Homework #4

Imagine that you have been hired to work at a small refinery. You've been asked to evaluate the blending of Eocene crude with Mutineer-Exeter (see attached). You will notice from the assay data that they are described with different cut point temperatures. You will do the blending based upon the definition of the cuts for Eocene; these cuts can be used as given. A great deal more work must be done to get the Mutineer-Exeter data ready for use. Do the following:

1. Tabulate the Eocene crude data for the increments as given (see Table 1). 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%]

   Add the following calculated values to the table:
   - Specific Gravity
   - Incremental yield [vol%]
   - Incremental yield [wt%]

2. Tabulate the Mutineer-Exeter crude data for the increments as given (see Table 2). Include the same information as for Eocene but also include the following calculated value:
   - Cumulative yield at the middle of the increment [vol%]

3. We must expand the number of cuts for the Mutineer-Exeter crude as the first step to create cuts that are consistent with the Eocene crude. Create a new table with these expanded cuts using the IBP & EP temperatures as shown in Table 3. Include the following:
   - Name of cut
   - TBP at Start & End [°F]
   - Cumulative Yield at Start & End [vol%] (interpolated from given yield vs temperature data)
   - Cumulative yield at the middle of the increment [vol%]
   - Incremental yield [vol%]
   - °API (interpolated from the given yield vs API gravity data)
   - Specific Gravity (from API gravity)
   - Sulfur content [wt%] (interpolated from the given yield vs API gravity data)

4. Blend these expanded cuts as appropriate to end up with a smaller number of cuts that are consistent with those defined by the Eocene assay. Use Table 3 for guidance. Include:
   - Name of cut
   - TBP at Start & End [°F]

- Incremental yield [vol%]
- °API
- Specific Gravity
- Sulfur content [wt%]

5. We want to determine the characteristics of a blend of 60,000 bpd Eocene with 40,000 bpd Mutineer-Exeter. Using your results from #1 & #4 determine the following properties for this blend:
   - Name of cut
   - Incremental amount [bpd]
   - °API
   - Specific Gravity
   - Sulfur content [wt%]

Table 1. Eocene Crude Oil – Summary of Major Cuts

	Whole Crude	Light Naphtha	Medium Naphtha	Heavy Naphtha	Kero	Atm Gas Oil	Light VGO	Heavy VGO	Vacuum Resid
TBP Temp At Start, °F	Start	55	175	300	400	500	650	850	1050
TBP Temp At End, °F	End	175	300	400	500	650	850	1050	End
Yield at Start, vol%		0.4	2.7	7.1	12.5	19.1	31.2	50.0	69.4
Yield at End, vol%		2.7	7.1	12.5	19.1	31.2	50.0	69.4	100.0
Gravity, °API	18.7	82.7	56.9	45.5	39.0	29.5	21.5	15.5	1.0
Sulfur, wt%	3.97	0.14	0.20	0.24	0.70	2.00	3.33	4.15	6.47
Nitrogen, ppm	2149			0	0	35	543	1466	5057
Hydrogen, wt%	11.4	16.2	14.9	14.1	13.6	12.9	12.2	11.3	9.3
Viscosity @ 40 °C (104 °F), cSt	132	0.813	0.940	1.20	1.92	4.56	31.2	245	5.01E+14
Viscosity @ 50 °C (122 °F), cSt	78.6	0.718	0.835	1.07	1.64	3.62	20.4	140	2.02E+11
Viscosity @ 100 °C (212 °F), cSt	13.5	0.445	0.530	0.686	0.916	1.55	4.76	21.1	84100
Viscosity @ 135 °C (275 °F), cSt	6.31	0.351	0.423	0.548	0.689	1.04	2.52	9.38	2850
Freeze Point, °C		-114.000	-98.000	-84.000	-66.000	-34.000			
Freeze Point, °F		-173	-145	-120	-86	-29			
Pour Point, °C	-37	-135	-104	-90	-71	-39	-2	19	100
Pour Point, °F	-35	-211	-155	-130	-96	-39	28	66	212
Characterization Factor (K Factor)	11.7	12.7	11.8	11.7	11.7	11.5	11.5	11.6	11.4
Research Octane Number, Clear		84.1	60.0	45.4					
Motor Octane Number, Clear		80.7	59.0						
Micro Carbon Residue, wt%	10.2								29.3
Ramsbottom Carbon, wt%	9.7								27.8
Vanadium, ppm	56								160
Nickel, ppm	21								60
Iron, ppm									

Table 2. Mutineer-Exeter – Summary of Major Cuts

		Whole Crude	Naphtha			Kerosene	Distillates	Vacuum Gas Oils	Residues
Boiling Range IBP	ºF		64	158	284	374	446	680	950
Boiling Range EP	ºF		158	284	374	446	680	950	
Yield Range IBP	vol%		0.11	2.15	23.19	40.21	53.01	84.76	98.71
Yield Range EP	vol%		2.15	23.19	40.21	53.01	84.76	98.71	100
Yield	vol%		2.05	21.03	17.03	12.8	31.74	13.95	1.29
API Gravity		43.4	83.9	62.1	53	44.8	33.7	29.5	13.9
Total Sulphur	wt%	0.033					0.035	0.074	0.269
Total Nitrogen ppm		32					12	62	1046
Basic Nitrogen ppm		17						54	
Reid Vapour Pressure	kPa	9	68.25	12.5					
Reid Vapour Pressure	psi	1.3	9.9	1.8					
Research Octane Number (calc.)			72.5	57.4					
Viscosity @ -20°C	cSt					4.78			
Viscosity @ 20°C	cSt	3.03				1.97			
Viscosity @ 40°C	cSt	2.23				1.43	3.61		
Viscosity @ 50°C	cSt							16.9	
Viscosity @ 100°C	cSt							4.52	102.6
Micro Carbon	wt%	0.2						<0.1	13.3
Nickel	ppm	<1						<1	9
Vanadium	ppm	<1						<1	8

Table 3. Expanded Cut Point Ranges for Blending of Mutineer-

Original Cut Ranges			Expanded Ranges for Blending			Reblended Cut Ranges		
Cut Name	IBP [°F]	EP [°F]	Cut Name	IBP [°F]	EP [°F]	Cut Name	IBP [°F]	EP [°F]
			Cut #1	55	64	Light Naphtha	55	175
Naphtha	64	158	Cut #2	64	158			
	158	284	Cut #3	158	175			
			Cut #4	175	284	Medium Naphtha	175	300
	284	374	Cut #5	284	300			
			Cut #6	300	374	Heavy Naphtha	300	400
Kerosene	374	446	Cut #7	374	400			
			Cut #8	400	446	Kero	400	500
Distillates	446	680	Cut #9	446	500			
			Cut #10	500	650	AGO	500	650
			Cut #11	650	680	LVGO	650	850
Vacuum Gas Oils	680	950	Cut #12	680	850			
			Cut #13	850	950	HVGO	850	1050
Residues	950	End	Cut #14	950	1050			
			Cut #15	1050	End	Vac Resid	1050	End