Name: Enrolment No:	UPES

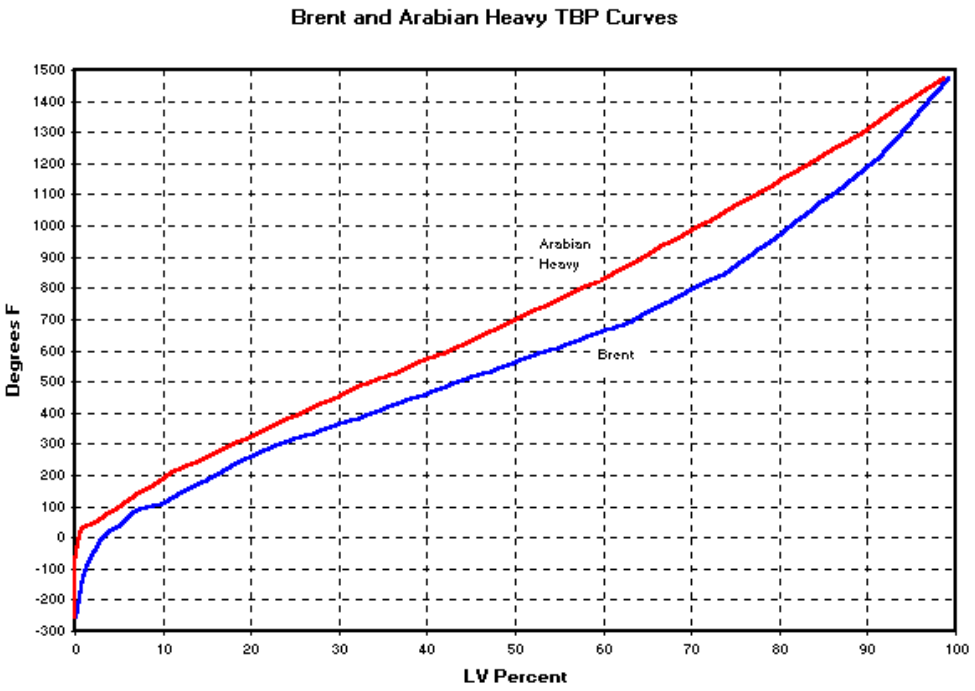
UNIVERSITY OF PETROLEUM AND ENERGY STUDIES

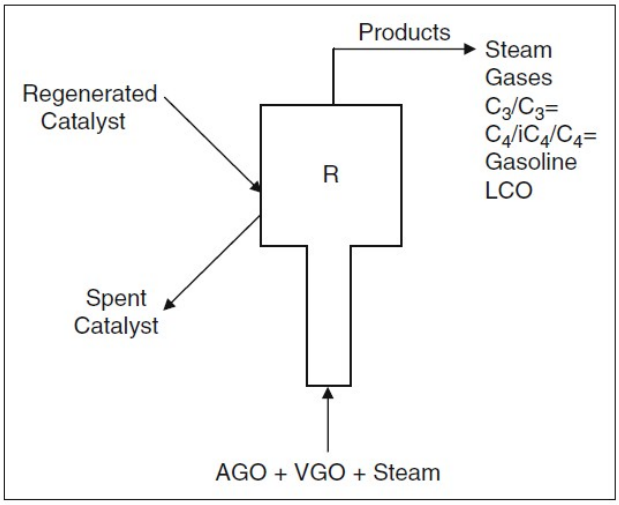
End Semester Examination, December 2018

Programme Name: B.Tech CE+RP **Semester : V**
Course Name : Petroleum Refining Technology **Time : 03 hrs.**
Course Code : CHEG 437 **Max. Marks: 100**
Nos. of page(s) : 10
Instructions: (1) Assume suitable Data wherever necessary

SECTION A (Attempt all **FIVE** Questions**)**

S. No.		Marks	CO
Q 1	For the given ASTM distillation, data in the following table calculate the UOP K factor, average boiling point (VABP, MEABP, and MABP), Correlation index, molecular weight and comment on the result. °API =23.5 Vol% | T°F 10 | 652 30 | 751 50 | 835 70 | 935 90 | 1080	**10M**	**CO2**
Q 2	Using the Wilson, Lobo, and Hottel Equation for a box-type heater, calculate the outlet temperature of petroleum stock in a furnace where it is fed at a rate of 1500 bbl/hr (sp.gr.0.8524) and is passed through heat exchangers before it is fed into radiant section of a box type heater at 200°C. The pipe still heaters burns refinery off gas at a rate of 3250 kg/hr. The refinery off gas has a heating value of 11,300 Kcal/kg. In the radiant section of furnace, there is one row of tubes of 10 m long of 11.5 cm O.D. spaced at 2 O.D. The projected area of tubes is 155 sq meters. Air Fuel ratio is 25. Sp.heat of stock is 2.66 kJ/kg °C, α=0.88.	**10M**	**CO3**
Q 3	What is meant by overhead corrosion in crude distillation unit? Explain briefly what measures need to be taken to prevent the same?	**10M**	**CO3**
Q 4	What are the different types of coking? Explain any one method of coking with a suitable diagram?	**10M**	**CO4**
Q 5	Explain catalytic reforming process with reference to the following points only with a suitable diagram. a) Objective b) Feed stock c) Catalyst used d) Major Reactions e) Process Conditions	**10M**	**CO4**
Q 6	What is the importance of cracking in refinery? Describe the process of hydrocracking in detail with suitable diagram?	**10M**	**CO5**

SECTION B (Attempt any **TWO** questions)			
Q 7	For the Arabian Heavy crude oil whose TBP curve (Vol% distilled Vs Temperature ^{o}F) is given below, estimate the TBP of products (Kerosene and LGO). The cut range for kerosene is 375^{o}F to 480^{o}F and cut range for LGO is 480^{o}F to 610^{o}F.  	**20 M**	**CO3**
Q 8	a) Explain the following**: 8M** i. Role of FCC in refinery ii. Modes of Fluidization iii. FCC catalyst b) A feed of 20,000 BPD of AGO (650–850^{o}F) having an API of 24 and a sulphur content of 0.2 wt%, is mixed with another of feed of 15,000 BPD of VGO (850–1050^{o} F) that has an API of 15 and a sulphur content of 0.35 wt%. They are used as a feed to FCC unit. Estimate the feed properties and Use the FCC correlations given in Appendix to calculate the yield of products from FCC. Assume a conversion of 75 LV%. **12M**	**20 M**	**CO4**

	 Reactor input and output streams		
Q 9	a)With the help neat process flow diagram, describe the solvent dewaxing process? **10M** b)Make a comparison between the various hydro conversion processes and reactor technology used.**10M**	**20 M**	**CO5**

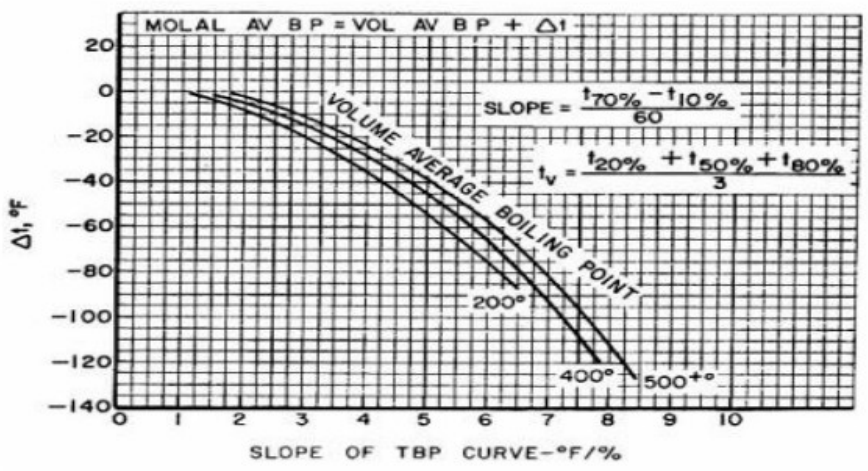


Fig. 10 Molal average boiling point of petroleum fractions

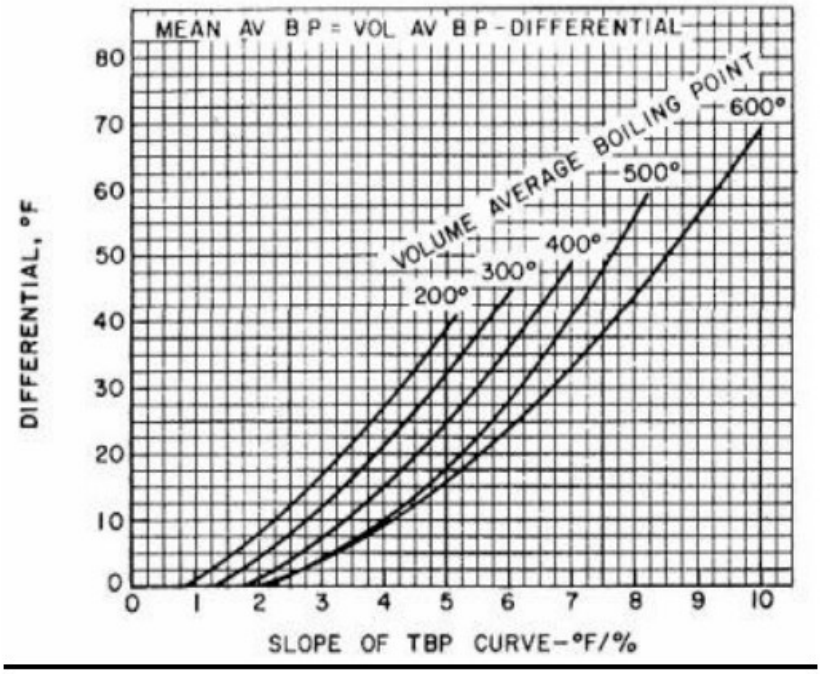
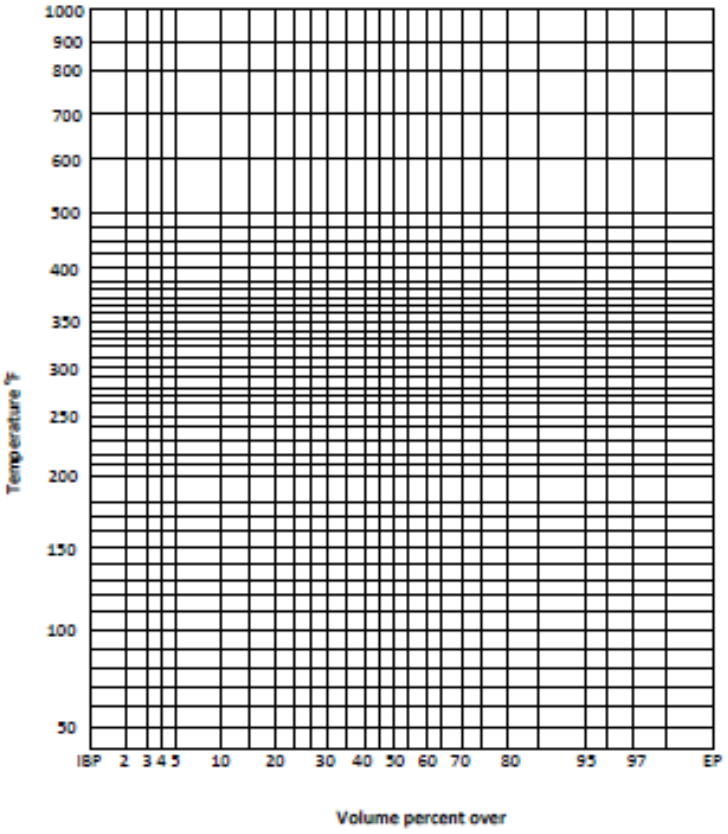


Fig.11 Mean average boiling point of petroleum fractions

480					201.319	191.174	181.139	171.254	161.127	
500					211.605	200.591	189.715	179.456	169.110	
520					222.386	210.830	199.031	187.685	176.365	
540					232.797	221.373	208.761	196.571	184.444	
560						232.206	219.068	206.019	192.562	
580						244.280	229.410	216.033	201.881	
600						256.867	241.053	226.386	211.664	
620						270.206	252.796	237.329	221.746	
640						284.579	265.535	249.244	231.901	
660						299.640	279.937	262.088	243.147	
680						314.428	294.088	274.070	254.362	
700						330.525	308.992	286.731	266.284	
720						346.094	324.137	302.034	279.799	256.350
740						362.792	339.010	317.470	293.587	269.871
760						378.761	356.110	331.730	307.285	282.406
780						396.112	371.811	347.474	321.642	295.480
800						414.225	388.517	362.886	336.861	308.755
820						431.710	404.926	378.024	350.271	322.104
840						448.263	422.817	394.631	366.309	336.478
860						467.186	439.000	411.105	381.136	350.167
880						485.253	456.069	426.951	397.625	365.202
900						504.444	473.298	443.368	412.016	380.935
920						521.642	491.813	460.804	427.960	396.645
940						540.431	508.462	477.082	443.855	413.040
960							526.999	493.824	460.293	428.276
980							543.180	511.031	476.876	444.464
1000							561.388	528.021	492.335	459.824
1020							579.708	545.854	510.006	474.981
1030							589.010	554.911	518.720	484.254
1040							597.408	563.222	526.663	492.425
1060								580.517	544.863	510.209
1080								599.227	561.993	526.436
1100									579.496	542.104
1120									596.069	558.957
1140										573.783

A		B		C		D		E	
T (°F)	Δ (°F)	T (°F)	Δ (°F)	T (°F)	Δ (°F)	T (°F)	Δ (°F)	T (°F)	Δ (°F)
126.4	-41.1	413.2	-18.9	476.5	-7.0	470.5	2.6	504.8	-13.3
316.4	-2.1	421.7	-20.2	453.4	-6.1	482.5	1.7	208.6	-6.6
324.1	-3.6	432.0	-21.6	460.3	-7.4	494.5	0.8	222.3	-8.0
334.4	-5.4	442.3	-22.3	471.4	-9.0	513.4	-1.1	236.0	-8.9
343.0	-7.0	455.1	-21.6	480.8	-10.5	531.3	-3.4	258.2	-11.0
351.5	-8.4	466.3	-20.3	490.2	-11.9	545.9	-4.8	280.5	-12.2
360.1	-10.0	474.8	-19.1	498.8	-13.5	559.6	-7.1	307.9	-14.7
369.5	-11.5	486.8	-17.5	515.1	-16.3	572.4	-9.0	328.4	-15.9
378.1	-13.0	495.4	-16.7	521.9	-17.9	589.6	-12.2	345.5	-17.3
385.8	-14.4	504.8	-15.6	531.3	-19.7	601.5	-14.3	367.0	-19.3
395.2	-15.9	516.8	-14.8	543.3	-21.9	612.7	-16.4	386.6	-20.7
404.6	-17.5	355.8	-4.5	550.2	-23.9	622.1	-18.5	406.3	-22.4
		363.5	-5.6	559.6	-25.6	628.9	-20.4	426.9	-23.5
		371.2	-6.1	565.6	-27.7	637.5	-22.0	446.6	-24.9
		380.7	-7.3	576.7	-30.5	646.1	-23.7	466.3	-26.6
		390.1	-8.2	584.4	-32.3	652.9	-25.7	486.0	-28.2
		396.9	-8.9	593.0	-34.2	659.8	-27.2	504.8	-29.5
		402.9	-9.6	639.2	-40.5	666.6	-29.2	522.8	-30.7
		409.8	-10.5			672.6	-30.7	544.2	-32.6
		417.5	-11.2			682.0	-32.7	565.6	-34.2
		428.6	-12.8			688.9	-35.1	585.3	-35.8
		437.2	-13.8					602.4	-37.0
		444.9	-15.1					620.4	-38.6
		455.1	-16.8					648.6	-40.6
		454.3	-17.0					662.3	-41.6
		464.6	-18.2					677.7	-42.8
		474.8	-20.3					690.6	-43.9
		481.7	-21.7						
		488.5	-23.3						
		496.2	-25.4						
		504.8	-27.5						
		511.6	-29.3						
		519.3	-31.2						
		524.5	-32.6						
		532.2	-34.4						
		545.9	-37.7						
		553.6	-39.8						
		560.4	-41.7						
		569.0	-43.9						
		578.4	-45.4						
		587.0	-45.8						
		599.0	-45.4						
		615.2	-42.1						
		628.1	-37.9						
		640.9	-35.1						
		652.1	-33.0						

End point correlation data presented by Good, Connel et. al. Data sets represent fractions whose cut point starts at 200 °F TBP or lower (Set A); 300 °F (Set B); 400 °F (Set C); 500 °F (Set D); 90% vol temperature of the cut Vs. 90 % vol TBP cut for all fractions (Set E).

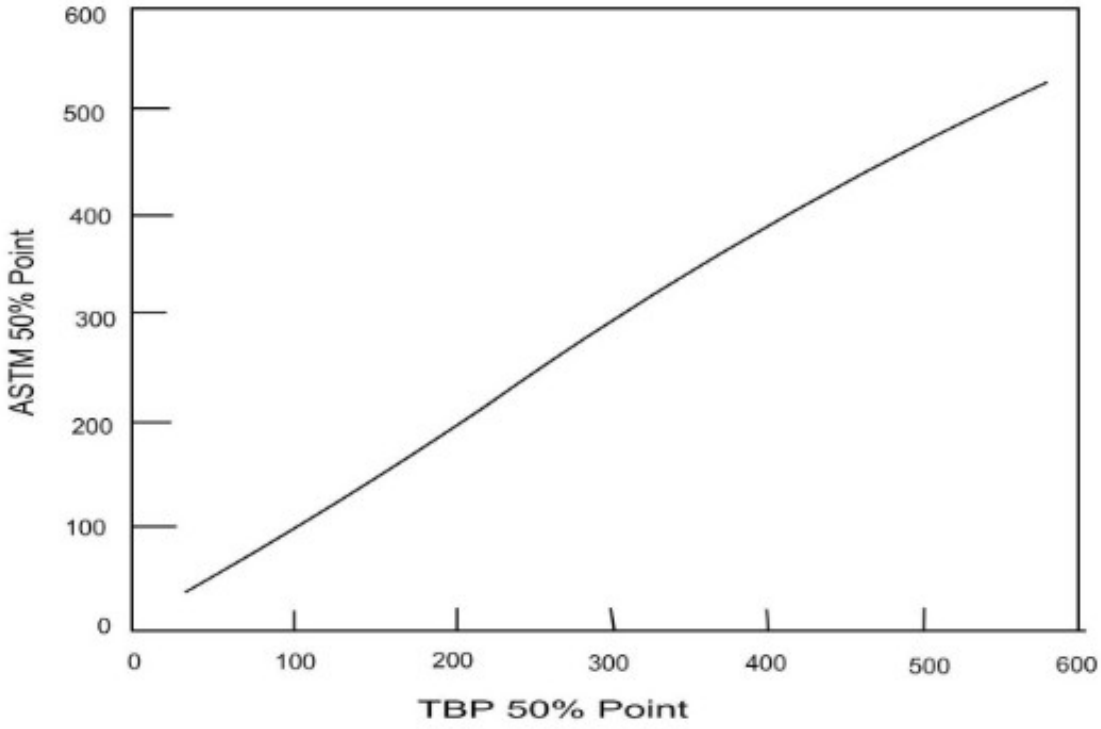


Probability chart developed by Thrift for estimating ASTM temperatures from any two known values of ASTM temperatures.

Segment of Distillation Curve, Volume Percent												ASTM 50 % to TBP 50 %	
0 to 10 %		10 to 30 %		30 – 50 %		50 – 70%		70 – 90%		90 - 100%		ASTM 50 % Temp (°F)	TBP 50 % Temp (°F)
ASTM ΔT (°F)	TBP ΔT (°F)	ASTM ΔT (°F)	TBP ΔT (°F)	ASTM ΔT (°F)	TBP ΔT (°F)	ASTM ΔT (°F)	TBP ΔT (°F)	ASTM ΔT (°F)	TBP ΔT (°F)	ASTM ΔT (°F)	TBP ΔT (°F)		
0.27	0.27	0.27	0.55	0.27	0.27	0.55	1.09	0.28	0.82	0.55	1.09	101.70	-9.87
1.37	4.37	2.74	4.64	1.93	4.89	3.58	8.16	4.13	7.34	6.32	7.61	141.50	-8.75
3.01	8.19	5.21	11.74	5.78	13.05	3.30	7.07	12.10	17.66	14.29	16.30	199.15	-7.62
6.03	13.92	10.14	20.74	10.45	18.21	7.97	12.50	17.87	25.00	22.26	26.08	258.17	-5.66
8.49	19.65	16.71	31.93	13.75	23.92	20.89	31.52	23.09	30.43	30.23	33.41	310.33	-4.26
11.23	25.11	21.10	38.76	18.70	30.44	29.14	42.12	28.31	36.95	36.00	39.66	359.75	-2.32
14.52	30.29	26.03	46.13	22.55	36.69	33.54	46.74	32.98	41.30	41.77	44.82	416.04	-0.10
18.08	36.57	29.59	51.04	27.22	42.94	38.21	52.99	39.03	48.09	46.16	50.25	464.10	2.11
22.19	42.85	33.15	56.50	31.62	48.10	45.35	59.50	43.97	54.07	51.11	54.87	501.18	4.05
27.12	49.95	38.36	62.24	36.02	53.81	53.32	67.65	51.12	61.40	55.23	60.31	553.37	7.35
30.96	55.14	42.74	66.61	40.14	58.70	58.82	73.36	59.36	69.00	59.08	63.84	595.95	10.37
35.07	60.33	46.85	72.07	44.53	63.04	64.86	79.88	64.30	73.08	65.12	70.90	631.67	13.38
39.73	66.61	50.69	75.90	48.93	67.12	71.45	85.31	69.52	78.51	69.52	75.24	685.26	18.31
43.56	71.79	54.52	80.26	53.52	73.91	77.22	90.47	76.12	85.30	73.37	81.50	725.13	22.96
47.12	76.44	58.90	84.09	60.47	78.79	87.11	98.88	83.26	91.27	78.04	88.83	755.39	27.33
50.69	81.35	63.01	88.19	65.14	83.41	92.88	104.59	90.95	98.88	82.99	96.44	787.03	32.51
56.16	87.90	68.49	92.29	69.81	87.49	99.20	110.02	96.45	102.68	85.74	101.88	818.68	38.23
61.10	93.09	72.05	95.84	74.48	91.83	105.79	116.54	98.92	105.94	89.32	108.40	847.60	44.50
66.03	99.65	75.34	98.57	80.25	96.99	113.76	123.60	104.69	111.10	92.34	114.38	869.64	49.67
70.41	105.65	75.34	98.84	85.47	102.42	120.35	129.84	111.01	117.35	94.82	119.82	897.23	58.37
75.62	111.39	90.14	111.68	91.24	106.77	125.30	134.73	118.70	124.68	97.02	125.80		
81.37	117.94	94.25	115.23	95.36	110.84	131.07	140.17	125.57	131.47				
85.21	123.40	97.81	117.42	103.60	118.17	135.46	145.05	130.24	135.81				
89.04	128.04	102.47	122.06	108.54	122.52	140.68	149.40	137.11	143.96				
		106.85	125.62	114.59	127.95	144.81	154.56	142.60	148.85				
		110.41	128.90	120.63	133.38	150.58	161.08	147.00	153.47				
		114.79	132.45	127.23	139.90	157.72	167.33	150.30	156.73				
		119.45	137.09	131.35	143.43	162.39	173.85	153.87	160.80				
		124.93	141.74	137.12	149.68	167.62	182.00	156.34	163.79				
		129.32	146.11	143.44	156.47	172.29	187.98	159.92	168.41				
		133.15	150.20	148.11	160.81	175.31	191.78	163.76	171.67				
		138.90	155.39	153.05	166.52	179.43	196.13	167.61	177.65				
		144.38	160.58	158.27	173.04	178.06	198.31	170.63	182.00				
		150.14	167.41	162.67	177.93			175.03	187.43				
		155.34	173.96	166.79	183.09			178.33	191.51				
		160.82	180.52	169.54	186.89								
		166.03	187.07	174.22	192.87								
		172.60	194.99	176.97	197.22								
		179.45	203.45	179.71	200.21								

ASTM-TBP correlation data from Edmister method.

TBP VS ASTM 50% B.P



Products	Correlation
Coke wt%	$0.05356 \times CONV - 0.18598 \times API + 5.966975$
LCO LV%	$0.0047 \times CONV^2 - 0.8564 \times CONV + 53.576$
Gases wt%	$0.0552 \times CONV + 0.597$
Gasoline LV%	$0.7754 \times CONV - 0.7778$
iC_4 LV%	$0.0007 \times CONV^2 + 0.0047 \times CONV + 1.40524$
nC_4 LV%	$0.0002 \times CONV^2 + 0.019 \times CONV + 0.0476$
$C_4^=$ LV%	$0.0993 \times CONV - 0.1556$
C_3 LV%	$0.0436 \times CONV - 0.8714$
$C_3^=$ LV%	$0.0003 \times CONV^2 + 0.0633 \times CONV + 0.0143$
HCO	$100 - CONV - (LCO\ LV\%)$