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ADSORPTION ISOTHERMS FOR THE REMOVAL OF Fe AND Pb BY ADSORPTION

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*T*here is a defined distribution of solute between the solution and solid phase at the equilibrium when any particular temperatures at the solid solution interface. This provides an idea about the capacity of the adsorbent for the adsorbates. At constant temperature, the maximum possible accumulation of the solute at the solid surface is a function of its concentration

viz-**qe=f(Ce)** **…(1)**

Where, qe (mg g^{-1}), is the amount of adsorbate-adsorbent at equilibrium and Ce (mgl^{-1}) is the equilibrium concentration of the adsorbate in solution. This type of relationship is generally named as adsorption isotherm.There are various types of adsorption isotherms have been proposed from time to time for explaining the equilibrium data. But previous study reveals that, the validity of particular isotherms is highly limited and is quite specific to the actual nature of the system, for a given range of variations.

The present study of isotherms is helpful in determining the adsorption capacity of various adsorbents for the removal of Fe and Pb. The applicability of Langmuir isotherm at different temperature has been tested. The study of adsorption isotherm helps the environments in selecting an appropriate adsorbent for a particular temperature.

EXPERIMENTAL:

Different 250ml glass bottles containing 50ml aqueous solution each of Fe and Pb were agitated with 1.0 gm of different adsorbents till the equilibrium is established in each bottle at constant temperature.

The equilibrium data for different adsorbate-adsorbents system are reported in table 1.1-1.4

Table 1.1 Equilibrium data for the adsorption of Fe on Fly ash at different concentration and temperature

Initial concentration (mg)	*DIFFERENT TEMPERAURE*					
	20±0.1° C		**30±0.1° C**		**40±0.1° C**	
	Equilibrium concentration (mgl^{-1})	**Amount adsorbed (mgl^{-1})**	**Equilibrium concentration (mgl^{-1})**	**Amount adsorbed (mgl^{-1})**	**Equilibrium concentration (mgl^{-1})**	**Amount adsorbed (mgl^{-1})**
4.0	0.06	0.201	0.26	0.190	0.45	0.185
5.0	0.28	0.241	0.44	0.235	0.69	0.219
6.0	0.44	0.286	0.76	0.272	1.08	0.254
7.0	0.76	0.318	1.18	0.298	1.56	0.280
8.0	1.16	0.355	1.64	0.336	1.98	0.316
9.0	1.70	0.382	2.18	0.347	2.54	0.328

Note-Particle Size: <53µm, pH=4.0

Table 1.2 Equilibrium data for the adsorption of Fe on China clay at different concentration and temperature:

Initial concentration (mg)	***DIFFERENT TEMPERAURE***					
	20±0.1° C		**30±0.1° C**		**40±0.1° C**	
	Equilibrium concentration (mgl^{-1})	**Amount adsorbed (mgl^{-1})**	**Equilibrium concentration (mgl^{-1})**	**Amount adsorbed (mgl^{-1})**	**Equilibrium concentration (mgl^{-1})**	**Amount adsorbed (mgl^{-1})**
4.0	1.56	0.135	1.74	0.124	1.84	0.116
5.0	2.18	2.36	2.38	0.145	2.56	0.128
6.0	2.80	2.96	2.96	0.162	3.26	0.148
7.0	3.56	3.84	3.84	0.171	3.94	0.162
8.0	4.40	4.50	4.56	0.190	4.78	0.171
9.0	5.18	5.34	5.34	0.196	5.70	0.176

Note-Particle Size: <53µm, pH=4.0

Table 1.3 Equilibrium data for the adsorption of Pb on Fly ash at different concentration and temperature:

Initial concentration (mg)	***DIFFERENT TEMPERAURE***					
	20±0.1° C		**30±0.1° C**		**40±0.1° C**	
	Equilibrium concentration (mgl^{-1})	**Amount adsorbed (mgl^{-1})**	**Equilibrium concentration (mgl^{-1})**	**Amount adsorbed (mgl^{-1})**	**Equilibrium concentration (mgl^{-1})**	**Amount adsorbed (mgl^{-1})$^{-1}$-**
10	3.56	0.335	4.70	0.285	5.70	0.230
20	8.10	0.610	10.50	0.540	12.80	0.390
30	15.40	0.770	17.40	0.660	21.50	0.470
40	24.50	0.810	26.50	0.730	30.40	0.550
50	34.50	0.850	35.50	0.770	39.50	0.590

Note-Particle Size: <53µm, pH=7.2

Table 1.4 Equilibrium data for the adsorption of Pb on China clay at different concentration and temperature:

Initial concentration (mg)	***DIFFERENT TEMPERAURE***					
	20±0.1° C		**30±0.1° C**		**40±0.1° C**	
	Equilibrium concentration (mgl^{-1})	**Amount adsorbed (mgl^{-1})**	**Equilibrium concentration (mgl^{-1})**	**Amount adsorbed (mgl^{-1})**	**Equilibrium concentration (mgl^{-1})**	**Amount adsorbed (mgl^{-1})**
10	2.20	0.550	3.30	0.450	4.50	0.280
20	7.25	0.850	9.50	0.700	9.70	0.490
30	12.80	0.950	15.50	0.850	19.50	0.680
40	22.80	1.13	23.80	0.890	25.80	0.750
50	30.70	1.16	33.40	0.960	36.90	0.750

Note-Particle Size: <53µm, pH=7.2

The equilibrium data for the adsorption of Fe and Pb from their aqueous solution at the various temperatures were analyzed in the light of Langmuir mode of adsorption, which is based on mono-molecular adsorbed layer on the surface of the adsorbent. The rearranged Langmuir equation based on above argument may be written as;

$$Ce/qe=1/Q_0b+Ce/Q_0 \qquad \ldots(2)$$

Where, ce and qe are the equilibrium concentration of adsorbate in solution (mgl^{-1}) and amount of adsorbate adsorbed at equilibrium (mgg^{-1}) respectively, Q_0 and b are related to the capacity and energy of adsorption respectively.

The straight line plots ce/qe Vs ce for the adsorption of Fe and Pb for all systems confirm the validity of the Langmuir isotherm in the present concentration. The value Q_0 and b at 20,30 and 40 ˚C were determined from the slopes and intercepts of respective plots in each system.

The validity of Langmuir isotherm was further examined by the regression analysis of the equilibrium data at 20, 30 and 40 ˚C using following equation representing the slope (m) and intercept (c) of straight line.

$$\mathbf{M}=\frac{n\Sigma x1y1-\Sigma n1y1_{-}}{n\Sigma x1-(\Sigma x1)^2} \qquad \textbf{...(3)}$$

And,

$$\mathbf{C=1/n}[\Sigma yi - m\Sigma xi] \qquad \textbf{...(4)}$$

Where,n is the number of pair of x and y, here x is ce and y is ce/qe. The value of m and c were calculated and substituted in straight line equation y = mx+c, to give the following relations for different system at 20,30 and 40˚ c respectively.

(1)For Fe-Fly ash

ce/qe=2.6000ce+0.5260 …(5)

ce/qe=2.8400ce+0.7400 …(6)

ce/qe=3.143ce+0.9190 …(7)

(2)For Fe-China clay

ce/qe=3.5490ce+7.6000 …(8)

ce/qe=3.6770ce+8.2490 …(9)

ce/qe=3.9900ce+9.860 …(10)

(3)For Pb-Fly ash

ce/qe=0.9470ce+7.7660 …(11)

ce/qe=1.1430ce+10.9560 …(12)

ce/qe=1.5480ce+15.5720 …(13)

(4)For Pb-China Clay

ce/qe=0.9304ce+3.5520 …(14)

ce/qe=0.8970ce+6.6300 …(15)

ce/qe=0.9910ce+12.2380 …(16)

Table 1.5Langmuir Constant (graphical and regression values) at different temperature for various adsorbates-adsorbents system:

Adsorbate	Adsorbent	Temperature ±0.1°C	Langmuir Constant			
			Q_0(mg g^{-1})		B (mg l^{-1})	
			Graphical values	Regression values	Graphical values	Regression values
Fe	Fly ash	20	0.4400	0.4380	5.9000	5.8600
Fe	Fly ash	30	0.3800	0.3960	4.7000	4.4550
Fe	Fly ash	40	0.3600	0.3536	3.8400	3.4990
Fe	China Clay	20	0.2900	0.2950	0.4865	0.4780
Fe	China Clay	30	0.2800	0.2840	0.4580	0.4560
Fe	China Clay	40	0.2700	0.2718	0.4190	0.4170
Pb	Fly ash	20	1.1550	1.1338	0.1450	0.1324
Pb	Fly ash	30	0.9450	0.9634	0.1284	0.1005
Pb	Fly ash	40	0.8000	0.6990	0.0850	0.9900
Pb	China Clay	20	1.3000	1.3050	0.2580	0.2550
Pb	China Clay	30	1.1000	1.1390	0.1720	0.1475
Pb	China Clay	40	1.1028	1.1390	0.0990	0.0905

CONCLUSION:

It is clear from the table 1.5 that the adsorption capacity of fly ash and china clay for the adsorption of Fe and Pb decreases with increasing solution temperature from 20 to 40˚C.

The result reported from the above study may prove vital to public health engineer with respect to the following facts:

(1)Higher adsorption capacity of different adsorbents would be helpful in selecting a particular adsorbent for a particular adsorbate in order to get maximum removal,and

(2)The equilibrium data may be used in designing and fabricating a wastewater treatment plant having low input and output policy.

REFERENCES:

1. Furusawa, T. and Smith ,J.M, Am.Inst.Chem.Eng.J., 19,401(1973), 20 88(1974). “Fly ash and its application as a building material ”, Booklet No. 16 , U.N. Regional Housing Centre ,ECAFE ,New Delhi, India(1970).
2. Gupta, G.S. , Prasad, G. Pandey,K.K. and Singh, V.N. ,water,air and soil pollution, 37, 13(1988).
3. Gupta, G.S. , Prasad, G. and Singh, V.N. ,J.Environ. Sci. Hlth., A23, 205(1988).
4. Govindan , V.S. and Sundarlingam, S. V. , Indian J, Environ. Hlth., 21, 321(1979).
5. Gupta, G.S. , Prasad, G. and Singh, V.N. ,J.Environ. Tech. Lett., 9 , 153(1988).
6. Gupta, G.S. , Prasad, G. ,Pandey,K.K and Singh, V.N. ,IAWPC Tech. Annual., 13,83(1986).
7. Gadsen ,J.A ,”Infrared Spectra of Minerals and Related Inorganic Compounds”, Butterworths ,London (1975).
8. Gupta, G.S. , Prasad, G. and Singh, V.N. Research and Industry ,33, 132(1988).
9. Jain , K.K, Ph.D. Thesis , Banaras Hindu University, Varanasi, India(1980)
10. Khanna. P and Malhotra S.K, Indian J Environ. Hlth. 19, 224(1977).
11. Khare , S.K Pandey, K.K. Srivastava, R.M.N and Singh ,V.N.,J . Chem. Tech. Biotechnol., 38, 99(1987).
12. Mokay, G., Ramprasad , G. and Mowali .P.P , water ,Air and Soil Pollution, 29,273 (1986).
13. Mundhra, G.L. , Tiwari, M.P. and Tiwari, J.S. ,J. Indian. Chem. Soc. 57 , 404 (1980a).
14. Mahanta,D.andRahman,A. ,Indian J.Chem.,25A,825 (1986).

15. Mckay , G. water. Air and Soil Pollut. 12, 307(1979).
16. Mckay , G. , Otterburn, M.S. and Aga ,Water, Air and Soil Pollut. , 36 , 381(1987).
17. Pandey , K.K , Prasad , G . and Singh , V.N Water, Air and Soil Pollut., 27 ,287(1986).
18. Pandey , K.K , Prasad , G . and Singh, V.N. , Indian J. Chem. , 23A ,514(1984).