinda crude (see attached). Do the following:

1. Tabulate the yield data for all of the given increments. Include:
 - Name of cut
 - TBP at Start (°F)
 - TBP at End (°F)
 - Cumulative Yield at Start (vol%)
 - Cumulative Yield at End (vol%)
 - °API
 - Specific Gravity
 - Sulfur content

Are the given °API and specific gravity values consistent?

2. Add the following calculations to the table:
 - Cumulative yield at the middle of the cut (vol%)
 - TBP consistent with this mid-increment yield.
 - Watson K Factor (using Specific Gravity & mid-increment TBP).
3. Plot the values of Cumulative Yield at start of cut (vol%) vs. TBP at start of cut (°F).
4. Plot the values of specific gravity vs. the mid-increment Cumulative Yield (vol%).
5. Plot the values of sulfur content vs. the mid-increment Cumulative Yield (vol%).
6. Using blending rules, what is the °API gravity & the sulfur content of the total gas oil (atmospheric, light vacuum, & heavy vacuum)?
7. How much material (vol%) is there in the following cut point ranges? What is the mid-increment Cumulative Yield (vol%).

Component	IBP (°F)	EP (°F)
Pentanes & lighter		nC5
Light Naphtha	nC5	180
Heavy Naphtha	180	350
Distillate	350	520
AGO	520	650
VGO	650	1000
Vacuum Residuum	1000	

Cabinda Crude Oil – Summary of Major Cuts

	Whole Crude	Light Naphtha	Medium Naphtha	Heavy Naphtha	Kero	Atm Gas Oil	Light VGO	Heavy VGO	Vacuum Resid	Atm Resid
TBP Temp At Start, °C	Start	10	80	150	200	260	340	450	570	340
TBP Temp At End, °C	End	80	150	200	260	340	450	570	End	End
TBP Temp At Start, °F	Start	55	175	300	400	500	650	850	1050	650
TBP Temp At End, °F	End	175	300	400	500	650	850	1050	End	End
Yield at Start, vol%		2.0	6.7	16.3	23.7	32.2	46.4	62.9	78.8	46.4
Yield at End, vol%		6.7	16.3	23.7	32.2	46.4	62.9	78.8	100.0	100.0
Yield of Cut (wt% of Crude)		3.6	8.4	6.7	8.1	13.9	16.9	16.8	24.2	58.0
Yield of Cut (vol% of Crude)		4.7	9.6	7.4	8.5	14.2	16.5	15.9	21.2	53.6
Gravity, °API	32.8	83.3	56.1	49.1	41.5	35.9	29.0	23.2	12.5	20.4
Specific Gravity	0.8610	0.6588	0.7542	0.7833	0.8177	0.8452	0.8818	0.9145	0.9826	0.9313
Sulfur, wt%	0.13	0.00	0.01	0.01	0.03	0.07	0.12	0.17	0.29	0.21
Mercaptan Sulfur, ppm		21	40	60	33	21	15			
Nitrogen, ppm	2022		0	0	8	98	724	1998	6400	3463
Hydrogen, wt%	13.1	16.3	14.7	14.2	13.9	13.6	13.0	12.4	11.6	12.3
Viscosity @ 40 °C (104 °F), cSt	12.9			0.983	1.75	4.19	21.1	151	7.27E+05	670
Viscosity @ 50 °C (122 °F), cSt	9.90		0.580	0.881	1.50	3.37	14.8	89.9	1.36E+05	330
Viscosity @ 100 °C (212 °F), cSt	3.75			0.578	0.825	1.51	4.25	15.4	1120	33.0
Viscosity @ 135 °C (275 °F), cSt	2.38			0.468	0.618	1.03	2.42	7.22	198	12.8
Freeze Point, °C				-68.000	-35.000	-1.000	32.0	49.0		
Freeze Point, °F				-91	-31	30	90	121		
Pour Point, °C	16			-74	-38	-5	29	46	38	29
Pour Point, °F	60			-101	-37	23	85	114	101	84
Smoke Point, mm (ASTM)			44	33	25	19	15			
Aniline Point, °C				59	66	78	92	101		
Aniline Point, °F				139	151	172	198	213		
Total Acid Number, mg KOH/g	0.06		0.0	0.1	0.1	0.1	0.1	0.1		
Cetane Index, ASTM D976				40	48	53				
Diesel Index				68	63	62	57	49		
Characterization Factor (K Factor)	12.3	12.8	11.8	11.9	11.8	12.0	12.1	12.2	12.0	12.1
Research Octane Number, Clear		65.2	49.9	25.7						
Motor Octane Number, Clear		63.8	48.7							
Paraffins, vol%		87.8	48.8	52.1	37.8	38.0	29.1			
Naphthenes, vol%		12.2	44.6	40.4	48.8	44.9	50.7			
Aromatics, vol%		0.0	6.6	7.5	13.0	16.1	18.7			
Thiophenes, vol%					0.5	1.1	1.6			
Molecular Weight	292	102	116	146	177	228	322	472	858	501
Gross Heating Value, MM BTU/bbl	5.93	4.82	5.34	5.51	5.69	5.83	6.02	6.18	6.46	6.25
Gross Heating Value, kcal/kg	10940	11640	11230	11160	11050	10940	10850	10720	10430	10640
Gross Heating Value, MJ/kg	45.8	48.7	47.0	46.7	46.2	45.8	45.4	44.9	43.7	44.5
Heptane Asphaltenes, wt%	0.2								0.7	0.3
Micro Carbon Residue, wt%	3.6								15.0	6.3
Ramsbottom Carbon, wt%	3.4								14.2	5.9
Vanadium, ppm	2								9	4
Nickel, ppm	16								66	27
Iron, ppm	3								12	5