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Research Article

Synthesis of Activated Carbon using Orange and Lemon Peel for Wastewater Treatment Application

Juhaina Jasim Mohamed Al-Farsi*, Dinesh Keloth*, Elansezhian Rasu

Caledonian College of Engineering, Department of Mechanical & Industrial Engineering,
Seeb, Muscat, Sultanate of Oman.
*Corresponding author's e-mail: juhaina11461@cceoman.net, dineshkeloth@caledonian.edu.om

Abstract

Wastewater from domestic and industries contain contaminants that are harmful for the environment as well as our health. Therefore it should be treated before discharging it out. Activated carbons have the highest degree micro-porosity volume. Activated carbons have the largest surface area. It is important to produce activated carbon from the waste peel by using it in eco-friendly method to decrease the pollution and increase economy. The applications of activated carbon are used to treat the wastewater, drinking water and oil industry. Most of literatures produce activated carbon from different peels and they use the same parameters like pH, contact time, temperature and adsorbent dosage. The results of the activated carbon that produces from the peel can treat and remove the colors from wastewater. Phosphoric acid H_3PO_4 standard solution is better than zinc chloride $ZnCl_2$ solution for producing activated carbon, but in this study the activated carbon will be taken from orange and lemon peels. Effectiveness of activated carbon made from orange and lemon peel is compared in terms of total suspended solid, total phosphorus, chemical oxygen demand, ammonia and nitrate parameters. The designs of study divided into four main steps, first samples and adsorbent collection, second preparation of adsorbent, third preparation of standard solution and the last one is batch adsorption study. The parameters analyzed in the present study are chemical oxygen demand, total suspended solid, ammonia, nitrate, total phosphorus and fecal Coliform. These parameters are compared between the activated carbon prepared from orange and lemon peel. The experimental and filtration procedure is in college laboratory, but the tests are in the Haya laboratory to check the parameter result. The experimental studies revealed that the best results comparing with SP3 parameter is when doing filtration by using orange peel activated carbon because the Fecal Coliform is <10 cfu/100 ml, total phosphorus is 3 mg/L. With this result it can be confidently concluded that activated carbon from waste orange peels is better than waste lemon peels activated carbon that can be used successfully wastewater treatment of SP3 of Haya Water Company.

Keywords: Orange peels, Lemon peels, Filtration process, Wastewater treatment, Activated Carbon, Phosphoric acid.

Introduction

Water is one of the most important basic requirements on the earth. All plants, animals, and humans are dependent on water to survive. One of the most important uses of water is in manufacturing area. For example, chemical industry produces a large volume of wastewater through the various processes. The industries treat the wastewater before discharging it to the environment to save the environment and make it as sustainable. Wastewater treatment is a process to remove the pollutants from the wastewater. There are many different types of wastewater treatment for example, distillation, electro coagulation, dehumidification process and adsorption process. There are many environmental problems caused by human contribution such as, excessive waste, industry pollution and over population but nowadays, water pollution is a major problem occurring all over world. Natural materials available may be used in the activated carbon adsorption process as low cost adsorbents. In many operations activated carbon made from rice husks, lemon peels, orange peels, banana peels and other organic materials have been used effectively [1]. Productions of activated carbon from watermelon peel [2].

Adsorption of Pb, Fe, Cu, and Zn from industrial electroplating wastewater can be done

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by orange peel activated carbon [3]. Production and characterization of activated carbon from banana empty fruit bunch and delonix regia fruit pod [4]. Removal of yellow 2G dye from aqueous solution using activated carbon prepared from mosambi and agricultural waste [5]. Activated carbon was produced from the palm-oil shell by paralysis and steam activation in a fixed bed reactor [6].

The activated carbon is created by two major processes. The first process is physical activation that converts the source material into activated carbon by using hot gas and is carried out at 800-1000°C. The second process is chemical activation using carbonaceous material after doing pretreatment with dehydrating agent like H_3PO_4, $ZnCl_2$ and KOH at 400-600°C.

These studies aim to treat wastewater by using natural waste from orange and lemon peels and discover a new and economical way to treat the wastewater. The treatment of wastewater is needed due to the absence of water resources all over the world, and after treatment the wastewater may be used again for different purposes likes chemical processes in the manufacturing works and irrigation of grasses in parks. Activated carbon is used in water station, waste water station, fuel storage, gas purification and chemical purification as all of these use the activated carbon to filter the impurity and color.

Materials and methods

The experimental procedure adopted, relevant materials and equipment employed during the investigation are reported. The major steps in preprocessing are given below: Collect the waste orange and lemon peels. Wash the waste peels of orange and lemon, cutting and drying for 2 days with sun and measure the mass. Treat the peels with100 ml of H_3PO_4 with 2 L distilled water for one day. Wash the orange and lemon peels with distilled water and check the pH = 7 by using the pH device and pH paper. Activate the peels in a furnace at 400^{o}C for 2 hours. Wash the peels by distilled water, check the pH=7 and dry the activated carbon of orange peels in the sun for one day.

The peels are sieved to get particle size (300 µm). Then divide the 6 L of wastewater SP3 supplied by the Haya company into two, 3 L of waste water treated with activated carbon from orange peel and the other 3 L for activated carbon from lemon because I need a 2 L after filtration for both lemon and orange peel activated carbon to test the parameter such as NH_3, NO_3, TSS, TP, COD and 100 ml separately for Fecal Coliform testing [7]. Next, 0.5 g of orange and lemon peel activated carbon with particle size of 300 µm are added into each 500 ml of the sample. Sample of waste water and activated carbon are mixed around 30 minutes. Treated water is filtered and put in the bottles provided by the Haya Company. For Fecal Coliform testing, I put the 100 ml bottles for both samples in the fridge in order to prepare the sample.

Fig. 1. Waste water sample

First, take the samples after filtration (Fig. 1) to Haya laboratory. Start with Ammonia test which use the Vapodest machine, this machine need H_2O, H_3PO_3, NaOH, empty sample and empty receiver. We use H_2O and NaOH to increase the pH. In this machine if the sample is clean, 100 ml of treated wastewater is required to test and if not clean only 50 ml of the treated waste water can be used. This machine work by two processes i. Distillation and ii. Titration. The first step is to put the sample in the batch and the batch includes 2 blank, 1 control blank and 2 standards (Glycine and $NH_4H_2PO_4$). The second step the catalyst (Cu) is added in the sample in order to increase the reaction rate. In the third step sulfuric acid is added in order to break the organic material. In the fourth step the sample is put in digester around 2 hours, then heating at 400^{o}C around 30 minutes and finally cooling for 30 minutes at room temperature. In the last step put sample in a Vapodest machine to measure nitrogen in ammonia. The result is shown in Vapodest manager program.

Then test the chemical oxygen demand in COD spectrophotometer. Take the two samples of activated carbon and take 2 ml each in COD

vials and kept around 2 hours at 150°C. Then cooled around 15 minutes and take the reading by spectrophotometer for both samples. After that do the total phosphorus test. Take the two samples after filtration and use 2 ml in TP vials for each sample and kept for one hour at 100°C. Then the samples are cooled at room temperature around 15 min and then take the reading by spectrophotometer for both samples.

Pall Corporation device is used for TSS test. First place the filter funnel on the membrane flitted hold. Then insert the filter paper inside the filter funnel. Clean the filter paper in order to remove all dirt present on it. Weight of the dried filter paper with dirt is measured in analytical balance. Insert the filter paper back to the funnel. Then take 1000 ml of sample and make sure that sample is clear. The sample is put on filter paper which is inside the funnel. Remove the filter paper from the funnel and heat it in furnace at 103-105°C for 1 hr.

Remove the filter paper from furnace and cooled in desiccators for 30 minutes. Finally, measure it in an analytical balance. Nitrate test is done by using Ionic Chromatography device for anion (-) and cation (+). Take 50 ml of the sample for each treated sample, then put it in column inside the machine.

The fecal coliform test takes the 100 ml of each sample and put it in fridge for 30 minutes before starting the test. Fecal coliform test is divided into two parts i. Take 10 ml of sample, then filter it by membrane filter, then put it in an incubator at 44.5°C for 24 hr, then put it in a microscope to see how many of the colonies are present and after that calculate fecal coliform by using the equation. ii. Take 1ml of sample and put it in an incubator at 44.5°C for 24 hr, then measure the colonies by microscope. Perform this test for each sample.

Result and discussion

Ammonia test

The result clearly indicates that the waste water treated with lemon peel has the least ammonia content when compared to that of orange peel (Fig. 2). But both of these activated carbon treated waste water has ammonia content less than that of SP3 water of Haya Company.

Chemical Oxygen Demand test

The result clearly indicates that the waste water treated with orange peel has the least COD content when compared to that of lemon peel (Fig. 3). But both of these activated carbon treated waste water has COD content less than that of SP3 water of Haya Company.

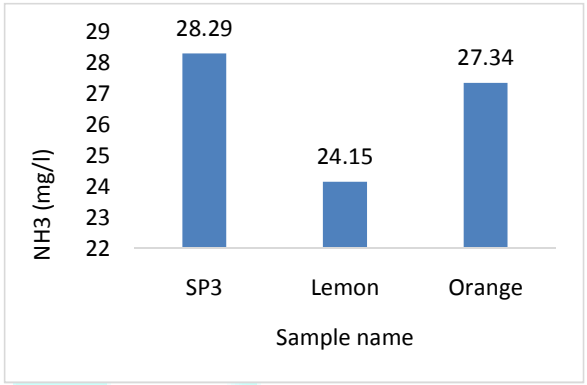

Fig. 2. Result obtained for NH_3 for SP3, Orange and Lemon

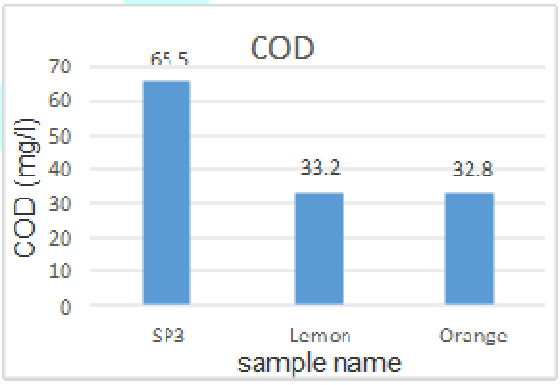

Fig. 3. Result obtained for COD for SP3, Orange and Lemon

Total Phosphorus

The result clearly indicates that the waste water treated with orange peel has the least TP content when compared to that of lemon peel (Fig. 3). But both of these activated carbon treated waste water has TP content less than that of SP3 water of Haya Company.

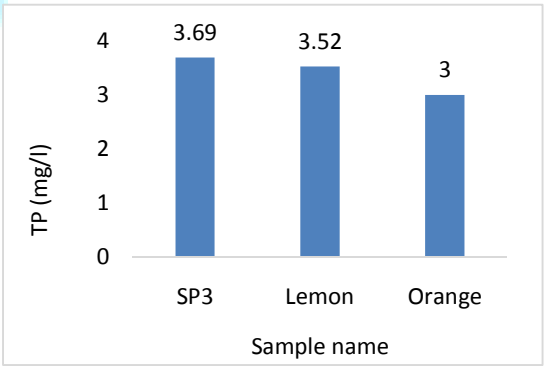

Fig. 3. Result obtained for TP for SP3, Orange and Lemon

Total suspended solid tests

The result clearly indicates that the waste water treated with lemon peel has the least TSS content when compared to that of orange peel (Fig. 4). But both of these activated carbon treated waste water has TSS content less than that of SP3 water of Haya Company.

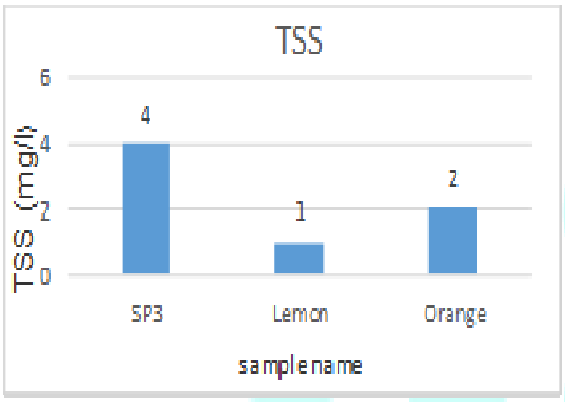

Fig. 4. Result obtained for TSS for SP3, Orange and Lemon

Nitrate test

The result clearly indicates that the waste water treated with orangae peel has the least nitrate content when compared to that of lemon peel (Fig. 5). But both of these activated carbon treated waste water has nitrate content less than that of SP3 water of Haya Company.

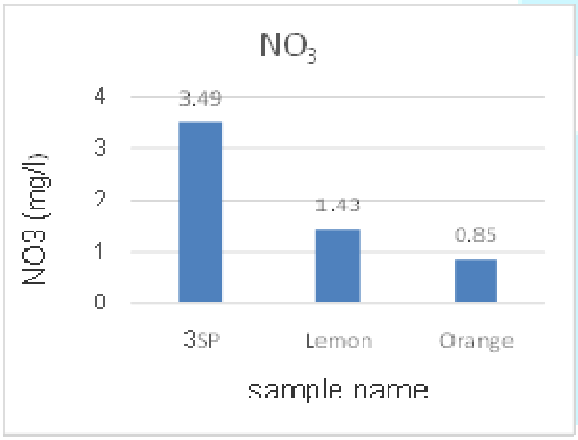

Fig. 5. Result obtained for NO_3 for SP3, Orange and Lemon

Fecal Coliform test

The result clearly indicates that the waste water treated with orange peel has the least Fecal coliform content when compared to that of lemon peel (Fig. 6). But both of these activated carbon treated waste water has fecal coliform content less than that of SP3 water of Haya Company.

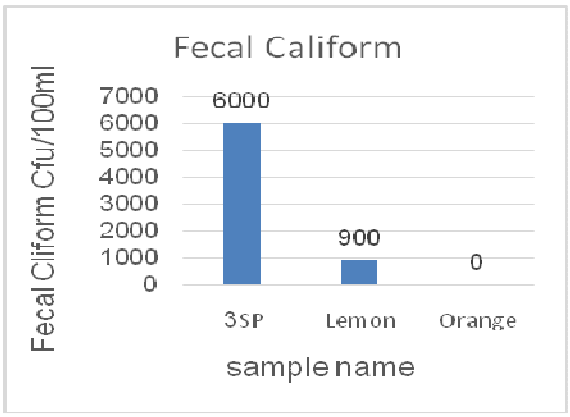

Fig. 6. Result obtained for Feacal Coliform for SP3, Orange and Lemon

Conclusion

Alternative and inexpensive material has been investigated to treat wastewater SP3. Orange and lemon peels are natural substances and they are an organic waste, which can be changed into activated carbon and it may be useful for industries in the future, because the water treatment operation considered as an expensive method. The benefit of the project will help the industry to produce activated carbon from peels by using eco-friendly method so that the method will decrease the pollution and increase the economy. The successful removal of impurities of wastewater SP3 was achieved by doing filtration with orange peel activated carbon, the COD value was 32.8 mg/l, TP is 3 mg/l and fecal coliform was <10 CFC/100 ml which are important parameters to be reduced for waste water treatment. With this result it can be confidently concluded that activated carbon from waste orange peels is better than waste lemon peels activated carbon and can be used successfully for treatment of wastewater SP3. The SP3 wastewater is the wastewater before adding chlorination and the primary role of adding chlorination is to diminish the value of fecal coliform. The waste orange peel activated carbon already decreased the fecal coliform value. Hence only less amount of chlorination is required than before because the orange activated carbon already decreased it and this result will decrease the cost of chlorination.

Conflict of Interest

Authors declare there are no conflicts of interest.

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