

## Homework #7

Imagine that you have been hired to work at a 150,000 bpd refinery. You've been asked to estimate the performance of the FCCU for processing the total gas oil for the Brent crude oil (i.e., all of the atmospheric and vacuum gas oils).

1. What is the total gas oil vol% yield from the crude oil? What is the gas oil wt% yield?
2. How many bpd FCCU feed will be available?
3. For this gas oil feed, what are: the API & specific gravities, Watson K factor, sulfur content, & the viscosity (cSt) @ 275°F? What is the average boiling point?
4. Assume that the FCCU will be operated at 74% conversion using zeolite catalyst. Using the appropriate figures in the textbook determine the yield structure of the FCCU products:
  - Light gases (C2-): lb/day & sulfur content.
  - Propane (C3): bpd & sulfur content.
  - Propylene (C3=): bpd & sulfur content.
  - Iso-butane (IC4): bpd & sulfur content.
  - n-butane (NC4): bpd & sulfur content.
  - Butylenes (C4=): bpd & sulfur content.
  - Gasoline (C5+): bpd & sulfur content.
  - Light Cycle Oil (LCO): bpd & sulfur content.
  - Heavy Cycle Oil (HCO): bpd & sulfur content.
  - Coke: ton/day & sulfur content.
5. Assume that the coke produced is completely combusted in the regenerator. How much SO<sub>2</sub> is produced (ton/day)?

## Brent 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%		3.4	11.3	27.1	37.1	47.1	61.8	78.3	89.8	61.8
Yield at End, vol%		11.3	27.1	37.1	47.1	61.8	78.3	89.8	100.0	100.0
Yield of Cut (wt% of Crude)		6.3	14.4	9.4	9.9	15.1	17.6	12.7	12.3	42.6
Yield of Cut (vol% of Crude)		8.0	15.8	10.0	10.0	14.8	16.5	11.5	10.2	38.2
Gravity, °API	38.5	83.2	54.4	48.2	40.9	35.1	27.9	22.1	10.3	21.1
Specific Gravity	0.8311	0.6591	0.7611	0.7874	0.8210	0.8494	0.8877	0.9212	0.9982	0.9273
Sulfur, wt%	0.43	0.00	0.00	0.01	0.04	0.25	0.57	0.82	1.44	0.90
Mercaptan Sulfur, ppm		3	5	4	4	3	3			
Nitrogen, ppm	1040			0	1	54	736	1910	5376	2423
Hydrogen, wt%	13.3	16.3	14.2	13.9	13.6	13.3	12.7	12.5	10.8	12.1
Viscosity @ 40 °C (104 °F), cSt	3.55			0.954	1.60	4.08	21.2	180	2.17E+05	189
Viscosity @ 50 °C (122 °F), cSt	2.94			0.853	1.37	3.24	14.6	102	51400	107
Viscosity @ 100 °C (212 °F), cSt	1.45		0.382	0.552	0.755	1.39	3.97	15.2	731	16.3
Viscosity @ 135 °C (275 °F), cSt	1.03			0.444	0.565	0.938	2.23	6.79	150	7.31
Freeze Point, °C			-100.000	-68.000	-42.000	-8.000	33.0	52.0		
Freeze Point, °F			-148	-90	-43	17	91	126		
Pour Point, °C	2		-114	-78	-49	-14	29	49	56	33
Pour Point, °F	35		-174	-109	-56	7	85	120	132	92
Smoke Point, mm (ASTM)				28	22	18	15	13		
Aniline Point, °C				53	61	71	83	93		
Aniline Point, °F				127	142	159	182	200		
Total Acid Number, mg KOH/g	0.05			0.0	0.0	0.0	0.0	0.1		
Cetane Index, ASTM D976				37	47	52				
Diesel Index				61	58	56	51	44		
Characterization Factor (K Factor)	12.1	12.8	11.7	11.8	11.8	11.9	12.0	12.1	11.8	11.9
Research Octane Number, Clear		65.2	56.8	43.3						
Motor Octane Number, Clear		63.8	54.7							
Paraffins, vol%		87.5	46.1	42.8	38.5	33.9	26.7	25.3		
Naphthenes, vol%		12.5	40.4	37.2	39.9	41.2	43.1	43.2		
Aromatics, vol%		0.0	13.5	19.9	21.5	24.9	30.2	31.6		
Thiophenes, vol%										
Molecular Weight	209	102	113	143	176	225	317	468	880	418
Gross Heating Value, MM BTU/bbl	5.76	4.82	5.37	5.52	5.70	5.85	6.03	6.18	6.47	6.20
Gross Heating Value, kcal/kg	10990	11580	11210	11140	11030	10940	10760	10660	10290	10620
Gross Heating Value, MJ/kg	46.0	48.5	46.9	46.6	46.2	45.8	45.0	44.6	43.1	44.5
Heptane Asphaltenes, wt%	0.4								3.1	0.9
Micro Carbon Residue, wt%	1.9								15.6	4.5
Ramsbottom Carbon, wt%	1.8								14.8	4.3
Vanadium, ppm	7								58	17
Nickel, ppm	1								11	3
Iron, ppm										