Water purification from phenol on materials from subtropical crops’ wastes

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Abstract. The article considers the possibility of using materials on the bases of wastes of subtropical crops for water purification from phenol. The modification of banana peel, orange peel and pineapple peel by chemical and thermal methods was carried out. The static and dynamic capacity of obtained sorbents was determined; their ability to regeneration was estimated.

Introduction

Phenol is one of the most widespread pollutants that transfer into the natural water bodies with discharge of sewage waters from various enterprises. It leads to the toxic influence on organisms and to the significant change in the regime of biogenous elements and dissolved gases (oxygen, carbon dioxide). The self-purification of water bodies from phenol is rather slow, therefore it is necessary to prevent their transfer into the environment.

Sorption materials, which are in a dissolved condition, are used for the phenol removal. These sorption materials can be obtained from various wastes: wood shavings [1], wastes from processing of the buckwheat husks and sunflower husks [2-4], wastes from processing of subtropical crops in their growing regions. This approach will allow recovering wastes and receiving sorbents for water purification.

The aim of this article is to obtain sorbents for water purification from phenols from garden wastes: orange peel, coconut shell, banana and pineapple peel.

Experimental procedure

The research was carried out on phenols’ simulated solutions with concentration from 10 to 2000 mg/l. The definition of phenols was conducted by means of photocolorimetric method using 4-aminoantipyrine. The method is based on the formation of phenol coloured compounds with 4-aminoantipyrine by potassium ferricyanide [K3Fe(CN)6]. This method allows determining the concentration of phenols in water to 5 mg/l; a sample must be diluted before carrying-out of an analysis of solution with stronger concentration.

Research of sorption kinetics

Initially, the kinetic characteristics of sorption on the native orange peel were researched. For this purpose, the solutions with a phenol concentration of 100 mg/l were used, in which 1 gram of peel was placed. Upon the expiry of certain time, the concentration of phenols in water was determined. The results are shown in Figure 1.
Figure 1 shows that the dynamic equilibrium in the system is established fairly quickly, at average in 10 minutes. At the same time, the maximal sorption capacity was 12.8 mg/g.

**Research of sorption statics**

The researched raw materials for the increase in sorption properties were modified by a sodium hydroxide solution with concentration of 500 mg/l and by pyrolysis method at a temperature of 600 °C. Sorption isotherms, shown in Figures 2-5, were obtained for all materials.

Figure 2 shows phenol sorption isotherms on the native and modified banana peel. A banana peel, modified by pyrolysis method has the maximal static capacity (17 mg/g), the maximal static capacity for the native material is 9.5 mg/g.

Sorption isotherms for orange peel are presented in Figure 3. It is stated that modification by pyrolysis increases the capacity to 16 mg/g in comparison with native peel (10 mg/g).
Figure 3 – Isotherms of phenol sorption by native and modified peel the orange

For pineapple peel, the similar research has shown that the peel modified by pyrolysis has the maximal statistic sorption capacity (11.1 mg/g) (Figure 4). The sorption characteristics of the material in the native form are 8.7 mg/g.

Figure 4 – Isotherms of phenol sorption by native and modified peel the pineapple

For coconut shell, the research was conducted only with native raw materials and raw materials modified by pyrolysis, since the original fraction was very finely dispersed (fine) and it was impossible to conduct pyrolysis processing. The results are shown in Figure 5. As it can be seen, modified and native coconut shell has almost the same sorption capacity – 7.6 and 7.9 mg/g respectively. This indicates that it is inexpedient to conduct modification by this method.
Research of sorption dynamics

Sorbent from pyrolysed banana showed maximal sorption capacity (17 mg/g) in static conditions. For this reason it was chosen for practical use as a sorption material for purifying water from phenol.

During the experiment, the dependence of purification efficiency on the used solution volume was obtained (Figure 6). As it can be seen, the maximum purification efficiency on a fresh material is 76%. The efficiency reduced to 22% after 10 liters of solution were passed. After purification of 18 liters of water, the regeneration of sorbent by hot water was conducted. Maximum purification efficiency decreased to 31%.

The dynamic capacity of the sorbet was calculated. It is 8 and 3 mg/g respectively for sorbent before and after regeneration. As a result, conduction of such type of regeneration is inexpedient. To sum it up, the conducted research has shown that sorbents based on proceedings of subtropical crops’ wastes can be used for water purifications from petroleum products. Banana and orange peel modified
by pyrolysis has presented the best sorption characteristics. They can be recommended for using in the regions of subtropical crops’ growth.

References

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