



UNIVERSIDAD NACIONAL DE INGENIERIA
POST GRADO DE INGENIERIA DEL PETROLEO Y GAS NATURAL

TRABAJO II

CURSO INGENIERIA DE PROCESOS

GRUPO A

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Crudo :	CUPIAGA
API	43.11

Destilacion del Crudo		
% Vol	% Peso	D 86 ° F
0	0	64.4
10	8.04	182.3
20	16.99	242.5
30	26.38	286.8
40	36.09	351.3
50	46.02	437.3
60	56.44	525.1
70	67.01	618.9
80	77.7	774.2

Construir lo siguiente:

- a : Determinar la TBP del Crudo
- b : Determinar a D86 completa
- c : Determinar la curva de °API
- d : Determinar los rendimientos del Crudo
- e : Determinar la ° API de cada corte

Precio	US\$/Bbl
Crudo	100.5994
GLP	65.52
Gasolinas	115.479
Nafta	111.9719
Jet	127.0095
Diesel	123.6335
Residual	95.8162

0.82

6.52

% de Carga

DETERMINACIÓN DE LOS RENDIMIENTOS

Datos del Crudo

° API =

43.1100

Densidad del Agua a 60 ° F

0.999012

Calculos del Crudo

Sp-Gr = $141.5 / (131.5 + ^\circ \text{API}) =$

0.8104

Densidad = Sp-Gr * Densidad (Agua a 60 ° F)

0.8096

Kg/Lit

DATOS DEL 20 % EN VOLUMEN DE FONDOS

P =

20

mmHg

Base

1

Litros de Crudo

Peso del Crudo

0.8096

Kg

Volumen de los Fondos

0.2

Litros

% Peso (data)

77.7

Peso de Fondos

0.1805

Densidad de los Fondos

0.902678

Kg/Lit

Sp-Gr de los Fondos =

0.903570815

°API =

25.1009

Sp-Gr de los Fondos =

0.9035708

Densidad de los Fondos

0.902678

DETERMINACION DE RENDIMIENTOS

Paso de la D86 del Crudo a TBP, primeros 80% de destilado

% Vol (Base Crudo)	Tb D86 ° F	Δ D86 ° F	A	B	Δ TBP ° F	TBP ° F
0	64.4					10.011
		117.900	7.4012	0.60244	130.9980759	
10	182.3					141.009
20	242.5					219.947
		104.500	4.9004	0.71644	137.0273334	
30	286.8					278.036
40	351.3					350.018
		150.500	3.0305	0.80076	167.9571188	
50	437.3					445.993
60	525.1					533.032
		181.600	2.5282	0.82002	180.0244951	
70	618.9					626.018
80	774.2					

$$\Delta T = T_b - T_b^* = 2.5 (K_{\text{watson}} - 12) * \log (P / 760)$$

Para $P = 20 \text{ mmHg}$

$$\text{Log } P = (2663.129X - 5.994296) / (96.76X - 0.972546)$$

$$P \geq 2 \text{ mmHg} \quad P \leq 760 \text{ mmHg}$$

$$X = \frac{\left[\frac{(T_b^* + 460)}{T + 460} - 0.0002867(T_b^* + 460) \right]}{[748.1 - 0.2145(T_b^* + 460)]}$$

Conversion de la D1160 a D86 y luego a TBP del 20% de Fondos (P=20 mmHg)

% Vol (Base 20% Fondos)	% Vol (Base Crudo)	T D1160 °F	Tb* D86 °F	Tb D86 °F	Tb D86 °F	Tb D86 °F	Δ D86 °F	A	B	Δ TBP °F	TBP °F
0	80	514.1	763.230	762.749	762.755	762.755					738.719
							6.558	7.4012	0.60244	22.9814137	
10	82	519.9	769.789	769.308	769.314	769.314					761.700
							10.274				
20	84	529	780.063	779.582	779.588	779.588					784.814
							15.574	4.9004	0.71644	35.0353518	
30	86	533.7	785.363	784.882	784.887	784.887					796.735
							19.574				
40	88	551.1	804.937	804.456	804.462	804.462					824.716
							43.442	3.0305	0.80076	62.0991993	
50	90	572.4	828.804	828.323	828.329	828.329					858.835
							28.328				
60	92	597.8	857.132	856.651	856.657	856.657					891.773
							74.852	2.5282	0.82002	87.0355114	
70	94	639.8	903.657	903.176	903.181	903.181					945.870
							86.129				
80	96	718.5	989.786	989.305	989.310	989.310					1018.859
							184.157	3.0419	0.75497	156.060648	
90	98	809.6	1087.813	1087.332	1087.338	1087.338					1101.931
							54.429	0.11798	1.6606	90.0168214	
100	100	860.9	1142.242	1141.761	1141.767	1141.767					1191.948

2

ΔT=Tb-Tb*

Tv (°F)

SL

lnΔ4

Δ4

Tme (°F)

Tme (°C)

Tme (°R)

K watson °R

	-0.4810	-0.4751	-0.4751
875.0851	874.6041	874.6100	874.6100
3.9753	3.9753	3.9753	3.9753
3.0307	3.0310	3.0310	3.0310
20.7123	20.7184	20.7183	20.7183
854.3728	853.8857	853.8917	853.8916
456.8738	456.6032	456.6065	456.6065
1313.9728	1313.4857	1313.4917	1313.4916
12.1218	12.1203	12.1203	12.1203

TBP COMPLETA DEL CRUDO

Uniendo ambas curvas, es necesario realizar un ajuste en 80%

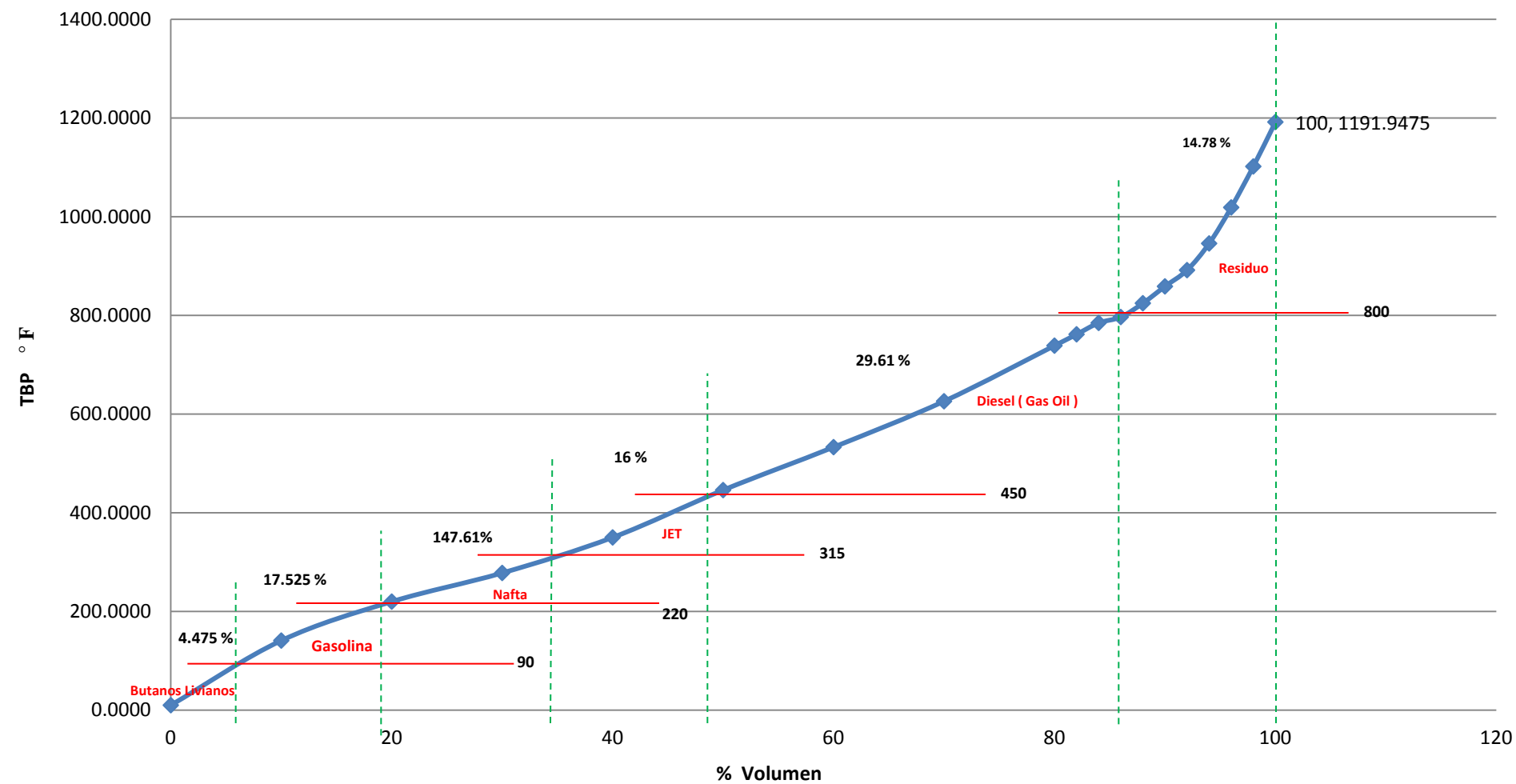
% Vol (Base Crudo)	% Peso (Base Crudo)	TBP °F	Densidad Kg/Lts	Sp-Gr	° API
0	0	10.0109	#¡DIV/0!	#¡DIV/0!	#¡DIV/0!
10	8.04	141.0090	0.6509	0.6515	85.6766
20	16.99	219.9472	0.6877	0.6884	74.0444
30	26.38	278.0363	0.7119	0.7126	67.0709
40	36.09	350.0179	0.7304	0.7312	62.0273
50	46.02	445.9934	0.7451	0.7459	58.2110
60	56.44	533.0317	0.7615	0.7623	54.1237
70	67.01	626.0179	0.7750	0.7758	50.9011
80	77.7	738.7186	0.7863	0.7871	48.2786
82	79.861	761.7000	0.7885	0.7892	47.7871
84	82.031	784.8140	0.7906	0.7914	47.3019
86	84.149	796.7353	0.7922	0.7929	46.9505
88	86.350	824.7162	0.7944	0.7952	46.4461
90	88.589	858.8345	0.7969	0.7977	45.8909
92	90.779	891.7732	0.7988	0.7996	45.4586
94	93.020	945.8700	0.8011	0.8019	44.9494
96	95.259	1018.8587	0.8033	0.8041	44.4682
98	97.569	1101.9307	0.8060	0.8068	43.8808
100	100.000	1191.9475	0.8096	0.8104	43.1100
20	0.223				

$$Sp - Gr = (Sp - Gr \text{ crudo} * \% \text{ Peso de fondos}) / (\% \text{ Volumen fondos})$$

$$Densidad = Sp - Gr * 0.999012$$

DETERMINACION DE LOS RENDIMIENTOS

% Volumen Vs TBP Completa del Crudo



UTILIZANDO LA MATRIZ DE TRIANGULIZACION POR ELIMINACION DE GAUSS

a11	a12	a13	a14
a21	a22	a23	a24
a31	a32	a33	a34

1	a	82.03066	b	6729.02918	c =	784.814029
1	a	84.14916	b	7081.081129	c =	796.735329
1	a	86.35017	b	7456.351859	c =	824.716172

1	a	82.03066	b	6729.02918	c =	784.814029	
0	a	2.11850	b	352.0519487	c =	11.9213005	
0	a	4.31951	b	727.322679	c =	39.902143	

1	a	82.03066	b	6729.02918	c =	784.814029	
0	a	2.1185	b	352.0519487	c =	11.9213005	
0	a	0	b	9.507284705	c =	15.5952387	

x3 =	c =	1.640346243	Comprobando	784.814029
x2 =	b =	-266.9652069	Comprobando	796.735329
x1 =	a =	11646.20841	Comprobando	824.716172

Ec. que mejor se ajusta

	a	b	c
y =	11646.20841	-266.9652069X	1.640346243 X ²

Teorema de la Ecuacion de 2do Grado

$$ax^2 + bx + c = 0$$

Reordenando la Ec. Para Aplicar

$$T = cx^2 + bx + a$$

$$cx^2 + bx + (a - T) = 0$$

Planteando de la Ec. Para Aplicar, Arreglada

$$x = \frac{-(b) \pm \sqrt{(b)^2 - 4(a - T)(c)}}{2(c)}$$

Si T = 800

Comprobando

Si v1 = 84.48723

a+bv+cv²=T

entonces T = 800.000

Entonces

v1 = 84.4872276

v2 = 78.2620749

RENDIMIENTOS DEL CRUDO Y API DE CADA CORTE

	Temp Corte °F	% Vol Ac (Base Crudo)	% Peso Ac (Base Crudo)	% Vol (Base Crudo)	% Peso (Base Crudo)	Densidad Kg/Lit	Sp - Gr	° API
Butano y mas livianos	90	5.61693	4.478727	5.61693	4.47873	0.6455	0.6462	87.4846
Gasolina	220	20.00771	16.997008	14.39078	12.51828	0.7042	0.7049	69.2283
Nafta	315	35.37505	31.569509	15.36734	14.57250	0.7677	0.7685	52.6339
JET	450	50.43878	46.465364	15.06373	14.89586	0.8006	0.8013	45.0779
Diesel (Gas oil)	800	86.30816	84.487228	35.86937	38.02186	0.8582	0.8590	33.2250
Crudo Reducido		100.00000	100.000000	13.69184	15.51277	0.9172	0.9182	22.6138

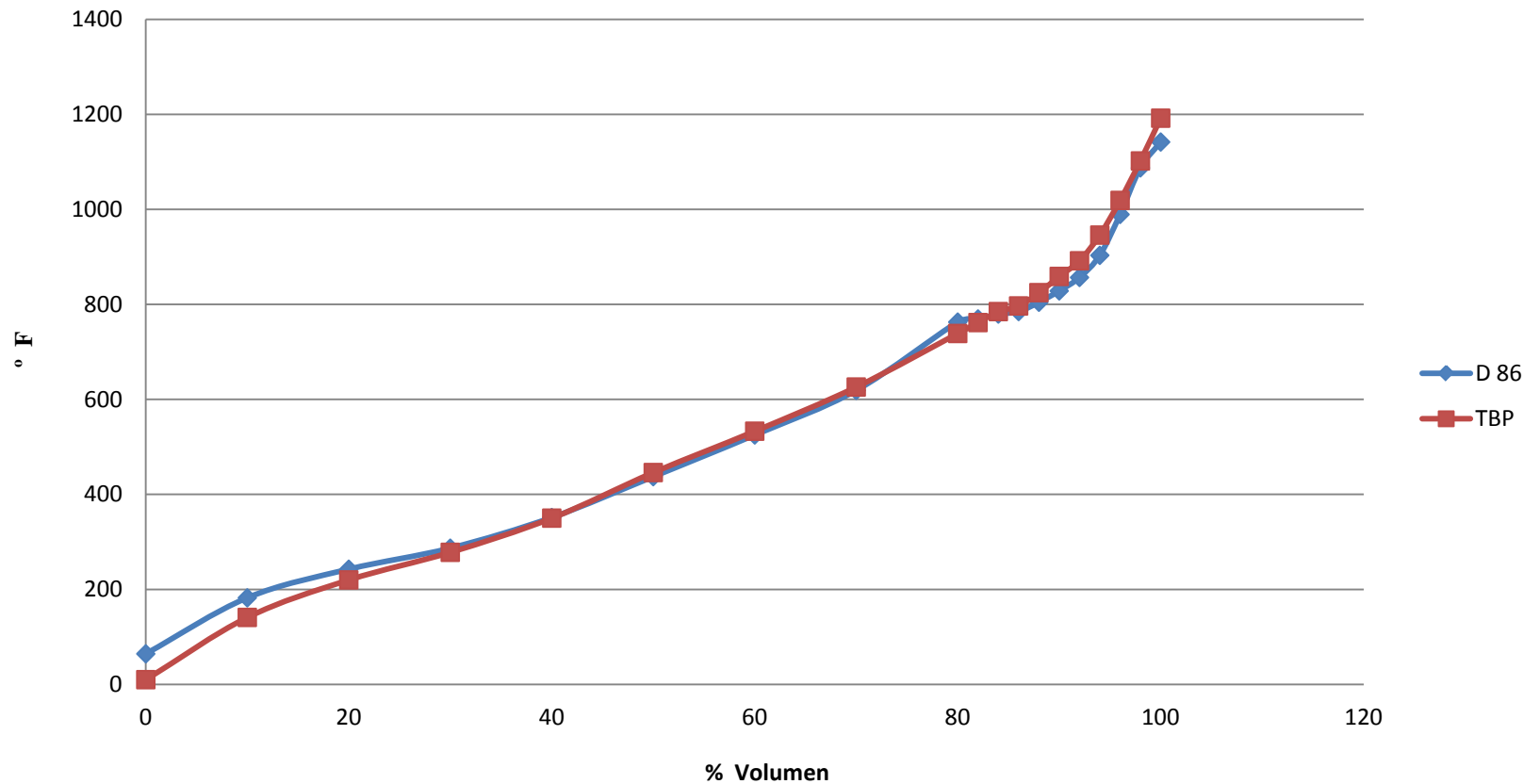
MARGEN DE REFINO

	Rendimiento (% Vol)		Precio US\$/Bbl	Ingresos US\$/Bbl
	Teorico	Real		
Butano y mas livianos	5.61693	5.25071	65.52000	3.44026
Gasolina	14.39078	13.45250	115.47900	15.53481
Nafta	15.36734	14.36539	111.97190	16.08520
JET	15.06373	14.08158	127.00950	17.88494
Diesel (Gas oil)	35.86937	33.53069	123.63350	41.45517
Crudo Reducido	13.69184	12.79913	95.81620	12.26364
Autoconsumo Mermas		6.52000		0.000
Total de Ingresos				106.66403
Precio del Crudo				100.5994
Costes Variables				0.82
Margen de Refino				5.24463

DETERMINACION DE LA D86 Y TBP (COMPLETA)

% Vol (Base Crudo)	Tb D86 ° F	TBP °F
0	64.4	10.010893
10	182.3	141.008969
20	242.5	219.947203
30	286.8	278.036302
40	351.3	350.017925
50	437.3	445.993421
60	525.1	533.031696
70	618.9	626.017916
80	762.75530	738.718564
82	769.31377	761.699978
84	779.58822	784.814029
86	784.88736	796.735329
88	804.46154	824.716172
90	828.32924	858.834529
92	856.65713	891.773219
94	903.18141	945.870040
96	989.31041	1018.858721
98	1087.33802	1101.930688
100	1141.76668	1191.947510

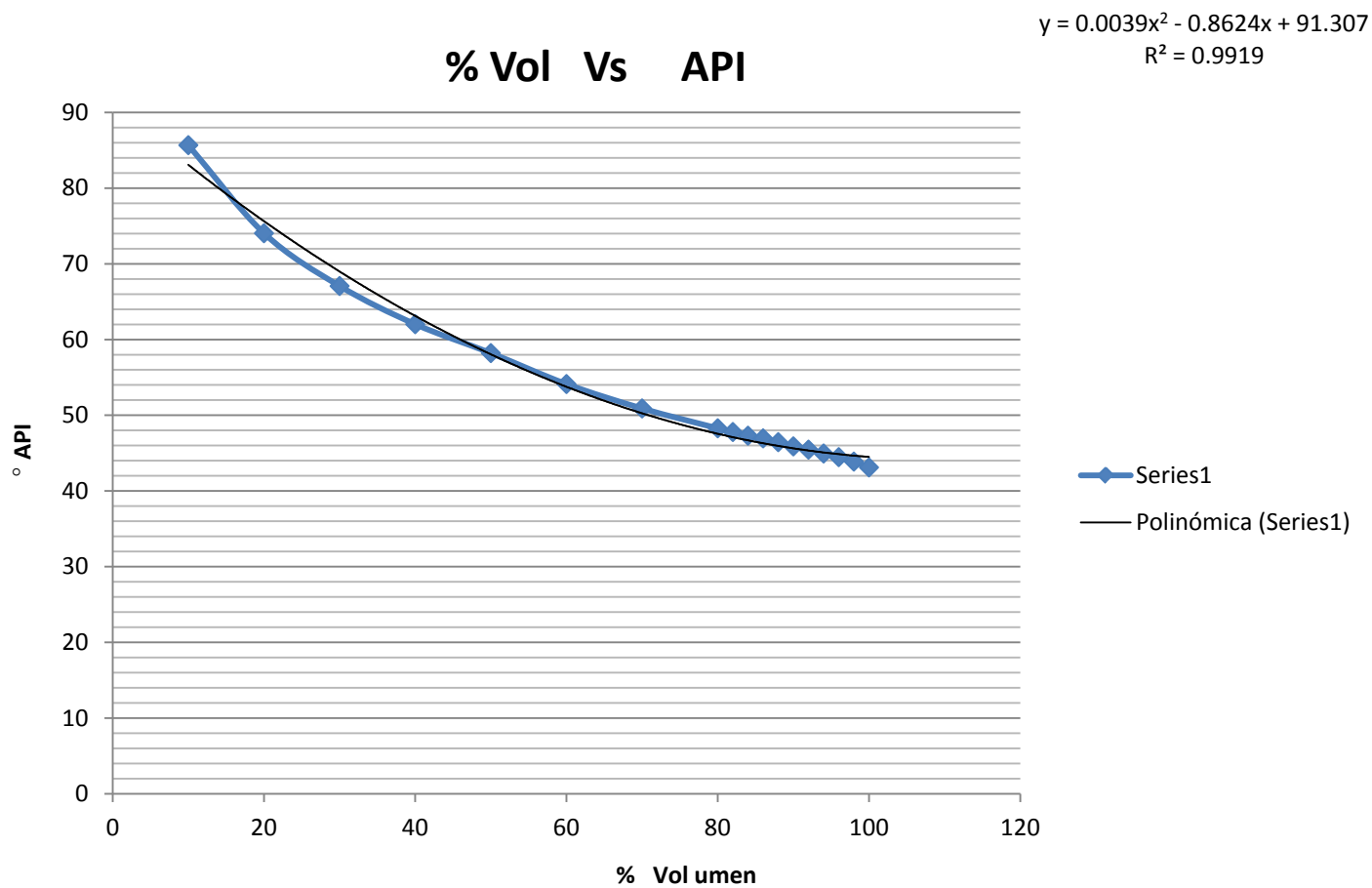
CURVAS DE D86 Y TBP



DETERMINACION DEL API

% Vol (Base Crudo)	° API
0	#¡DIV/0!
10	85.67661692
20	74.04443790
30	67.07088704
40	62.02729288
50	58.21099522
60	54.12367116
70	50.90113416
80	48.27863578
82	47.78705260
84	47.30192601
86	46.95050384
88	46.44614649
90	45.8909180
92	45.45864515
94	44.94939105
96	44.46821802
98	43.88078063
100	43.11000000

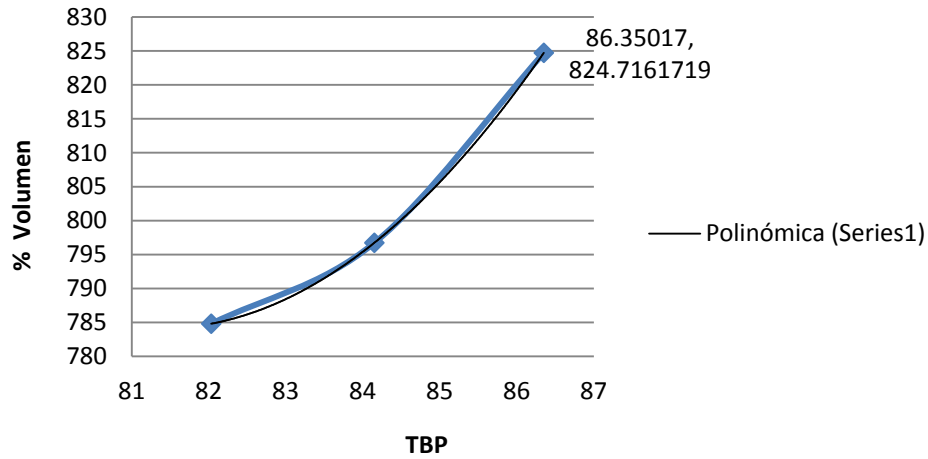
DETERMINACION DE LA CURVA API



AJUSTAMIENTO DE LAS CURVAS EN LAS ECUACIONES POLINOMICAS

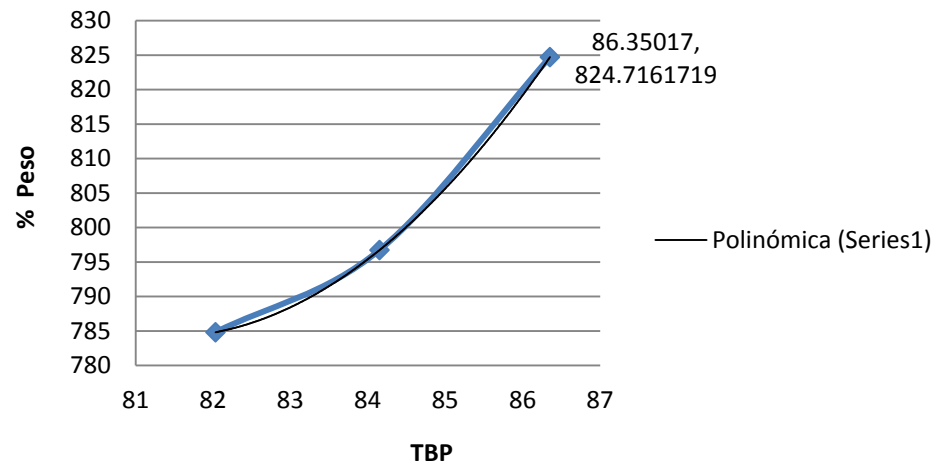
T = 90

$$y = 1.6403x^2 - 266.97x + 11646$$
$$R^2 = 1$$



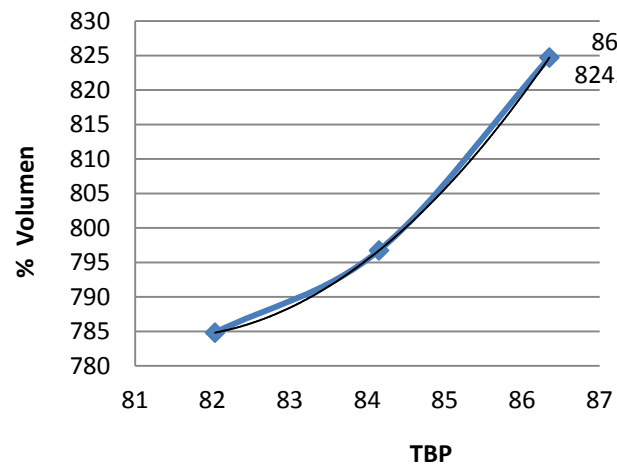
T = 90

$$y = 1.6403x^2 - 266.97x + 11646$$
$$R^2 = 1$$



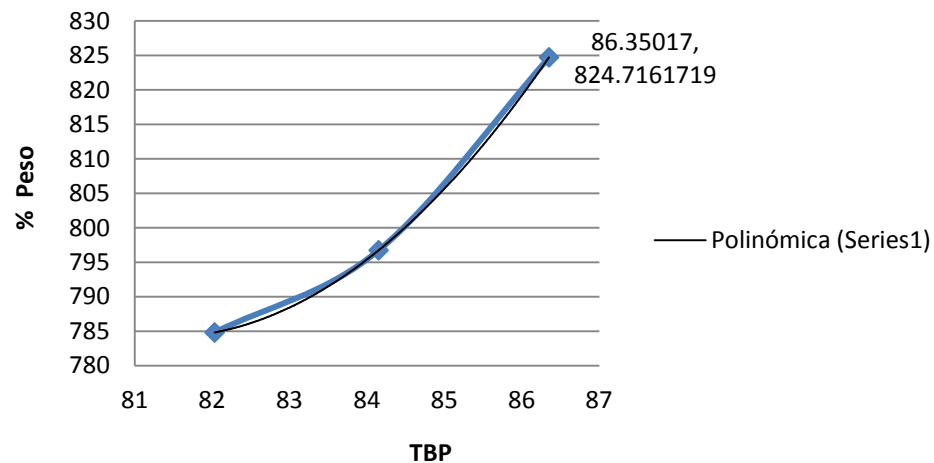
T = 220

$$y = 1.6403x^2 - 266.97x + 11646$$
$$R^2 = 1$$



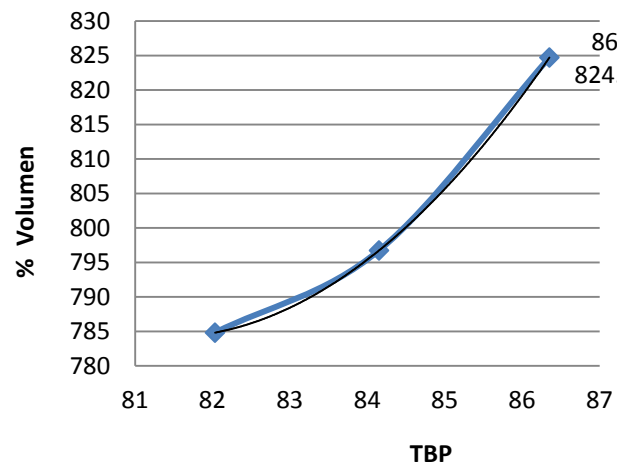
T = 220

$$y = 1.6403x^2 - 266.97x + 11646$$
$$R^2 = 1$$



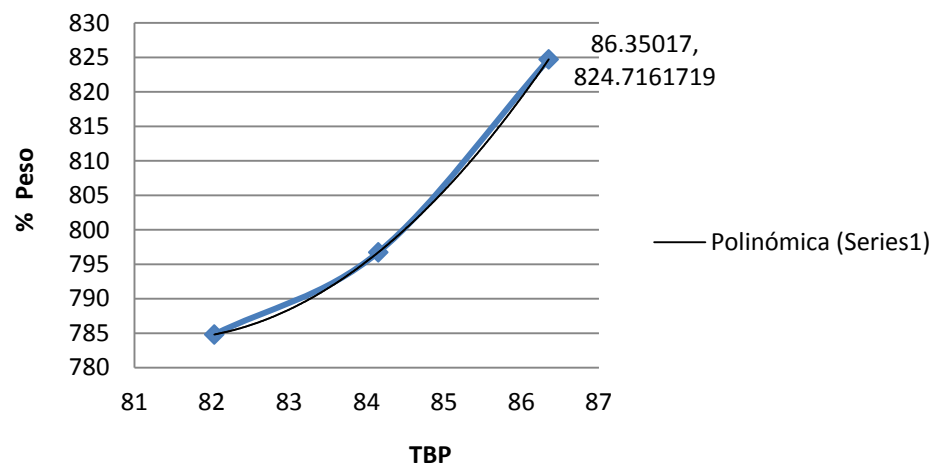
T = 315

$$y = 1.6403x^2 - 266.97x + 11646$$
$$R^2 = 1$$



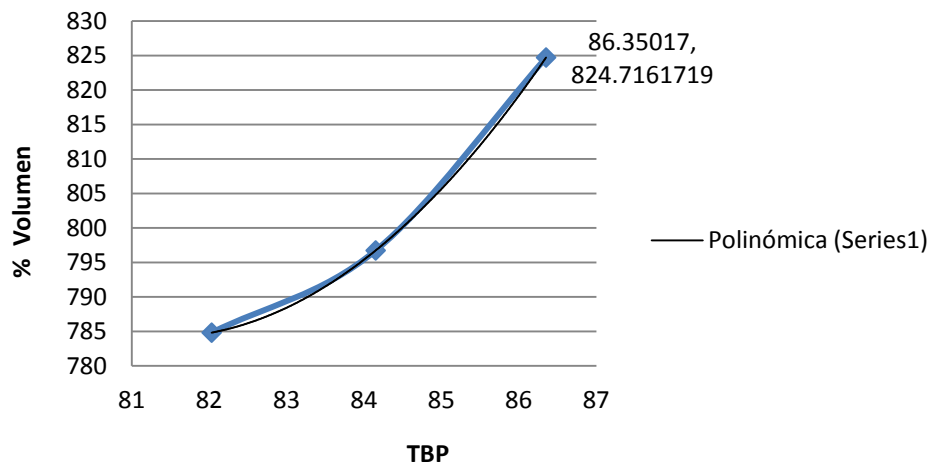
T = 315

$$y = 1.6403x^2 - 266.97x + 11646$$
$$R^2 = 1$$



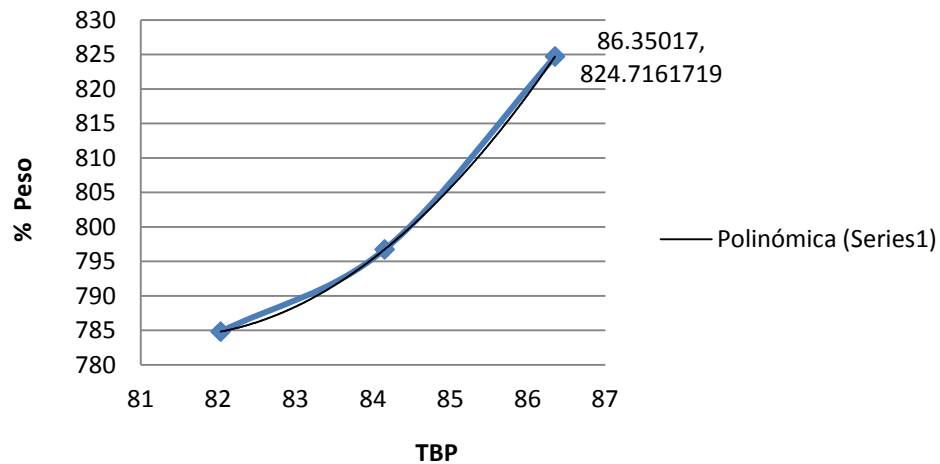
T = 450

$$y = 1.6403x^2 - 266.97x + 11646$$
$$R^2 = 1$$



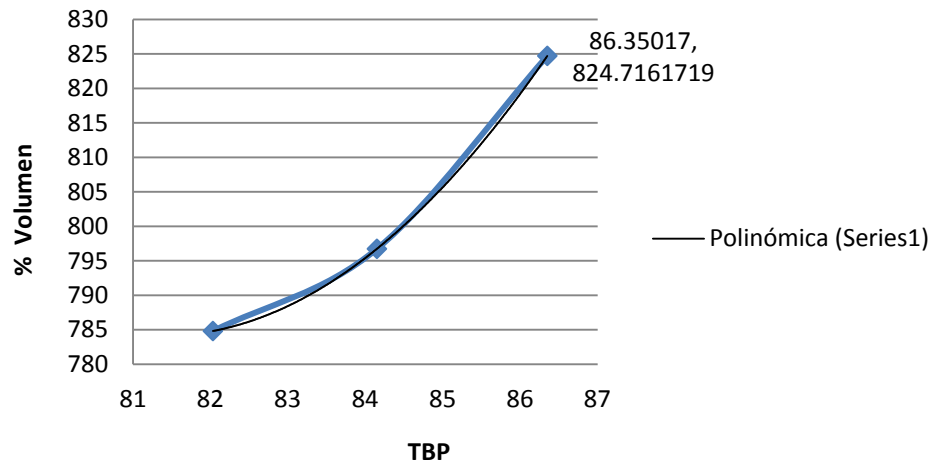
T = 450

$$y = 1.6403x^2 - 266.97x + 11646$$
$$R^2 = 1$$



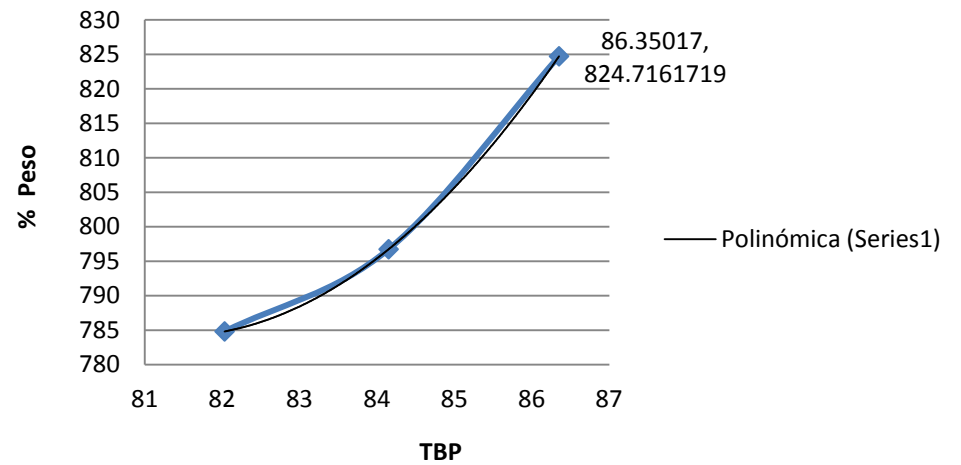
T = 800

$$y = 1.6403x^2 - 266.97x + 11646$$
$$R^2 = 1$$



T = 800

$$y = 1.6403x^2 - 266.97x + 11646$$
$$R^2 = 1$$



GRACIAS POR SU ATENCION