Study of Green Coconut Shell Biosorbent for Dye Removal Preparation and it's Applications

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Abstract:

To study the possibility of using coconut shells to remove of popular in the textile industry dyes from aqueous solutions. The sorption abilities of an unconventional sorbent were tested against four anionic dyes: Reactive Black , Reactive Yellow , Acid Yellow , Acid Red as well as two cationic dyes: Basic Violet and Basic Red. The scope of research included to investigate the effect of pH on the effectiveness of sorption of dyes, to determine the time of equilibrium of sorption and to determine the maximum sorption capacity of coconut shells with respect to pigments. The most favorable pH of sorption for the anionic dyes and Basic Violet was pH 3 and for Basic Red 46 - pH 6. The equilibrium time of sorption was the shortest in the case of acidic dyes , while the longest in the case of alkaline dyes.

Key words: Reactive Black , Reactive Yellow , Acid Yellow , Acid Red as well as two cationic dyes: Basic Violet and Basic Red.

1. Introduction:

Coconut (*Cocos nucifera*) is a palm tree belonging to the Arecaceae family that possesses a thousand and one uses. Each part of the tree has it's uses and can be made into products. Also, various parts of the coconut tree have been utilized to remove various types of dyes from water and waste water via chemical, physical and biological methods. Adsorption is one of the widely used physical methods over their counterparts owing to cost efficiency and ease in handling. The key parameters for the adsorption process are the initial concentration of adsorbate, dosage of adsorbent, the pH and contact time. Additionally, the kinetic parameters, equilibrium isotherm and thermodynamics of the adsorption of dyes on the adsorbent were explored. In this modern era, water pollution in India has escalated owing to the growing numbers of polluted rivers from 2006 to 2010. The major point sources of polluted rivers in India arises from the sewage treatment plants (54.1%), manufacturing (38.7%), agro-based industries (2.8%), and animal farms (4.5%).

Also, the rivers in India are heavily contaminated by the diffused (non-point) sources such as agricultural activities and surface runoffs. According to Afroz and Rahman (2017), the manufacturing industries comprise of food and beverage industry (23.7%), electricity and electronics (11.4%), chemical industry (11.2%), paper industry (8.8%) finishing industry (7.4%), textile (5.3%), effluents from oil palm industry (5.3%), effluents from rubber industry (2.0%) and others (24.9%) which have contributed to the rivers pollution in India.

2. Review of Literature:

Dye molecules are organic compounds that interact with the functional groups on the surfaces of the fabrics to impart color as well as the ability to withstand the action of detergents . Each dye molecule is divided into two parts, namely chromophores and auxochromes . Chromophores in the dye molecule are constructed by the delocalized electron–withdrawing groups (i.e. alkenes, carbonyl, nitro, –C=N–, –N=N– and –N=O) that are responsible for the color of the dye. There are several ways to classify dyes, namely: (a) natural and synthetic (b) chromophores and (c) applications. Generally, dyes are predominantly divided into three categories, namely : (a) anionic, (b) cationic and (c) non-ionic. Anionic dyes are negatively charged organic molecules. The presence of negative charge on the dye molecule is due to the oxygen atom that has great electronegativity towards the electron rich area in the carbonyl group for the entire chromophore system.

Different types of dyes possess different disadvantages that cause severe harm to the environment and human health. Therefore, various methods (i.e. chemical, physical and biological) have been proposed to overcome this problem. Chemical treatment methods consisted of electrolysis and oxidation. Oxidation is a method to remove dye by utilizing oxidizing agents (i.e. ozone, ultra violet, titanium oxide, fenton, photo-phenton and hydrogen peroxide). These oxidants trap the dye molecules through the bonding with the radicals. However, the technique produces harmful decomposition products such as formate and benzene sulfonate ions as by-products. Electrolysis is a process to break down the dye molecules by using electricity. The process is costly due to the electricity consumed and electrodes replacements. In this process, the current

is used to breakdown the dye molecules into free ions. The ions produced then flow to the electrodes which eventually be oxidized and reduced to less harmful products. On the contrary, the use of microorganisms such as bacteria, fungi, yeast and algae in the adsorption of dyes molecules is environmental friendly and low cost. For instance, it does not require larger space to construct robust equipment for the decolorization of dyes as well as less toxic decomposition products. However, the time needed to obtain a pure culture is relatively long.

Coconut shell was the predominantly used part for the removal of dyes from the waste water. There are three ways to modify the coconut shell prior to the removal of dyes, namely activated carbon acid or base treatment and as immobilizer for the bacteria. The physical parameters, adsorption kinetic and equilibrium isotherm of the modified coconut shell. Among the parameters mentioned, contact time is the time for the adsorbent to interact with the adsorbate. It is a niche parameter in order to develop a cost effective method. Demonstrates the effect of contact time for the uptake of Methylene Blue by the activated carbon using coconut shell treated with NaOH via hydrothermal treatment. The time needed to adsorb 25 and 50 mg/L of Methylene Blue is less than 30 min. The contact time increased by four times to 2 h for the adsorption of 75 and 100 mg/L. As the concentration of Methylene Blue increased to 150, 200 and 250 mg/L, the adsorbent requires 6 h to achieve a steady maximum adsorption capacity. The dyes were adsorbed rapidly at initial stage owing to huge amount of available sites and the number of active sites increases with the concentration. However, the available sites in adsorbent will eventually be saturated thereafter achieving a steady state.

The pH of the adsorbate is another important parameter that affects the adsorption process. The interaction between dye molecule and adsorbent at different pH is shown. Supporting Information. At low pH, the concentration of H^+ ions are high. Hence, anionic (negatively charged) dye interacts well in acidic condition owing to ion–dipole interaction. In fact, the adsorption of anionic dyes will be elevated by the impregnation of phosphoric acid on the dried coconut shell prepared by Ndifor-Angwafor et al. because the H^+ ions on the activated carbon provides sites to adsorb anionic dye molecules . The result is in well agreement with the research conducted by Jóźwiak et al. (2018). On the contrary, Islam et al .modified the activated carbon based coconut shell via hydrothermal and sodium hydroxide (COSHTC3) treatments which facilitates more negatively charged sites on its surface for the adsorption of cationic dyes. In basic condition, the concentration of OH^- ions is high and hence it enables the entrapment of cationic dyes. The interaction was strengthened by the base modification on the activated carbon by coconut shell because it facilitates more available sites for cationic dyes.

Statement of Problem:

The first problem with the approach is the possibility of unforeseen interactions. These may include chemical reactions, reactions with the impurities, and the effect of the adsorbent on the medium.

Hypothesis or Objectives:

The future prospective of research included investigation pertaining to the effect of pH on the effectiveness of sorption of dyes, conducted in order to determine the time of equilibrium of sorption and determine the maximum sorption capacity of coconut shells with respect to pigments.

Materials:

Coconut shells Coconuts from coconut palm (Cocos nucifera), were purchased at a local hypermarket. Due to the monotypic nature of the Cocos genus, the coconuts available on the market always have a similar composition, regardless of the country of origin. The shells of coconuts usually contain 46% lignin, 14% cellulose and 32% hemicellulose [Cagnon et al. 2009].

Dyes:

Six dyes popular in the textile industry; including 4 anionic and 2 cationic dyes were used in the research. Among the anionic dyes there were 2 reactive dyes (Reactive Black , Reactive Yellow) and 2 acid dyes (Acid Red , Acid Yellow). The tested cationic dyes were Basic

Methodology:

The coconut shells were ground in a laboratory grinder and sifted through the sieves with a mesh diameter of 5 mm and then 3 mm. A 3–5 mm diameter fraction was placed in 2M H2 SO4 . After 24 h, the shells were rinsed with distilled water, then placed in 2 M NaOH for 24 h. Next, the shells were drained and washed with distilled water (until pH ~ 7 was obtained in the leachate). The coconut shells (CS) were ready for study after drying at 105°C. The coconut shells (CS) were weighed in an amount of 1 g each and added to the series of conical flasks (250 mL). Then, dye solutions (10 mg/L – 100 mL) at pH 2–11 were added to the flasks. Then, the flasks were placed on a laboratory shaker (150 r.p.m.) with vibration amplitude of 25 mm. After 60 min, the samples were taken from the flasks (10 mL) to determine the concentration of dye in the solution.

Significance or Future prospective:

Coconut shell–derived activated carbon was used as adsorbents to remove methylene blue (Man et al., 2015), lead, copper, cadmium, arsenic, etc. (Okafor et al., 2012) in water purification or treatment of industrial and municipal effluents.

The coconut shells are easily available waste material from the food industry. Their popularity, which translates into a low price of raw material is the result of wide range of applications of coconut. This paper explores the possibility of using coconut shells for the removal of dyes popular in the textile industry from aqueous solution.

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