

Isotermas de adsorción

Para el cálculo de las isotermas de adsorción para el colorante natural añil se tomaron las siguientes consideraciones.

$$C_f = \frac{C_{ads}^s k_i C_b}{1 + k_i C_b} \quad (11.1)$$

$$\frac{1}{C_f} = \frac{1 + k_i C_b}{C_{ads}^s k_i C_b} \quad (11.2)$$

$$\frac{1}{C_f} = \frac{1}{C_{ads}^s k_i} \cdot \frac{1}{C_b} + \frac{1}{C_{ads}^s} \quad (11.3)$$

C_f es la concentración al equilibrio en la fibra, C_b la concentración final del baño después de la tintura, C_{ads}^s es la cantidad de adsorbato y k_i la constante de adsorción donde la pendiente de la recta es:

$$m = \frac{1}{C_{ads}^s k_i} \quad (11.4)$$

Y la ordenada al origen:

$$b = \frac{1}{C_{ads}^s} \quad (11.5)$$

Sustituyendo se obtiene la constante de adsorción:

$$k_i = \frac{b}{m} \quad (11.6)$$

El procedimiento para realizar el cálculo de la isoterma de adsorción para el colorante natural añil comprendieron las siguientes tinturas.

Temperatura	Numero de Tinturas
60	10
50	9
40	8

Tabla 11.1 Número de experimentaciones para la isoterma de adsorción

En cada una de las experimentaciones, se obtuvieron la concentración al equilibrio del colorante en la fibra y en el baño, dichos valores fueron obtenidos con la siguiente curva de calibración.

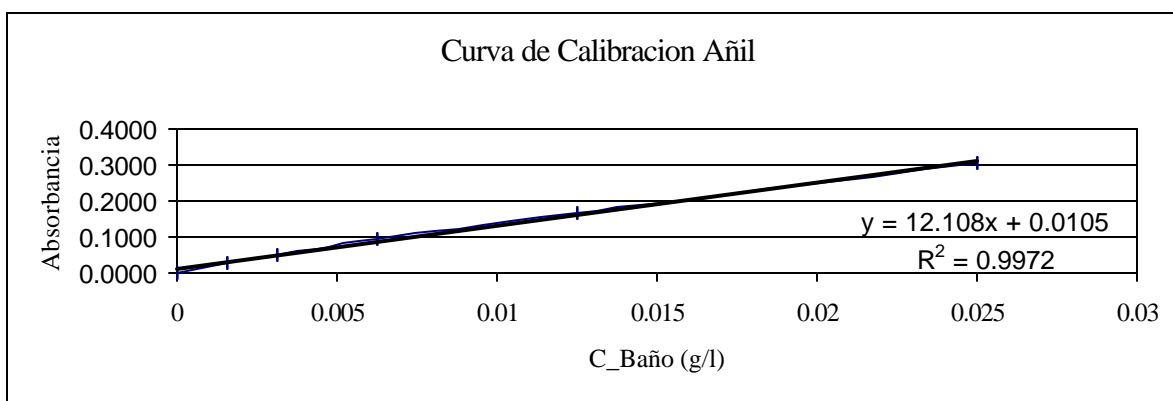


Figura 11.1 Curva de Calibración Añil para sistema cerrado

Es importante mencionar que la curva de calibración difiere de la anterior reportada porque las tinturas se realizaron en sistemas abiertos y para este caso en un sistema cerrado empleando el Mathis Labomat para tener un buen control de la temperatura. La lista de datos obtenidos se muestra a continuación.

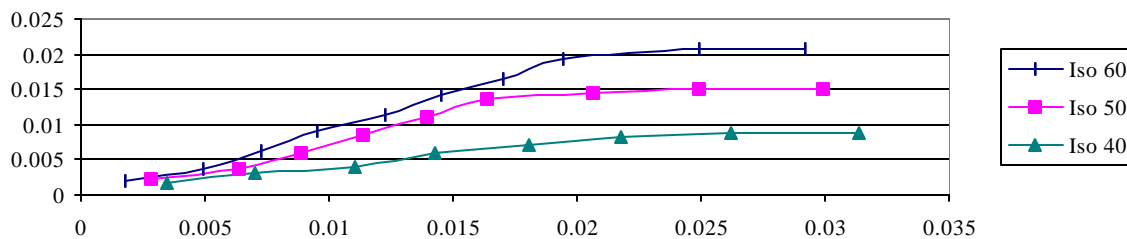


Figura 11.2 Isothermas de Adsorción para Anil²⁶

11.1 Isotherma a 40° C

Ci(wc/200ml)	Abs	Ci (g/l)	Cb (g/l)	Cf(g/l)	Cf/Adsorbato	1/Cb	1/Cf
0.00102	0.0520	0.0051	0.0034275	0.0016725	0.6690056	291.76	1.49
0.00202	0.0950	0.0101	0.0069789	0.0031211	1.2484572	143.29	0.80
0.00302	0.1440	0.0151	0.0110258	0.0040742	1.6296928	90.70	0.61
0.00402	0.1830	0.0201	0.0142468	0.0058532	2.3412884	70.19	0.43
0.00502	0.2290	0.0251	0.0180459	0.0070541	2.8216320	55.41	0.35
0.00602	0.2740	0.0301	0.0217625	0.0083375	3.3350116	45.95	0.30
0.00702	0.3280	0.0351	0.0262223	0.0088777	3.5510671	38.14	0.28
0.00802	0.3900	0.0401	0.0313429	0.0087571	3.5028345	31.91	0.29

Tabla 11.2 Datos de la isoterma a 40° C Anil

Isotherma a 40°C

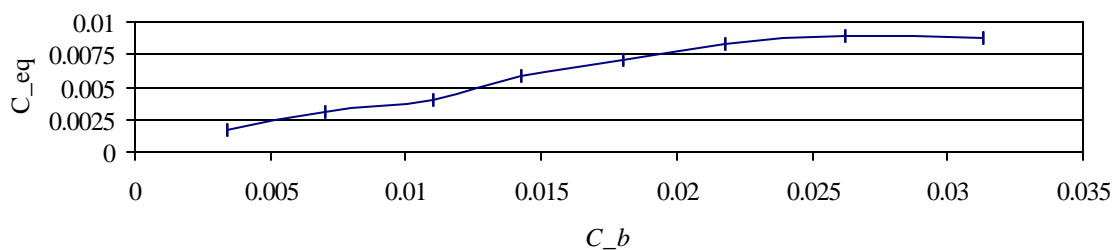


Figura 11.3 Isotherma a 40° C Anil

²⁶ Ver Apéndice E.

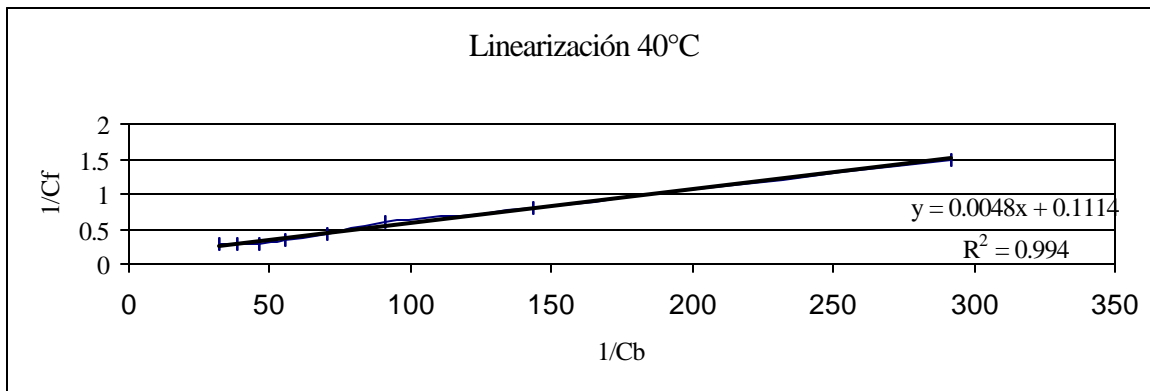


Figura 11.4 Linearización Isoterma a 40° C Añil

11.2 Isoterma a 50° C

Ci(wc/200ml)	Abs	Ci (g/l)	Cb (g/l)	Cf(g/l)	Cf/Adsorbato	1/Cb	1/Cf
0.001	0.0450	0.0050	0.0028494	0.0021506	0.8602577	350.96	1.16
0.002	0.0879	0.0100	0.0063925	0.0036075	1.4430129	156.43	0.69
0.003	0.1182	0.0150	0.0088949	0.0061051	2.4420218	112.42	0.41
0.004	0.1484	0.0200	0.0113892	0.0086108	3.4443343	87.80	0.29
0.005	0.1797	0.0250	0.0139742	0.0110258	4.4103072	71.56	0.23
0.006	0.209	0.0300	0.0163941	0.0136059	5.4423522	61.00	0.18
0.007	0.2604	0.0350	0.0206392	0.0143608	5.7443013	48.45	0.17
0.008	0.3125	0.0400	0.0249422	0.0150578	6.0231252	40.09	0.17
0.009	0.3732	0.0450	0.0299554	0.0150446	6.0178394	33.38	0.17

Tabla 11.3 Datos de la isoterma a 50° C Añil

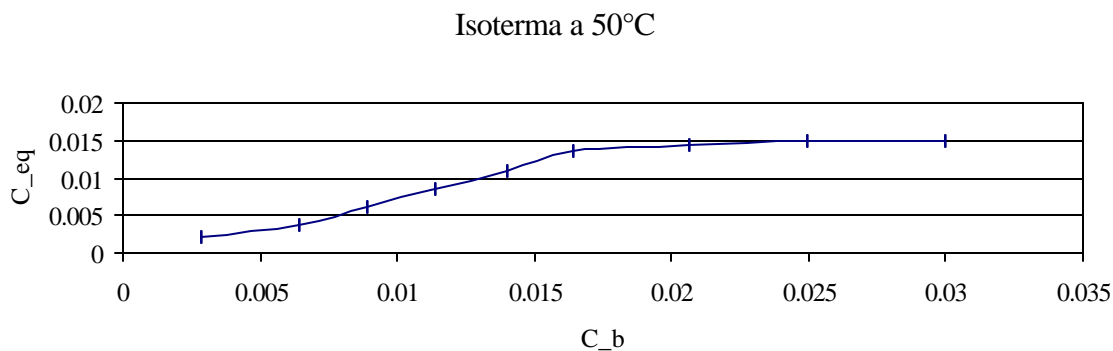


Figura 11.5 Datos de la isoterma a 50° C Añil

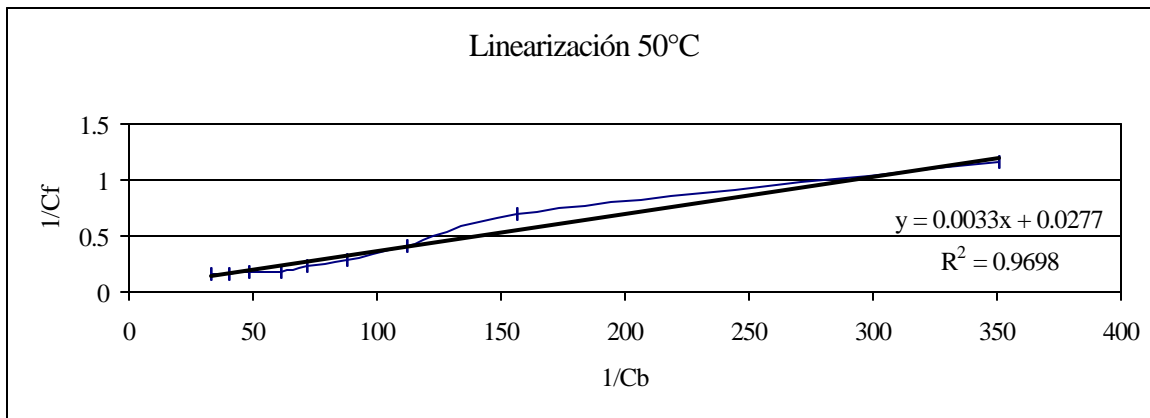


Figura 11.6 Linearización Isoterma a 50° C Añil

11.3 Isoterma a 60° C

Ci(wc/200ml)	Abs	Ci (g/l)	Cb (g/l)	Cf(g/l)	Cf/Adsorbato	1/Cb	1/Cf
0.00073	0.0319	0.0037	0.0017674	0.0018826	0.7530294	565.79	1.33
0.00173	0.0703	0.0087	0.0049389	0.0037111	1.4844466	202.47	0.67
0.00273	0.0986	0.0137	0.0072762	0.0063738	2.5495276	137.43	0.39
0.00373	0.1256	0.0187	0.0095061	0.0091439	3.6575553	105.20	0.27
0.00473	0.1590	0.0237	0.0122646	0.0113854	4.5541526	81.54	0.22
0.00573	0.1860	0.0287	0.0144945	0.0141555	5.6621804	68.99	0.18
0.00673	0.2170	0.0337	0.0170548	0.0165952	6.6380641	58.63	0.15
0.00773	0.2459	0.0387	0.0194417	0.0192083	7.6833234	51.44	0.13
0.00914	0.3127	0.0457	0.0249587	0.0207413	8.2965180	40.07	0.12
0.0100	0.3640	0.0500	0.0291956	0.0208044	8.3217707	34.25	0.12

Tabla 11.4 Datos de la isoterma a 60° C Añil

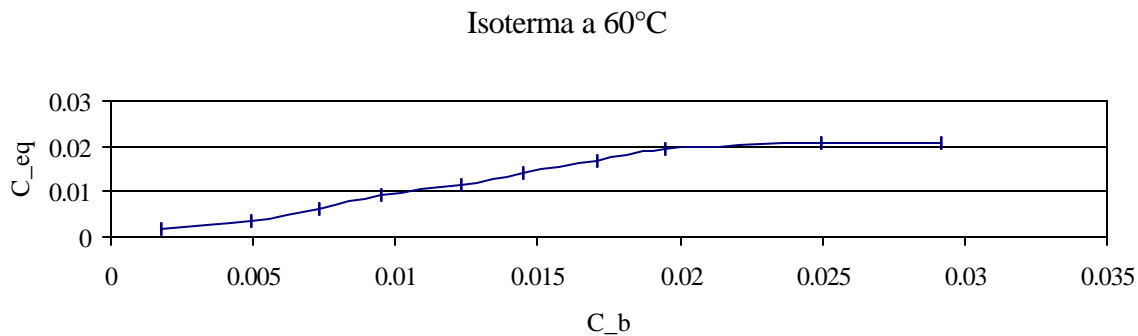


Figura 11.7 Datos de la isoterma a 60° C Añil

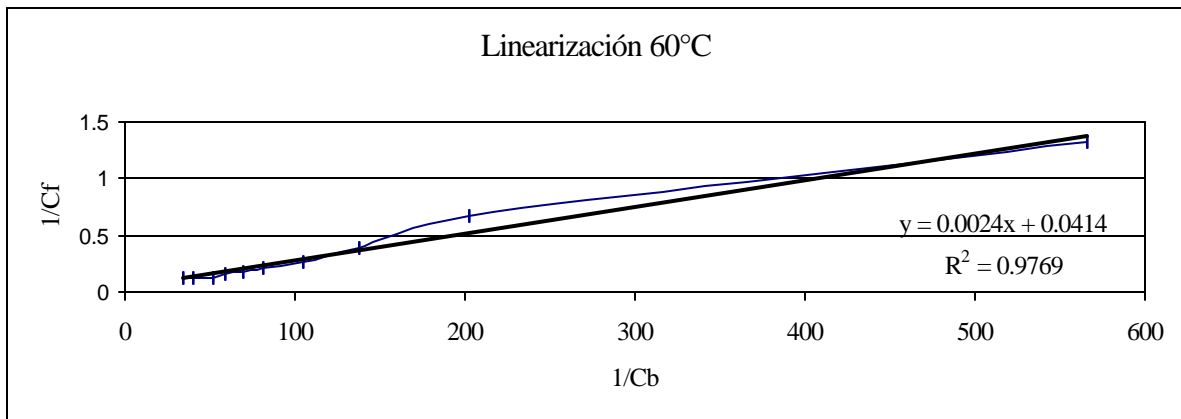


Figura 11.8 Linearización Isotherma a 60° C Añil²⁶

Obteniéndose la constante k en función de la temperatura.

Temperatura	Constante de adsorción k.
40° C	23.2083
50° C	17.2500
60° C	8.3939

Tabla 11.5 Constante de adsorción

²⁶ Ver Apéndice E.

11.4 Analysis of 40°C Isotherm

The regression equation is

$$1/C_f = 0.112 + 0.00476 1/C_b$$

Predictor	Coef	StDev	T	P
Constant	0.11231	0.01904	5.90	0.001
1/C _b	0.0047587	0.0001514	31.42	0.000

S = 0.03482 R-Sq = 99.4% R-Sq(adj) = 99.3%

Analysis of Variance

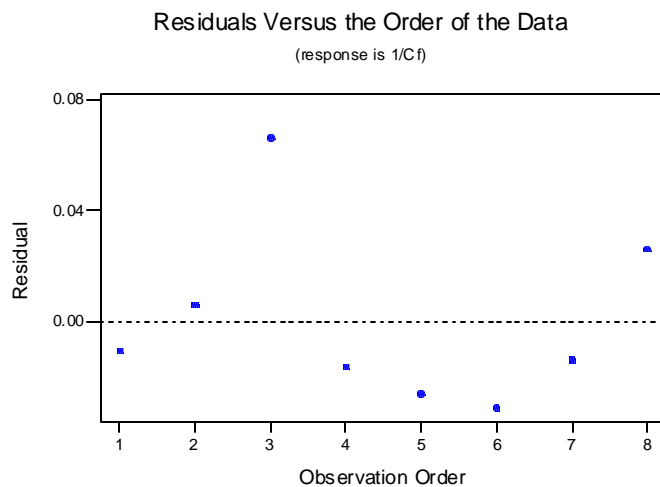
Source	DF	SS	MS	F	P
Regression	1	1.1970	1.1970	987.36	0.000
Residual Error	6	0.0073	0.0012		
Total	7	1.2043			

Unusual Observations

Obs	1/C _b	1/C _f	Fit	StDev Fit	Residual	St Resid
1	292	1.4900	1.5007	0.0321	-0.0107	-0.79 X
3	91	0.6100	0.5439	0.0123	0.0661	2.03R

R denotes an observation with a large standardized residual

X denotes an observation whose X value gives it large influence.



11.5 Analysis of 50°C Isotherm

The regression equation is

$$1/C_f = 0.0288 + 0.00334 \ 1/C_b$$

Predictor	Coef	StDev	T	P
Constant	0.02880	0.03171	0.91	0.394
1/C _b	0.0033373	0.0002231	14.96	0.000

S = 0.06272 R-Sq = 97.0% R-Sq(adj) = 96.5%

Analysis of Variance

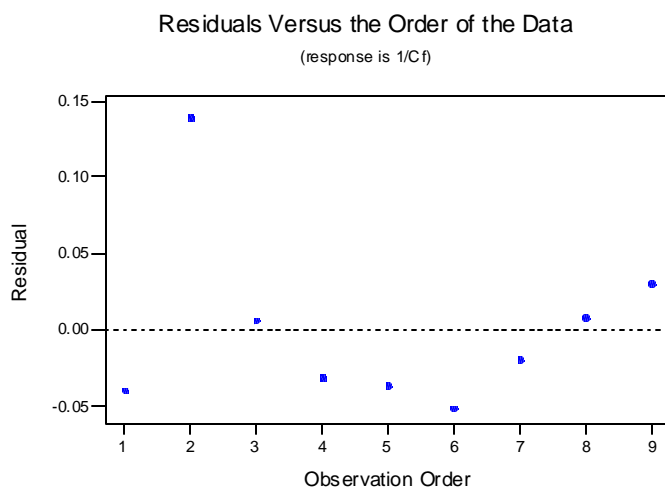
Source	DF	SS	MS	F	P
Regression	1	0.88049	0.88049	223.83	0.000
Residual Error	7	0.02754	0.00393		
Total	8	0.90802			

Unusual Observations

Obs	1/C _b	1/C _f	Fit	StDev Fit	Residual	St Resid
1	351	1.1600	1.2001	0.0583	-0.0401	-1.74 X
2	156	0.6900	0.5509	0.0236	0.1391	2.40R

R denotes an observation with a large standardized residual

X denotes an observation whose X value gives it large influence.



11.6 Analysis of 60°C Isotherm

The regression equation is

$$1/C_f = 0.0405 + 0.00236 1/C_b$$

Predictor	Coef	StDev	T	P
Constant	0.04050	0.02539	1.59	0.149
1/C _b	0.0023591	0.0001252	18.84	0.000

S = 0.06008 R-Sq = 97.8% R-Sq(adj) = 97.5%

Analysis of Variance

Source	DF	SS	MS	F	P
Regression	1	1.2813	1.2813	355.00	0.000
Residual Error	8	0.0289	0.0036		
Total	9	1.3102			

Unusual Observations

Obs	1/C _b	1/C _f	Fit	StDev Fit	Residual	St Resid
1	566	1.3300	1.3753	0.0572	-0.0453	-2.48RX
2	202	0.6700	0.5182	0.0208	0.1518	2.69R

R denotes an observation with a large standardized residual

X denotes an observation whose X value gives it large influence.

