STUDIES OF FREUNDLICH ADSORPTION ISOTHERM ON THE ADSORBENT PREPARED FROM WASTE MATERIAL.

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Abstract –
Nowadays water contamination is a serious problem because of harmful effects on human being. Various methods are used for removal of heavy metals from contaminated water. Adsorption is one of the methods. In present study adsorbents were prepared from waste materials like fenugreek Sticks, peels of green chana and peels of watermelon. Freundlich adsorption isotherm was studied for the adsorbents prepared from waste material. The adsorbent was found to be good for removal of heavy metals.

Keywords - Adsorption, adsorbent, Freundlich and Langmuir adsorption isotherm.

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Introduction –

As a result of rapid industrialization, global population growth, industrial exploitation of natural resources the environmental pollution has increased to a noticeable level.[1,2] The growth of industry, agricultural and municipal activities has contributed directly to rise in the continuous discharge of heavy metals, phenolic and phosphate compounds, dyes, inorganic compounds into water bodies[3]. Heavy metal ions are found in waste water due to waste from industry, agriculture. Accumulation of heavy metals because of its toxicity in living tissues throughout the food chain is still measure concerns of human life. The danger of heavy metals is due to cancer, brain damage, poisoning.[1] Many methods like floatation, precipitation, floatation, electro dialysis, membrane adsorption, ion exchange, reverse osmosis, membrane filtration, ion exchange [1,4] methods are used for removal of heavy metals The key drawbacks of membrane filtration system are the problems of regeneration, high cost and getting rid of the produced sludge[5]. Due to high expenditure and maintenance and disposal of residual metal sludge, reverse osmosis and ion exchange don't seem to be low cost potential[6]. Heavy metals are poisonous, bio-accumulative and non biodegradable and are harmful to both people and aquatic life[7]. Organic pollutants could be generated to environment due to pesticides, fertilizers, phenols, plasticizers, detergents, oils, pharmaceuticals, proteins, carbohydrates[8]. Adsorption is a surface phenomenon which is nowadays used for removal of heavy metals from contaminated industrial waste water. Amongst all methods, adsorption is the cheaper method used for removal. Adsorbents are prepared from various materials. To study adsorption waste materials like fenugreek sticks, watermelon peels, green chana peels are used for adsorption studies. Several adsorption isotherms like Freundlich, Langmuir, BET, Gibb's adsorption isotherm have been used to describe adsorption phenomenon. In present work Freundlich adsorption isotherms is used. The Freundlich isotherm explains about the adsorption process wherein a heterogeneous adsorbent surface involves in the monolayer distribution of the adsorbate with interaction amongst adsorbed molecules. A low cost adsorbent is one which needs a little processing before use, abundant in nature, a by- product or waste material from industry. For improving sorption capacity may require the cost for additional processing. Many researchers conducted research for developing inexpensive and effective adsorbents for removal of heavy metal ions. The main aim of this work was to prepare activated charcoal from waste fenugreek sticks, watermelon peels and green chana peels and to study their adsorption capacity.

Experimental method –

The waste materials like fenugreek sticks, watermelon peels, green chana peels were washed thoroughly with distilled water several times and dried. Carbon prepared from it was activated with calcium chloride. In this way prepared charcoal was used for experiment.

Freundlich Adsorption –

The amount of gas adsorbed depends on the equilibrium pressure and temperature. The curve obtained by plotting amount of gas adsorbed on a solid surface against the pressure of the gas or concentration of solution at constant temperature are called as "Adsorption isotherm". The relation is expressed mathematically by empirical equation known as Freundlich adsorption isotherm.

$$x/m = K C^{1/n} \quad \text{---------} \ (1)$$

x = amount of solute adsorbed

m = mass adsorbent

C = equilibrium concentration of adsorbed substance in the solution.

$$\log x/m = \log K + n \log C \quad \text{-----}(2)$$

If the graph is plotted by taking log x/m on Y- axis and log C along X-axis, a straight line graph will be obtained with the slope 1/n.

Experimental Method -

Six bottles were prepared as given in table along with prepared activated charcoal and oxalic acid solution. Bottles were shaken for one hour and then the filtered solution was titrated with standardised sodium hydroxide solution.

For fenugreek sticks Activated charcoal –

Bottle No.	Wt. of charcoal taken(m) gm	Acid+ Water	Vol. of NaOH for 10 ml acid before adsorption (A) ml	Vol. of NaOH for 10 ml acid After adsorption (C) ml	Amount of acid adsorbed in terms of NaoH (X= A-C)	X/m	Log X/m	Log C	$\frac{C}{x/m}$
1.	0.1 g	50+0	20	17.5	2.5	25	1.3979	1.2430	0.7
2.	0.1 g	40+10	16	13.7	2.3	23	1.3617	1.1367	0.5956
3.	0.1 g	30+20	18	14.9	3.1	31	1.4913	1.1731	0.4806
4.	0.1 g	20+30	4	2.5	1.5	15	1.1769	0.3979	0.1666

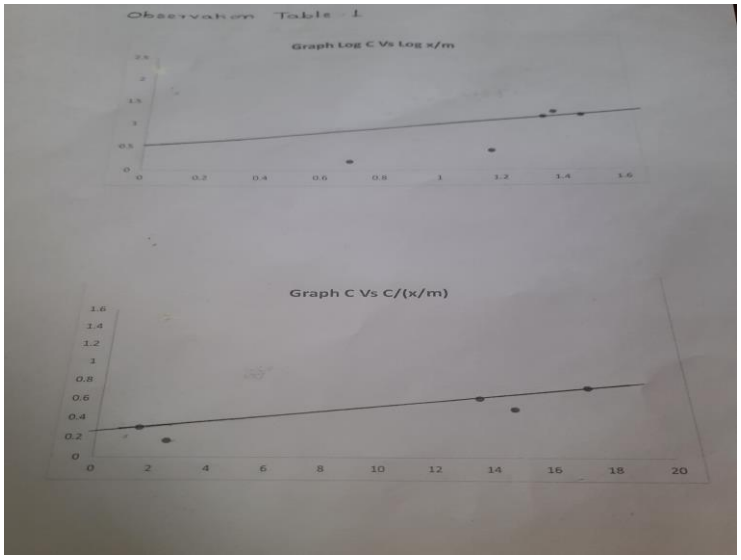
5.	0.1 g	10+40	2	1.5	0.5	5	0.6989	0.1760	0.3
6.	0.1 g	5+45	2	1.9	0.1	1	0	0.2787	1.5

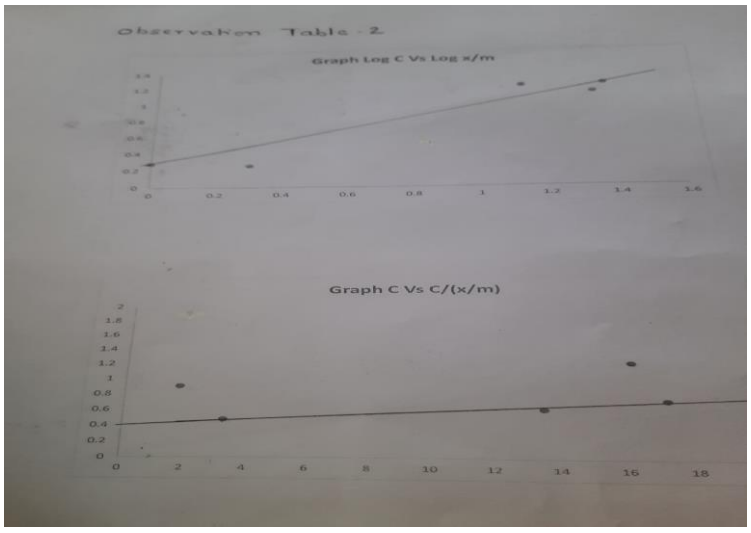
For Green chana peels Activated charcoal

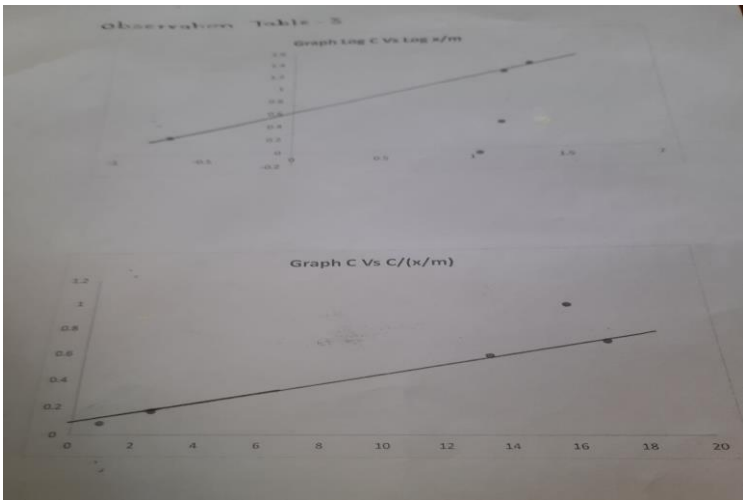
Bottle No.	Wt. of charcoal taken (m) gm	Acid+ Water	Vol. of NaOH for 10 ml acid before adsorption (A) ml	Vol. of NaOH for 10 ml acid After adsorption (C) ml	Amount of acid adsorbed in terms of NaoH (X= A-C)	X/m	Log X/m	Log C	$\frac{C}{x/m}$
1.	0.1 g	50+0	20	17.5	2.5	25	1.3979	1.2430	0.7
2.	0.1 g	40+10	16	13.7	2.3	23	1.3617	1.1367	0.5956
3.	0.1 g	30+20	18	16.6	1.4	14	1.1461	1.2201	1.1857
4.	0.1 g	20+30	4	3.3	0..7	7	0.8450	0.5185	0.4714
5.	0.1 g	10+40	2	1.8	0.2	2	0.3010	0.2552	0.9
6.	0.1 g	5+45	2	1.9	0.1	1	0	0.2787	1.9

For Watermelon peels Activated charcoal -

Bottle No.	Wt. of charcoal taken(m) gm	Acid+ Water	Vol. of NaOH for 10 ml acid before adsorption (A) ml	Vol. of NaOH for 10 ml acid After adsorption (C) ml	Amount of acid adsorbed in terms of NaoH (X= A-C)	X/m	Log X/m	Log C	$\frac{C}{x/m}$
1.	0.1 g	50+0	20	17.4	2.6	26	1.4149	0.4149	0.6692
2.	0.1 g	40+10	16	13.6	2.4	24	1.3802	1.1335	0.5666
3.	0.1 g	30+20	18	16.3	1.7	17	1.2304	1.2121	0.9588
4.	0.1 g	20+30	4	2.5	1.5	15	1.1760	0.3979	0.1666
5.	0.1 g	10+40	2	0.9	1.1	11	1.0413	-0.0475	0.0818
6.	0.1 g	5+45	2	1.8	0.2	2	-0.6989	0.2552	0.9







Result and Discussion –

The Freundlich adsorption isotherm was studied for the adsorbent prepared from waste materials. It was found that the adsorbent obeys Frundlich and adsorption isotherm. It was clear that the prepared adsorbent can be used for removal of heavy metal ions. Nowadays removal of heavy metals from contaminated water is a problem by other methods. Adsorption is a cheaper method for removal of heavy metals provided the cost of adsorbent should be less. Hence the adsorbent prepared from waste material can be used for removal of heavy metals as it is cheaper.

References

1. S. Singh, K.C. Barick and Bahadur," Functiponal oxide nanomaterials and nanocomposites for removal of heavy metals and dyes." Nanomater. Nanotechnol. Vol. 3, No. 1, pp 1-19, 2013, doi: 10, 5772/57237.
2. S. Hao, Y Zhong, F. Pepe, and W. Zhu," Adsorption of Pb2+ and Cu2+ on anionic surfactant- tempted aminofunctionalised mesocorpus silicas." Chem Eng. J. Vol. 189-190, pp. 160-167, 2012, doi: 10, 1016/j cej.2012.02.047.
3. S. Singh, K. L. Wasewar, and S. K. Kansal," Low-cost adsorbents for removal of inorganic impurities from wastewater." INC, 2020.
4. M. Nageeb," Adsorption technique for Removal of Organic Pollutants from water and Waste Water". Organic Pollut. -Mohit Risk Treat., 2013, doi: 10.5772/54048.
5. S. S. Fiyadh, Alsaadi, Mohammed Abdulhakim, Jaafar,, Wan Zurina, Alomar, Mohamed Khalid, Fayad, Sabah saadi, Mohd. Nuruol Syuhadaa, Hin. Lai Sai," Review on heavy metal adsorption processes by carbon nanotubes". J. Clean. Prod., Vol. 230, pp783-793, 2019, doi:10. 1016/ j. jclepro. 2019.05.154.
6. V.Ivanov, J. H. Tay, S. T. I. Tay, and H.I. Jiang,"Removal of micro-granules used for aerobic wastewater treatment." Water Sci. Technol., vol.50, no.12, pp 147-154,2004, doi: 10.2166wst.2004.0707
7. Y. Tan. M Chen,and Y. Hao,"High efficient removal of pb(II) by amino-functionalised Fe 3o 4 magnetic nanoparticles," Chem Eng.J.vol 191,pp 104-11,2012,doi:10.1016/ j.cej.2012. 02.075.
8. I.Ali,M. Asim,and T. A. Khan,"Low cost adsorbents for the removal of organic pollutants from wastewater,"J. Environ. Manage, vol. 113, pp170-183,2012, doi:10. 1016/jenvman.2012.08.028.
9. Acharya et. Al., 2009b J. Acharya, J. N. Sahu, B. K. Sahoo, C. R. Mohanty, B. C. Meikap, Removal of chromium (VI) from waste water by activated Carbon developed from Tamarind wood activated with zinc chloride. Chem. Eng. J., 150(1) (2009), pp. 25-39