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ABSTRACT

Preparation of Activated Carbon from Household Waste Materials

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Background: Adsorption gained an important role in the purification, separation and recovery process at an industrial scale. Activated carbon is perhaps one of the most widely used adsorbents in industry for environmental applications such as the Water pollution because it is increasing due to the different factors such as population growth, large-scale urbanization, deforestation, and unethical activities in the river or other sources of water. Activated carbon are carbons of highly micro porous structure with both high internal surface area and porosity, and commercially the most common adsorbents used for the removal of organic and inorganic pollutants from air and water streams , Due to the increasing demand of activated carbon, there is a strong need for sorting out new precursors for its preparation which should be cost effective at par with the commercially available activated carbon. Although a variety of raw materials were explored for the preparation of activated carbon in earlier studies, scientists are still trying to explore new materials depending on their availability and suitability. The aim of the preparation of activated carbon from renewable energy because it's affordable, an eco-friendly manner for various applications. Activated carbon can be produced from a wealth of different raw materials.However, the utilization of agricultural waste as a raw material for the preparation of activated carbon has increased notably in recent years. Activated carbon is a black solid substance resembling granular or powdered charcoal. Activated carbons have high porosity; high surface area manufactured by carbonization

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and activation of carbonaceous materials. There are two processes for preparation of activated carbon: chemical & physical activation.

Objectives: In this work, activated carbon was prepared from household waste food mixture (mixture of orange peels, banana peels, walnut shells and olive stones). Chemical carbonization and several laboratory tests were conducted to test the effectiveness of laboratory-prepared activated carbon as a cheaper and efficient alternative to commercial activated carbon in the adsorption of methylene blue dye.

Methods: Materials,Household waste food composed from a mixture of orange peels, banana peels, walnut shell and olive stone were used as a precursor for the preparation of activated carbon. Potassium hydroxide (KOH) (from Merck with purity of 85%) and calcium chloride (CaCl2) (from Sigma-Aldrich with purity of 99%) were used for the impregnation process to activate all waste food carbons, All chemicals were used without further purification

Activated Carbon Preparation: Waste food peels were washed with tap water three times and then dried under sunlight for one week. Then they were crushed to increase the surface area of material and the efficiency. Finally they were dried in an oven at 100℃ to remove any moisture content in the peels. The sample was put in a stainless steel autoclave with a hole at the center, heated in the furnace at the temperature 500ºC for 1.5 hr. All of the materials were completely carbonized; the carbonized materials were cooled and kept in a closed container, then for optimizing the production of activated carbon by chemical activation of carbon were carried out using potassium hydroxide (KOH) and calcium chloride (CaCl2) as chemical reagents for the impregnation process for 24 hr to activate all waste food carbons, The effect of optimized parameters such as density, moisture content , ash content, pore volume and porosity , pH testing, and methylene blue number were analyzed , Several thermodynamic studies have been carried out by different researchers to show that adsorption system is spontaneous and endothermic as a negative and positive value and adsorbent can actually be affected by initial concentration of the adsorbate, adsorbent dose, contact time and temperature.

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Results:

Characterization of Activated Carbon

The analysis of activated carbon conducted in this study were density, moisture content , ash content, pore volume and porosity , pH testing, and methylene blue number.

3.3.1 Density

Generally, activated carbon has a density between 0.3 and 0.5 g/ml. The density of laboratory prepared carbon was found 0.27 which is close enough to the standard values.

3.3.2 Moisture Content

The moisture content of activated carbon should not contain excess water and is within the target moisture content. When processed into a finished product the amount of moisture of the activated carbon should fall within 3-6%

The result of activated carbon prepared from household waste was found to be 3.87 % which indicates good results compared to commercial Activated carbon].

3.3.3 Ash Content

The ash content reflects the percentage of inorganic substances in the sample. Ash content for commercial activated carbon was 4.39 and for prepared one was equal to 4.60. There is a very small difference in the result between the commercial activated carbon and prepared one which indicates the purity of the prepared activated carbon.

3.3.4 Pore Volume and Porosity

The use of autoclave in the carbonization process leads to an increase in the porosity of the organic materials, which means an increase in the number and size of the pores in the prepared activated carbon.

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The presence of large and small pores increases the adsorption capacity and retention of pollutants, which enhances the efficiency of activated carbon as an adsorbent. Result of pore volume was equal to 0.115 cm3/g

Porosity was calculated by dividing the pore volume of the particle to the total volume of the particle. It was found to have a value of 0.287

3.3.5 pH of Activated Carbon

The pH of the commercial and the prepared AC were 8 and 7 respectively which satisfy the standard pH value of activated carbon that ranges between 6.5- 7.5.

3.3.6 Methylene Blue Number

The removal rates of methylene blue for the commercial and prepared activated carbon were 84%, and 52% respectively.

Commercial activated carbon is more effective in removing methylene blue dye compared to the prepared activated carbon. This high efficiency achieved may be due to several factors: better Structure, pretreatment, adsorption Power etc.

Conclusions: In this research, a comparison was made between two types of activated carbon: commercial and laboratory prepared activated carbon from waste food. The commercial activated carbon has a good ability to adsorb methylene blue dye from an aqueous solution, and this has been proven through laboratory experiments. The removal rate was about 84% for commercial activated carbon and 52% for the prepared activated carbon). According to the results, the commercial and prepared activated carbons have different properties, and the commercial activated carbon indicates best results in methylene blue test. But commercial activated carbon is often more expensive, needs regular replacement to maintain its efficiency, meanwhile activated carbon prepared from household waste has a low cost. It can be prepared in different ways using easily available natural materials.

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It should be known that the difference between types of activated carbon depends on factors such as the method of preparation, the raw materials used, and the final application.

Keywords: Activated carbon, Household, Waste Materials, Carbonization, Chemical Activation.

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