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Adsorption of Natural Oil Spills Using Human Hair As Sorbent

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ABSTRACT

Industrial growth has accelerated the emission of various oily wastes from the sources such as petrochemical and metallurgical industries. Transportation & domestic sewage. These oily wastes are one of the major pollutants of the aquatic environment. The Government regulations are become stricter for the discharge of waste water & oily water. Oil exploration has huge economic benefits, but these are associated with environmental causes arising from oil spills. Several methods are there t for cleaning up oil spills which cause huge financial burden Nowadays researchers are focusing on methods that are environmentally friendly and cost effective. This paper reviews the methods, efficiency and mechanics of using human hair to clean up crude oil contaminated water . Several researchers have done the experimental studies and confirmed that human hair can be modified into boom to clean-up oil spills. This is a promising area that researchers need to focus more on in order to explore the huge benefits it presents. The efficiency of human hair when subjected to the process of recovery and reuse was also examined by researchers and found to be effective. Hence, this is an indication that human hair can be modified into boom and used as low-cost, environmentally friendly adsorbent for cleaning up oil spill, especially considering its potential for reusability without significantly altering the sorption features.

Keywords : Adsorption capacity, adsorption isotherm, clean-up, human hair, oil spill, sorption kinetics, sorbent.

1. INTRODUCTION

Oil exploration, production and transportation are critical to the development of the economy of many nations across the world owing to the enormous benefits derived from it. Due to the essential nature of oil, it is very difficult for an individual or a country to complete the day's activities without directly or indirectly depending on petroleum products. However, these processes (petroleum exploration, production and transportation) over the years have impacted negatively on the environment as a legacy, ranging from oil spillages, release of dangerous substances into the air, water and land, species extinction etc. The inevitable nature of oil spills has necessitated the need to seek for ways of mitigating its environmental impacts [4]. There are several methods employed to clean up oil spills in water such as direct burning, use of dispersants, mechanical skimmers, use of booms and sorbents. Human hair (50-100 um in diameter) is a natural bio-sorbents consisting of dead cells made up of the cuticle, water, lipids, trace elements and 65-95% proteins, mainly polymers of amino acids such as keratin and cysteine, medulla and cortex. The cuticle is highly hydrophobic, which makes it water repellent. It also contains numerous peptide bonds and CO- as well as NH- group which forms hydrogen bonds between neighbouring molecules on the human organic follicle surface and has a highly porous cortex [1],[4],[5].

2. LITERATURE REVIEW

Structure and Composition of Hair

The essential growth structures of hair are follicles which are deeply penetrated in the scalp tissue in the tens of thousands. At the base of each follicle, the cells proliferate. As they stream up-ward, the complex processes of protein synthesis, structural differentiation, align material which is known as hair. Hair grows at a rate of about cm per month for a period of 3-5 years, followed by a arresting period of 4-6 months .During which the old hair is shed and a new growth beings. Scalp hair is typically 50- 80mm in diameter and its exterior consists of a layer of flat, cuticle scales pointing outward from root to tip. This arrangement of cuticle cells permits better mechanical retention of the fiber in the follicle and also serves as self cleaning feature. Although the individual scales are thin,

i.e. 0.5 mm. they are long and overlap each other to form a continuous multi-layered shield (3-4mm) around the fibre. Enveloped by the protective sheath of the cuticle is hair cortex which constitutes the bulk of the fiber. The cortical cells are fiber distributed throughout the structure of cortex are pigment particles called melanin. Their number, chemical character, and distribution pattern determine the colour of hair in some hairs, centrally located vacuolated medulla cells are also present. Chemically, hair is a biopolymer composed largely of cross-linked proteins termed keratins. Two principle protein fractions have been isolated from hair. i.e. low and high sulphur proteins. The low sulphur fraction consistent of protein of high molecular weight and high degree of molecular organization, i.e. U - helical; the protein of the high sulphur group are of low molecular weight and of unknown structural pattern. Electron microscope studies reveal that both proteins participate in a bi phase composite, filament-matrix texture which is the dominant structural element of hair cortex. The filaments are composed of low sulphur proteins and the surrounding matrix is made up of high sulphur proteins. The structure and chemical composition of the cuticle differs from that of the cortex, and cuticle cells do not seem to contain and organized low sulphur proteins. The distal zone of each cuticle is heavily cross-linked by crystalline; this fact, in conjunction with the multi-layered structure, makes the cuticle a formidable barrier to penetration of materials into the interior of the hair. Although hair of different racial origin differs in shape, degree of waviness (curl), and colour, there is very little difference in the underlying chemical composition and physical structure. The rate of reaction with a variety of chemical reagents and most physical properties are similar. Differences between hair from different ethnic groups are much smaller than the variation in the properties of hair taken from different individuals within one ethnic group. Compared to Caucasin hair, Negro hair is more oval in the shape of its cross-section, and is much curlier. The tight curls are occasionally associated with unevenness in fiber diameter, resulting in weak spots along the fiber length. These could cause problems during chemical treatments as well as during hot combing. A saint hair tends to be more perfectly round than Caucasian hair and somewhat thicker in diameter, on the average. The greater fiber diameter results in a slow uptake of dyes because the ratio of surface area to volume is smaller [1],[8],[9].

The utilization of human hair waste for the removal of phenol from aqueous solutions was investigated and found that the percentage of phenol removed lay in the range 74–92% when the sorbent concentration was changed from 2 mg/ml to 20 mg/ml at an initial phenol concentration of 60 ppm. Increasing either the initial pH of the solution or the temperature resulted in an increase in the phenol uptake by human hair. This study confirmed the capability of human hair for the removal of micro-organic pollutants such as phenol from aqueous solutions .[10]

The removal of oil from waste water using human hairs was investigated in batch process and continuous Column experiments. In batch studies the behavior of the adsorption was investigated through studying the influences of pH, contact time and adsorbent doses and found that the oil removal rate increased with a decrease in pH. The maximum removal of oil achieved at pH 1.0 at 30^{o}C temperature. The maximum adsorption obtained from the batch process was 13.88 mg/g for gent's hair and 9.80 mg/g for ladies hair adsorbent. Langmuir and Freundlich isotherms were used to fit the equilibrium isotherm. Freundlich model is best suitable. The effect of bed heights, flow rates and inlet oil concentration found that the break through point has been observed after 60 min for gents and ladies hair and exhaustion point observed after 300 min. for gents' hair and 270 min. for ladies hair.[11]

3. METHODS

3.1 Methods of Establishing Hair Categories and Properties

In sealed plastic bags collected the hair samples from the hair salons and hairs are separated by colour, and established three categories: black, brown, and blond. Then the hair diameters of the colour groups are measured by a microscope. Then it placed in a measured amount of hair into each pouch. Next each pouch are put onto a film of 10weight, non-detergent oil for the same amount of time, further proceeded. An electronic balance is used measure the mass of the oil uptake by the pouch and the hair. The image to the right displays approach. Method of testing adsorption properties using different mesh pouches. Using black hair only, and following the same process described above for measuring basic oil adsorption, then compared oil uptake using mesh pouches made from pure nylon, with those made from a nylon and Lycra blend. Method of testing adsorption properties of different oil types, using black hair only and the same methodology as described for measuring basic adsorption, then measured the oil uptake for 10 weight non-detergent in a crude oil.

3.2 Method of testing oil adsorption properties in a water oil mixture

City water from Halifax, salt water from the Bay of Fundy and distilled water were mixed with 10weight non-detergent oil in the rations of 40ml.to 80ml. And 80ml to 40ml oil to water. Using black hair only, and following the same procedure as described above for measuring basic oil adsorption, we compared oil uptake and water uptake using nylon mesh pouches with the standard hair fill. Method of Testing oil adsorption properties in Top Soil, standardized samples of topsoil were prepared. To these was added 10 weight non-detergent oil in the range of 12 to 72 ml, in 10ml increments. The oil was allowed to penetrate the soil for a standard time period. Standardized nylon pouches of black hair were buried in the soil for ten minutes; pouch and hair oil uptake was measured.

3.3 Method of Oil Reclamation

The black hair samples soaked with 10 weight non-detergent oil were measured to establish the oil to hair ration and were then wrung with physical pressure to squeeze the oil out.

4. REUSABILITY TEST

There are several methods in which the adsorbent can be recovered and reused, e.g. compression, centrifugation, solvent extraction [3]. The solvent extraction method was employed in this research. In evaluating the reusability of human hair for oil sorption, the adsorbent was first washed with hot and cold water. All remaining oil was then extracted using n-hexane. The recovered adsorbent was then dried and reused for the batch adsorption experiments in four continuous cycles after each desorption test [3].

5. ADSORPTION OF OIL ON HAIR

Since water is taken in larger concentration than oil it is more probable for water to be adsorbed in larger quantities than oil, but reverse is found to be true when experiments are conducted.

Moreover, when the phenomenon is studies under optical microscope it is seen that oil replaces water from the hair surface. It can be explained in terms of selective physical adsorption. The adhesive forces between oil and hair are greater than those existing between water and hair. Thus, in presence of oil and water, hair selectively adsorbs oil. Thus, oil is separated from water when a mixture is passed through a bed of hair. The adsorption might be taking place on the glassy membrane, a non-cellular portion [2].

6. CONCLUSION

The capacity of human hair to adsorb crude oil, vegetable oil and diesel fuel was reviewed with the aim of establishing its potential for oil spill clean-up. Human hairs are low cost adsorbent and can be used as best adsorbent for the removal of oil from waste water. By using low cost adsorbents we can minimize the cost, instead of using costly chemicals or adsorbents. Low cost adsorbents improve the treatment process without affecting chemical characteristics of waste water. This is timely not just because of the need to remove contaminants from the environment without due diligence to its impact, but because it is environmentally friendly and also encourage the principle of converting waste to wealth. Hence, this is an indication that human hair can be modified into boom and used as low-cost, environmentally friendly adsorbent for cleaning up oil spill, especially considering its potential for reusability without significantly altering the sorption features. Further studies on Hair as adsorbent opens the door for further research designed to increase the efficiency of adsorption.

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