Homework #3

Imagine that you have been hired to work at a small refinery. You've been asked to evaluate the Ratawi 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
   - Sulfur content (wt%)

2. Add the following calculated values to the table:
   - Specific Gravity
   - Incremental yield (vol%)
   - Cumulative yield at the middle of the cut (vol%)
   - TBP consistent with vol% mid-increment yield.
   - Incremental yield (wt%)
   - Cumulative Yield at Start (wt %)
   - Cumulative Yield at End (wt %)

We want to analyze the gas oil cut between 550°F to 1000°F as the feed to the FCCU.

3. Determine the following values for the gas oil fraction between 550°F to 650°F: ~~What is the cumulative yield (both vol% & wt%) at 550°F? At 1000°F?~~
   - Cumulative Yield at Start (vol%)
   - Cumulative Yield at End (vol%)
   - Cumulative yield at the middle of the cut (vol%)
   - °API (as determined from the mid-increment yield)
   - Specific gravity (as determined from the API gravity)
   - Sulfur content (wt%, as determined from the mid-increment yield)

4. Do the same for the gas oil fraction between 850°F to 1000°F.

5. Using blending rules determine the API gravity & the sulfur content for the total gas oil between 550°F to 1000°F.

Ratawi 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%		1.7	5.6	15.3	21.0	29.2	40.4	57.3	71.5	40.4
Yield at End, vol%		5.6	15.3	21.0	29.2	40.4	57.3	71.5	100.0	100.0
Gravity, °API	24.5	82.9	57.0	49.3	41.4	33.2	22.1	15.7	3.5	11.2
Sulfur, wt%	3.88	0.01	0.08	0.33	0.98	2.42	3.50	4.20	6.96	5.41
Mercaptan Sulfur, ppm		274	597	258	72	29	8	0		
Nitrogen, ppm	2066		0	0	1	90	759	1528	5156	3158
Hydrogen, wt%	11.7	16.2	14.3	14.3	13.7	13.0	12.0	11.1	9.2	10.4
Viscosity @ 40 °C (104 °F), cSt	30.5			1.13	1.78	5.87	27.0	272	1.10E+09	4102
Viscosity @ 50 °C (122 °F), cSt	21.5			0.982	1.51	4.40	17.7	143	6.13E+07	1750
Viscosity @ 100 °C (212 °F), cSt	6.19			0.576	0.824	1.59	4.18	17.5	32200	115
Viscosity @ 135 °C (275 °F), cSt	3.52			0.443	0.613	0.996	2.23	7.33	2660	37.9
Freeze Point, °C				-60.000	-38.000	-4.000	27.0			
Freeze Point, °F				-76	-36	25	81			
Pour Point, °C	-23			-68	-41	-6	24	41	40	22
Pour Point, °F	-10			-90	-42	22	76	106	104	72
Smoke Point, mm (ASTM)				28	23	18				
Aniline Point, °C			52	57	61	68	73	78		
Aniline Point, °F			125	135	142	154	164	173		
Total Acid Number, mg KOH/g	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.1		
Cetane Index, ASTM D976				43	48	49				
Diesel Index			71	66	59	51	36	27		
Characterization Factor (K Factor)	11.8	12.8	11.8	12.0	11.8	11.8	11.6	11.7	11.5	11.6
Research Octane Number, Clear		68.1	51.0	18.6						
Motor Octane Number, Clear		66.5	48.9							
Paraffins, vol%		85.7	57.7	62.1	46.8	43.5	29.0			
Naphthenes, vol%		14.3	28.6	21.4	32.9	28.2	30.2	30.2		
Aromatics, vol%		0.0	13.7	16.5	20.3	28.3	40.8	38.4		
Thiophenes, vol%										
Molecular Weight	320	102	116	150	177	228	308	456	1080	525
Gross Heating Value, MM BTU/bbl	6.01	4.83	5.32	5.50	5.66	5.83	6.07	6.22	6.44	6.30
Gross Heating Value, kcal/kg	10530	11610	11230	11140	10990	10750	10470	10280	9740	10080
Gross Heating Value, MJ/kg	44.1	48.6	47.0	46.6	46.0	45.0	43.8	43.0	40.8	42.2
Heptane Asphaltenes, wt%	6.1								18.5	9.4
Micro Carbon Residue, wt%	11.3								34.2	17.3
Ramsbottom Carbon, wt%	10.5								32.0	16.2
Vanadium, ppm	47								144	73
Nickel, ppm	22								67	34
Iron, ppm	4								12	6