THE ACTIVATED CHARCOAL ADSORPTION OF PHENOL

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Abstract

Key words: activated charcoal, phenol, adsorption, water treatment, Langmuir's and Friendlich's adsorption isotherm, physical adsorption, chemical adsorption, area, chemical reaction, experience.

Research field: Colloidal Chemistry.

Related sciences: Physics, Ecology, Mathematics .

The problems of treatment of the waste water were considered in this work. The main method of the activated charcoal adsorption of phenol was investigated. The adsorption properties of the adsorbent were also considered. Along with it Langmuir's and Friendlich's adsorption isotherm has been studied and analyzed.

Introduction

Objectives: researching of waste water was considered in this work. The main method of the activated charcoal adsorption of phenol from aqueous medium; the removal of phenol method of the activated charcoal adsorption of phenol from wastewater.

There are a lot of industrial companies which have problems of discharge into aqueous medium chlorophenol and phenol on the territory of the Russian Federation. These substances possess cancerogenic properties which promote destruction of biocenoses and deterioration of natural waters. Sewage water of industrial companies needs cleaning. There are methods of water treatment from phenol and chlorophenol: extraction, evaporation, sorption. Using of activated charcoal can be effective for purification of low-concentration sewage water. Phenols are widespread kind of industrial sewage water pollution. It is found in sewage water manufactures related to thermal processing of timber, shale, peat, plastics factories. For economic reasons, if concentration exceeds 2 g / l regeneration of phenols from sewage water is suitable. However, regeneration methods are sometimes used for lower concentrations.

The phenomenon of adsorption on the activated charcoal

We will consider the adsorption phenomenon on the activated charcoal and properties of this adsorbent. The activated charcoal is adsorbent with highly developed porosity which is received from various carboniferous materials: charcoal, coal coke, oil coke, coco shell, etc. The activated charcoal, made of a coco shell, is the best quality cleaning and service life. It can be regenerated repeatedly thanks to high durability. The activated charcoal possesses high adsorption because it has a large number of pores. Increase of porosity is called activation. This process consists in opening of closed pores by means of processing with superheated steam or carbon dioxide.

Classification of pores in the activated charcoal

Macro-, meso - and micro – pores are distinguish in activated charcoals. Activated charcoal should be processed with different ratio of pore size , since the adsorbates molecules have different sizes . Pores in activated charcoal are classified according to their linear dimensions – X (half-width - for the slit pore model , the radius - for the cylindrical or spherical model)

$X \leq 0,6\text{-}0,7$ nm - micropores ;

$0.6\text{-}0.7 < x < 1.5\text{-}1.6$ nm - super- micropores ;

$1.5\text{-}1.6 < x < 100\text{-}200$ nm - mesopores ;

$X > 100\text{-}200$ nm - macropores .

The mechanism of volume filling is characteristic for adsorption in micropore. In supermikropores -intermediate area between micropores and mesopores the adsorption takes place in a simiral way. In this area, properties of micropores gradually degenerate and properties of mesopore appear . The mechanism of adsorption in mesopores is sequential formation of adsorption layers (polymolecular adsorption) , which then is completed by pore the filling according to capillary condensation mechanism. Macropores serve as transport channels bringing absorbed molecules to adsorption space activated charcoal granules . Micro-and mesopores compcise the greatest part of the surface of activated charcoal , respectively , they contribute mostly to their adsorption properties . Micropores suit particularly well for adsorption of small sized molecules, but for mesopores adsorbtion large of organic molecules. Feedstock of activated charcoalstructure has determining influence. Activated charcoals based on coco shell are characterized by a higher proportion of micropores , and activated charcoal prodused by from coal - a larger share of mesopores. A large proportion of macropores is characteristic of activated charcoals based on timber. [3]

Intermolecular attraction which leads to the adsorption force exists in activated charcoalpores. The removed pollutant molecules are retained by intermolecular forces of Van der Waals on the surface of activated coal. Thus, activated charcoals remove contaminants from the being clean . Chemical reactions can also occur between the adsorbed substances and activated charcoal surface. These processes referred to as chemical adsorption or chemisorption . However, basically physical adsorption process occurs when an activated charcoal and the adsorbed substance react . Physical adsorption is reversible, i.e. adsorbed substances can be separated from the surface and returned to their original state under certain conditions. In chemisorption , associated adsorbate is linked with surface by means of chemical bonds. Chemisorption is not reversible. [4]

With this understanding of how the adsorption process works, we must then understand why it works, or why water contaminants become adsorbates. Water contaminants adsorb because the attraction of the carbon surface for them is stronger than the attractive forces that keep them dissolved in solution.Those compounds that are more adsorbable onto activated carbon generally have a lower water solubility, are organic (made up of carbon atoms), have a higher molecular weight and a neutral or non-polar chemical nature. It should be pointed out that for water adsorbates to become physically adsorbed onto activated carbon, they must be both dissolved in water and smaller than the size of the carbon pore openings so that they can pass into the carbon pores and accumulate.[5]

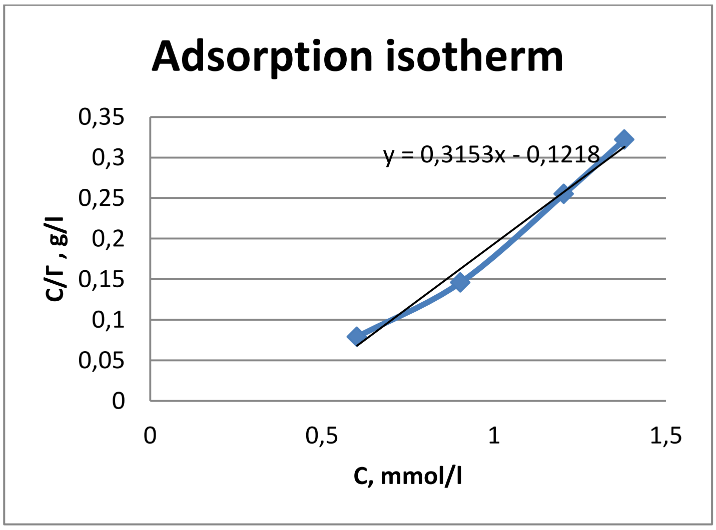
Experiment

We investigated efficiency of water purification from phenols by adsorption on activated charcoal.Forthe experiments we took phenol without rectification. The maximum solubility of phenol in water at the room temperature is 6,7 g on 100 ml. The concentration of phenol is 4 mol / l, 8 mol / l, 16 mol / l ,24 mol / l . We poured 1 g of activated charcoal previously pounded in a porcelain crucible and flowed the received solutions in the test tubes. We closed the test tubes jams, placed into a shaker and carried out adsorption process during 30 minutes supposing the adsorption equilibrium is established during this time. The concentration of phenol solution will decrease due to the adsorption of its molecules on the particles of coal. When phenol was adsorbed on activated charcoal at 20 ° C the following data were obtained:

Tab 1. The concentrations and phenol adsorption

Γ, mmol/g	1,2	1,4	1,8	2,1
C, mmol/l	4	8	16	24

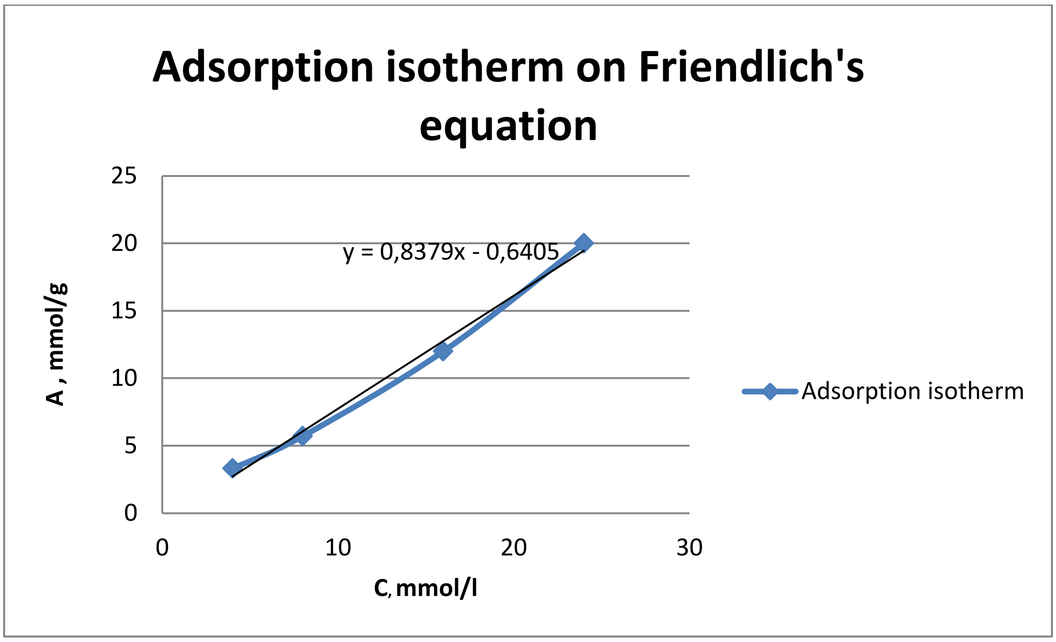
For more detailed studying we will determine adsorption by Langmuir and Friendlich's equation. We will analyze these equations and conclude which of them more accurately expresses the adsorption of phenol on activated charcoal. For finding of size of limit adsorption Γ_∞we will construct an adsorption isotherm in coordinates of a linear form of the equation of Langmuir C/Γ = f (C).



Graph 1. Adsorption isotherm.

We calculated constantsΓ_∞ and K in Langmuir’s equation on a graph: Γ_∞= 2,5 ; K = 0,2.

For finding of constants in Friendlich's equation of B and 1⁄n we will construct a straight line in coordinates Γ and C.

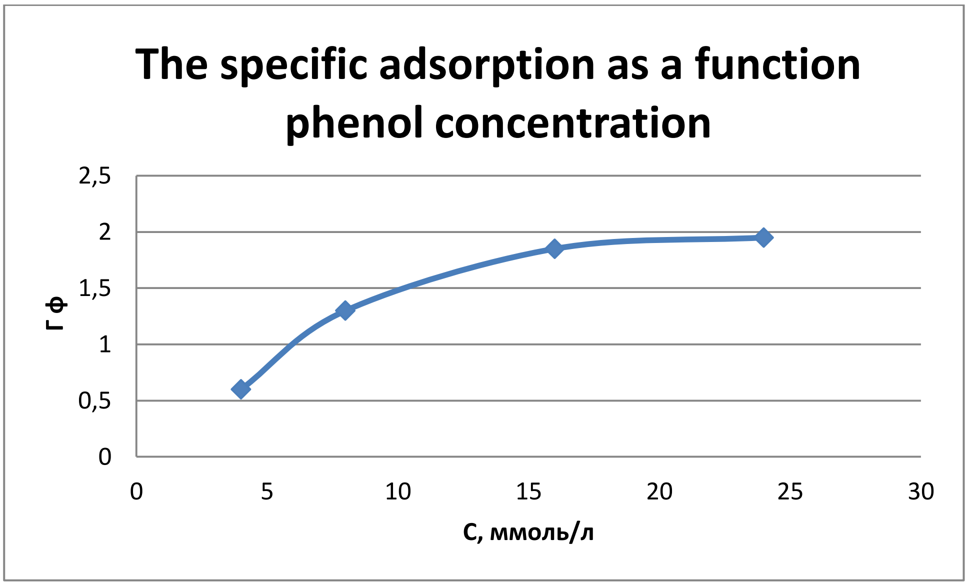


Graph 2.Adsorption isotherm on Friendlich's equation

We calculated constants in Friendlich's equation: $\mathcal{B}$ = 0,13; $^1/_n$ = 0,038.

We will construct dependence of specific adsorption on equilibrium concentration of phenol. We carry out construction by means of Friendlich's equation and experimental data. We will find value of specific adsorption $\Gamma_ф$ on Friendlich's equation:

$$\Gamma_ф = К \cdot C^{\frac{1}{n}}$$



Graph 3.The specific adsorption as a function phenol concentration

Friendlich's equation reflects process of adsorption of phenol as the isotherm of adsorption is more approximate to an isotherm constructed on experimental data.[6]

Conclusion

Water treatment from phenols is not only economically efficient, but also prevents deterioration of an ecological situation. There is an economy of means because we can return the phenol adsorbed on coal again in production. In the work we used isotherms of adsorption of Langmuir and Friendlich thanks to which it is possible to track sorption properties of a material which are necessary for definition of a technological mode of the adsorptive installation. Efficiency of removal of pollution depends on the nature polluting substance, type of coal, the initial levels of pollution and gas parameters.A thorough understanding of these sorptive mechanisms is essential for accomplishing the most effective use of active carbon in water and waste water treatment. Carbon adsorption on activated charcoal is a highly effective method and possesses high level of removal.

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