Research Article

STUDY OF ADSORBTION OF OIL FROM OILY WATER USING HUMAN HAIR

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ABSTRACT

Industrial growth has accelerated the emission of various oily water from the sources such as petrochemical and metallurgical industries,transportation, & domestic sewage which contains 70% free oil,25% emulsified, 5% soluble oil. The Present work was inspired by a small note published in science reporter.Keeping the concept in mind , the subject is explored further and its application in the field of oil seperation is studied.It is seen that at laboratory scale method is very efficient. Its effiicency is nearly 100% for free oil. Since human hair is very cheap and not easily biodegrable the method find a good usage for it.

KEY WORDS : Industrail growth,Oily water,Human Hair .

INTRODUCTION

Industrial growth has accelerated the emission of various oily waste from the sources such as petrochemical and metallurgical industries. Transportation & domestic sewage. These oily waste are one of the major pollutant of the aquatic environment. The special attention has been focused on the discharge of waste water & oily water & it regulatory restriction has become more strict. Oil water separation processes using polymeric or inorganic membranes have been proposed as effective & cost competitive alternative to conventional oil removal technologies but in present the commercial use of membrane in waste water treatment is currently limited by their low efficiency as well s high capital & operating cost.

These problem of separation of oil from water is widely faced in the industries especially in petroleum industry effluent plants and in sewage treatment Industrial waste contains nearly 70% free oil. 25% emulsified oil & 5% soluble soil. Separation of oil from water is necessary of the following reason. Oil slick on surface of water can prevent oxygen transfer from atmosphere to water and lead to over low dissolved oxygen level due to microbial & oxidative attack on the hydrocarbon molecules.

The Recycling of water it is necessary to remove oil because it may hinder the process.

- Oil in boiler feed causes foaming & so treatment is required.
- Oil & waxes solidify at low temperature & cause clogging in pipes & sever line.
- Oil slick is responsible for the death of birds.
- The oil penetrates in the feathers there by affecting their insulation & buoyancy.
- Birds become colder & more susceptible to diseases & experience difficulty in floating & flying.

The paper uses elaborate techniques to purify contaminated areas in different environments after oil spills. Rather than discarding of the human hair it can be used to help cleanse the effected area, absorb the oil then utilized as an effective fuel derivation. The oil absorption of potential wasted hair fibers could produce valuable slot for our prevent & modern society. We have investigated the ability of the human hair to absorb a variety of potential hazardous oils. Including motor oils, bilge oils & crude oils that have the possibility of being spilled in terrestrial or aquatic environments. Current increased demand for refined crude oil products such as heating oils, lubricant oils, gasoline & jet fuel & other such related products necessitated transportation of rushing products over greater distances when environments any serious accident resulting in spills. We have tried different hair colors & feel that overall black gave the best results for adsorbing the most oil. We are also using hair pellets as fuel that can be help reduce global warming which has also been prevent to provide the cleanest burn of any solid fuel. Thousand of tones of human hair is cue everyday & thrown into land fills as a waste produces which no direct benefits. Hair is not an easily degradable substance these are instances of hair. Our project looked at the possibility of finding a use for waste hair could be used to clean up oil spills & that the oil could be recovered or converted in fuel pillets. Also, the separation results obey frendlch's isotherm. Thus confirming that the oil removal is due to selective adsorption. As the process is eco-friendly and does not require any chemicals, it may lead to development of a new technique of separating oil water emulsion, which is simpler.

The present work is inspired by a small note published in science Reporter, starting that NASA is on the job of trying to develop a technology that could do the separation of oil from water using human hair as an adsorbing medium. It is generally seen that hair has good adsorbing capacity for oils. Keeping this concept is mind, the subject is explored further and its application in the field of oil separation is studied. It is seen that at laboratory scale, the method is very efficient. Its efficiency is nearly 100% for free oil. However, the most intriguing thing observed is, its efficiency in separating emulsified oil. Since hair is very cheap and not easily biodegradable, the method may find a good usage for it.

2 METHODS :

Method of Establishing Hair Categories And Properties

We gave seal able plastic bags to many hair salons and asked them to collect hair samples and for them to keep the hairs separated by colour, and established three categories: black, brown, and blond. We then measured the hair diameters of the colour groups using a microscope.

Method of testing basic adsorption properties of hairs by colour :

We made mesh pruches from nylon pantyhose by cutting out a standard sized piece then hot gluing all but one edge closed. Then we placed a measured amount of hair into each pouch. Next we put each pouch onto a film of 10 weight, non-detergent oil for the same amount of time, we prceeded to then accurately measure using an electronic balance 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, we 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, we measured oil uptake for 10 weight non-detergent oil, crude oil.

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 10 weight 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.

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.

Method of making and testing hair sawdust

fuel pellets :

Hair samples were prepared using the black hair from which the oil had been mechanically removed. Only hair and sawdust were mixed in standard rations. Measured amounts were placed into a hydraulic press, and pellets made. The energy output of the hair sawdust pellets was compared to commercial wood pellets in an oxygen bomb calorimeter.

OBSERVATIONS :

Findings for Hair Properties: We found that the black hair is the greatest diameter, followed by the blond, then the brown.

Findings for basic Hair Adsorption : The black hair had the best adsorption properties, followed by the blond, then the brown. We observed that this followed the same pattern as for hair diameter.

The oil uptake for hair in the blended nylon Lycra pouches was greater than in the straight nylon pouches. The blended nylon Lycra pouches allowed the hair to adsorb more oil while the poach itself absorbed less.

Brown Hair

Amount of Hair (Grams)	Oil Adsorbed (Grams)
1.0	15.4483
2.0	10.6493
4.0	21.2875

Black Hair

Amount of Hair (Grams)	Oil Adsorbed (Grams)
1.0	14.5088
2.0	13.1142
4.0	22.75

Blond Hair

Amount of Hair (Grams)	Oil Adsorbed (Grams)
1.0	16.6333
2.0	10.207
4.0	21.95

Findings for Adsorption Properties using different mesh pouches

100% Nylon	86 % Nylon: 14% Lycra
1.0	16.6333
2.0	10.207
4.0	21.95

OCURANCES AND HAZARDOUS

Industrial waste are the main sources of oily water. Petroleum is one of the major energy source today and huge volumes of oil are transported between points of production and consumption around the globe. All along these major transportation routes oil spills happen regularly and oil slicks are even present. With serious spills, many marine birds and other animals are chocked to death by the oiled slick. Even when dispersed, many hydrogen carbons in the oil are toxic to aquatic organism. Some are thought to be carcinogenic oil being lighter than water floats on the surface as a thin film which can interfere with the transfer of gases such as oxygen and carbon dioxide as well as heat between the water and the atmosphere.

Routine petroleum refining, storage and use also results in pollution by leaking oil, oily waste water and sludge. A significant proportion of underground fuel storage tanks in service are thought to leak oil into the ground water.

Hazardous :

Volatiles : After a spill, low-boiling aromatic compounds like benzene & toluene are the primary cause of immediate deaths. In warm water they evaporate 1-2 days; in cold waters it may take up to 1 week.

Floating tar : Like globs adhere to birds, otters, seals, rocks etc. Destroys natural insulation, buoyancy, animal drawn or die due to loss of body heat. Bacteria break down globs in weeks, months or in cold waters years.

heavy oil sinks to bottom of waters or wash into estuaries. These masses kill bottom dwelling organisms like crabs, oysters, etc.

4 CONVENTIONAL TECHNIQUE FOR TREATMENT OF OILY WATER

I) Preliminary Treatment :

The principal objectives of preliminary treatment are the removal of gross solids (i.e. large floating and suspended solid matter, grit, oil and grease if they are present in considerable quantities.)

Large quantities of floating rubbish such as cans, cloth, wood and other larger objects present in waste water are usually removed by metal bars, acting like strainers as the waste water moves beneath them in an open channel. The velocity of the water is then reduced in a grit-settling chamber of a larger size than the previous channel. Removal of gross solids is generally accomplished by passing waste water through mixed or moving screens. Different types of these screens are available, which include bar screens (described above), hand raked or mechanical raked screens, drum screens and wire rope screens. The moderns Mechanical screens cum filters include rotary, self cleaning, gravity type units and circular overhead fed vibratory units. There are costlier, as compared to the conventional bar screens, but are very effective in reducing the suspended solids and BOD. Sometimes, instead of screening, the gross solids in the sewage are cut into small pieces with the help of maccratory or comminutors. Grit (or detritus)is removed in the early stages of treatment in grit channels or tanks to safeguard against an damage to pumps and other equipment by abrasion and also to avoid setting in pipe bends and channels. Grit, being heavier than organic solids, can be separated from organic solids by careful regulation of the flow velocity in the grit takes. The grit settling chambers are periodically disconnected from the main system to remove the grit manually, for possible use in land-filling, road making and on stage grease, then it is advisable to remove as much of these as possible, in the preliminary treatment itself to avoid adverse effects on the rest of the plant. This is achieved by passing the waste water through skimming tanks were oil and grease are skimmed off. This process can be rendered more efficient by aeration, chlorination or vacuum flotation.

If the oil and grease are in emulsified condition as in wool-souring waste, ordinary skimming methods are ineffective. In such cases they may be removed with the help of chemical reagents in primary sedimentation tanks.

II)Primary Treatment :

After the removal of gross solids gritty materials and excessive quantities of oil and grease, the next step is to remove the remaining suspended solids as much as possible. This step is aimed at reducing the strength of the waste water and also to facilitate secondary treatment.

Sedimentation : Sedimentation is the separation from water by gravitational setting of suspended particle that are heavier than water. This tank is generally a cement concrete tank having a conical bottom. Its functions to allow the flocculated solids to settle at the bottom to from sludge. Mostly it is submerged in the ground and effluent is fed into the in its conical bottom at a height which clears the sludge level. This type of feeding enhances the solid separation and prevents them from being carried away with the clear supernatant liquid. In some cases, this tanks also functions as a coagulant-mixing tank in which periodically coagulants are added directly. To enhance dissolution of coagulants in water, sometimes air is blown from the bottom to impart mild turbulence to the content. It has a peripheral launder or weir so that clear supernatant liquid can be removed from the top.

If few cases, the tank is at an elevated position and is provided with gently rotating rake arms on its conical bottom to enhance sludge removal from bottom and radial top arms to facilitate removal of clear liquid from the top into the surrounding peripheral launder. Such unit is many times called 'clariflocculator' for it serves dual purpose of flocculation of solids and subsequent separation of liquid from the sludge. Sedimentated solids which accumulate on the conical bottom as sludge are removed from the bottom under the static head of liquid via underground masonry channels or pipes, and are also collected either in the sludge well or directly in the sludge-bed. Generally, two sedimentation tanks are provided for about 1 million liters of effluent flow per day and for higher flows, four or more tanks are provided which are operated cyclically. A common sludge well is usually provided from which sludge is pumped to the sludge bed. These sludge-beds are rectangular cement-concrete structures offering large surface areas so that the sludge can be easily sun-dried. There are usually three sludge beds and they are operated in such a way that while one will be receiving the fresh sludge, the other two will drying it. The clear supernatant liquid remaining on the surface of uniformly spread sludge in the sludge-bed is again taken back to the sump pit. After the sludge is completely dried, it is manually scraped off from the bed and disposed off.

Disadvantages :

- Required more time.
- The efficiency is less for same time as compared to low cost adsorbent.

Sedimentation aids :

Finally dividend suspended solids are colloidal particles cannot be efficiently removed by simple sedimentation by gravity. In such cases, mechanical flocculation or chemical coagulation is employed. In mechanical flocculation, the wastewater is passed through a tank with a detention time of 30 minutes and fitted with paddles rotating at an optimum peripheral speed of 0.43 m/s under this gentle stirring, the finely divided suspended solids coalesce into larger particles and settle out. Specialized equipment such as Clariflocculator is also available, where in flocculating chamber is a part of a sedimentation tank.

In chemical coagulation the sewage or other waste water is treated with certain chemicals which from a floc (flocculent precipitate) that absorbs and entrains the suspended and colloidal particles present. The coagulants in common use are :

- Hydrated lime
- Alum $Al_2(SO_4)_3$, $18H_2O$
- Copper as $FeSO_4 7H_2O$
- Ferri chloride and
- Chlorinated copper as, $FeSO_4CL$ (Mixture of ferric sulphate and chloride).

Alum is the most popular coagulant used both in water and waste water treatment. For best result the chemical used for coagulation are well mixed with the wastewater in baffled channels followed by mechanical flocculation before sedimentation. Pre-aeration for about 10 minutes before sedimentation is also found to help in the removal of entertained gases like CO_2 and H_2S and improved flocculation and separation of oil and grease.

Coagulation is the most effective and economical means to remove impurities.

III)Secondary Treatment :

In secondary treatment the dissolved and colloidal organic matter present in waste water is removed by biological processes involving bacteria and other micro-organisms. These processes may be aerobic or anaerobic. In aerobic processes, bacteria and other micro-organisms consume organic matter as food. They bring about the following sequential changes :

- Coagulation and flocculating of colloidal matter.
- Oxidation of dissolved organic matter to CO_2 and
- Degradation of nitrogenous organic matter to ammonia, which is then converted into nitrite and eventually to nitrate.

Thus, secondary treatment reduced BOD. It also removes appreciable amounts of oil and phenol. However, commissioning and maintenance of secondary treatment systems are expensive. The effluent from primary sedimentation tanks is first subjected to aerobic oxidation in systems, such as aerated lagoons, tricking filters, activated sludge units, oxidation ditches or oxidation ponds. Then the sludge obtained in there aerobic processes, together with that obtained in the primary sedimentation tanks, is subjected to anaerobic digestion in the sludge digesters

5 TYPE OF ADSORPTION :

Molecules and atoms in contact with a solid surface may from either chemical or physical bonds. Chemical bonding or chemisorption, occurs when a molecule interacts with the surface to form a single or multiple bonds. Physical bonding or physisorption, occurs when the molecules from weak vander-waals forces with the surface. The distinction between the two forms of bonding in unclear, but is usually classified according to the enthalpy of adsorption. In general, if the enthalpy of adsorption is similar to the energy of condensation (5 kcal/mol), the interaction is regarded as physisorption. Several models have been proposed to descrbe in the nature of the structure and bonding of the molecules. The simplest proposed model for characterizing adsorption is the Langmuir Isotherm. The Langmuir Isotherm assumes that each unit of surface are consists of "n" sites which can absorb one molecule and all of the sites are energetically equivalent. This model is an adequate approximation for uniform surfaces, however, it is inaccurate for inorganic solids commonly used in catalytic materials. In addition, the model does not account for the interaction of adsorbed species and multiplayer adsorbate growth. Another modes, the Freundlich Isotherm, is more accurate by considering an exponential distribution of enthalpies for low coverage of adsorbed species. The freundlich Isotherm is an improvement over the Langmuir Isotherm by including adsorption of species. The most widely used model is the Brunauer-Emmett-Teller (BET) Isotherm. The BET Isotherm is based on the same principles as the Langmuir Isotherm but it also includes the consideration of multiplayer adsorption of the adsorbate molecule. The BET Isotherm accounts for the multiplayer adsorption by assuming that the first layer of adsorbate is a site available for the second layer, the second layer of adsorbent is a site available for the third layer, and so forth. The development of the BET Isotherm allows for the routine measurement of surfaces which, in turn, can be used to normalize catalytic reaction rates. While the model is inexact, the commonality of the techniques assures a consistency between individual laboratory measurements. The exact structure of the adsorbed species is difficult to identify by current spectroscopic methods. While the nature of the adsorbed species can be identified determination of the crystallography is not applicable. As a result, only a few structure of simple species on metal single crystals have been characterized. The electronic structure and molecular configuration are typically characterized by vibrational techniques. Such as infrared (IR) or electron energy loss spectroscopy (EELS). When the adsorbate forms an ordered structure on the surface, the nature can be characterized by low energy electron diffraction (LEED). Carbon monoxide is frequently used to probe the structure of the surface due to the nature of the infrared spectra characteristics. Hydrogen is also used on metals and metal sides to form surface-OH groups, which are also easily characterized. Structure sensitive spectroscopic techniques are only applicable to single crystal model catalysts. However, single metal crystals serve as an approximation to describing the nature of the solid-adsorbate interaction. The clean single crystal model is an over simplification of the typical catalyst material. A conventional catalyst is comprised of various crystallographic faces and may contain impurities and surface defects. Also, the oxidation state of the active phase metal is in question when it is supported on oxides of metals that are stable in more than one oxidation state surface p[robe molecules (CO2H2) may provide some information about the oxidation state, but the molecules may also change it. As are result physical methods (X-ray photoelectron Spectroscopy, Electron Spin Resonance Spectroscopy) are frequently employed to characterize the oxidation state of the surface.

Adsorption Isotherm :

As the position of equilibrium there is a defined distribution of solid between liquid and solid phases and this ratio is major of position of equilibrium in the adsorption process. It may be function of cone of solid the cone completing solute, the nature of solution and so on. The preferred from expression for the depicting this distribution is to express quantity (the amount of solid adsorbed per unit weight of solid adsorbent) as the function of (Concentration of solute remaining in the solution as equilibrium at constant temp is referred as adsorption isotherm the adsorption isotherm is a functional expression for the variation of adsorption with concentration adsorbate in bulk solution at constant temperature commonly the amount of adsorbed material per unit weight of adsorbent increase with the increasing concentration but not in direct proportion. Most equilibrium data follow of can be made to follow one of the three commonly used models Langmueir Isotherm or Fruendlich isotherm these isotherms are based on theoretical development while the Friendich Isotherm is on imperial relationship. Langmuir Isotherm:

It is based on the assumptions that point of valance exist on the surface of the adsorbent and that the each of these sides area capable of adsorbing one molecule thus the adsorbed layer will be one molecule thick. Further more, it is assumed that all the adsorption sides have equal affinities for molecule of adsorbate & that the presence of adsorbed molecule at one side with not affect the adsorption of molecule at an adjacent side, the Langmuire eq. Is commonly written as follows :

$Qe = Qo + bQo / (1 + bCe)$

The liner from of Langmuier Isotherm can be expressed as :

$1/qe = 1/Qo + 1/bQo\ (1/Ce)$

When 1/qe is plotted against 1/Ce a straight line with slope 1/ bQo is obtained which shows the adsorption follow the Langmuire Isotherm. The Langmuir constant b & Qo are calculated from the slope & intercept with y axis the essential charactricts of Langmuir Isotherm can be expressed in terms of a dimension less separation factors, R1 or R with describe the type of Isotherm and is defined by

$R1 \text{ or } r = 1/ (1+bco)$

Where b & Co are term appearing in Langmuir Isotherm. The parameter indicates the shape of isotherm accordingly.

RL or r value	Type of isotherm
r > 1	Unfavorable
r = 0	Linear
O < r < 1	Favorable
r = o	Irreversible

Freundlich Isotherm :

On other equation for isothermal adsorption. The freundlich or van Bemmelen equation, has been widely used for many years. This equation was based on the assumption that the adsorbent had a heterogeneous surface composed of different classed of adsorption sites, with adsorption on each class of site following the Langmuir Isotherm. The Freundlich equation has the general form

$qe = kfc1/n$ --------- (a)

Where K f and n are the constant's and

If

1/n<1, bond energies increases with surface density.

1/n>1, bond energies decreases with surface density.

1/n=1, all surface sites are equivalent.

Freundlich equation can be put in a useful form by taking log of both.

$$\log qe= \log kf + 1/n \log C$$

Thus, a plot of log qe and log C should yield a straight line for adsorption data which follow the Freundlich theory. The values of the constants n and kf can be determined from the plot. The intercept is roughly an indicator of sorption capacity and the slope, 1/n, of adsorption capacity. The Freundlich equation generally agrees quite well with the Langmuir equation and experimental data over moderate ranges of concentration C

6. WHY DOES ADSORPTION OF OIL ON HAIR TAKE PLACE?

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.

Approach :

First of all, the expected parameters, affective the process are short listed and the experiments are so designed that their effect on the adsorption could be studies separately. The parameters short listed are bed width, concentration of oil in feed, mass of hair, condition of oil in water (free or emulsified), packing of hair in bed (regular or random), viscosity and density of oil. The oil chosen had the specific gravity of 0.965 which is near to that of water. The experiments are also conducted using dense oils and the results are good. The experiments are tried with both free and emulsified oil. As oil emulsion in water is unstable, detergent is used as an emulsifier. The final concentration of oil in extract is measured by turbidimetry using digital Nephelometric turbidimetry using digital Nephelometric turbidity meter

6. STRUCTURE AND COMPOSTION OF HAIR

The essential growth structures of hair are follicles which are deeply invaginated in the scalp tissue in the tens of thousands. At the based of each follicle, the cells proliferate. As they stream up-ward, the complex processes of protein synthesis, structural differentiation, align material which is know 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, limricated 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 multilayered shield (3-4mm) around the fiber. Enveloped by the protective sheath of the cuticle is hair cortex which constitutes the bulk of the fiber. The cortical cells are fibrillar in nature, highly elongated, and oriented along the length of hair. Dispersed throughout the structure of cortex are pigment particles called melanin. Their number, chemical character, and distribution pattern determine the color of hair in some hairs, centrally located vacuolated medulla cells are also present. Chemically, hair is a biopolymer composed largely of cystine-cross-linked proteins termed keratins. Two principle protein fractions have been isolated from hair. i.e. low and high sulfur proteins. The low sulfur fraction consistent of protein of high molecular weight and high degree of molecular organization, i.e. U - helical; the protein of the high sulfur 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 sulfur proteins and the surrounding matrix is made up of high sulfur 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 sulfur proteins. The distal zone of each cuticle is heavily cross-linked by cystine; this fact, in conjunction with the multilayered 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 color, 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 (1.2). 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 (1). The greater fiber diameter results in a slow uptake of dyes because the ratio of surface area to volume is smaller.

7. EXPERIMENTAL PROCEDURE

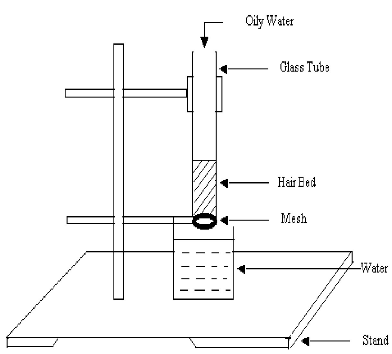
Two series of experiments were conducted and equipment was designed for the purpose. The first series is carried out at micro level to study and understand level to know the nature and the viability of the process and also to study the effect of various parameter on the process.

Macro-level experiments :

Keeping mass of hair (9 g) and concentration constant, the effect of width of hair bed on adsorption is studied. For 30 ml feed the cross sectional area of bed in kept at 75 cm2. For each concentration width are varied thrice and the results are noted. Width taken are 3, 4.5 and 7.5 cm. For each bed width, concentration is varied thrice, and the concentrations being 10,20 experiment and the apparatus washed with detergent for greater accuracy.

Micro-level experiments :

Two slides were prepared by keeping a strand of hair and microscope was adjusted at a specific magnification. A minute droplet of colored water is put on the hair followed by a minute droplet of oil and the phenomenon is studied under the microscope.



EXPERIMENTAL SETUP

The process was repeated number of times to get accurate results. Photographs of the slide were taken the figure 1 & 2.

8. RESULTS & DISCUSSION

I) Micro-level study :

From fig. 1 & 2, it is inferred that the phenomenon that takes place is selective physical adsorption.

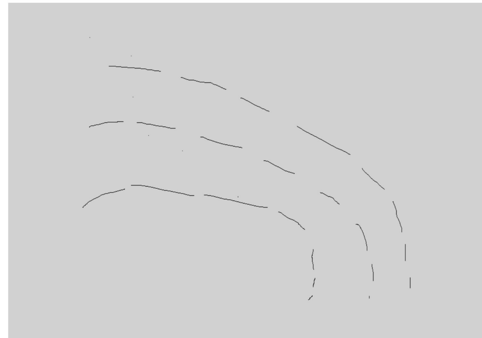


Fig 1 Photograph showing water being replaced by oil (H-Hair ,O-oil, W-water)

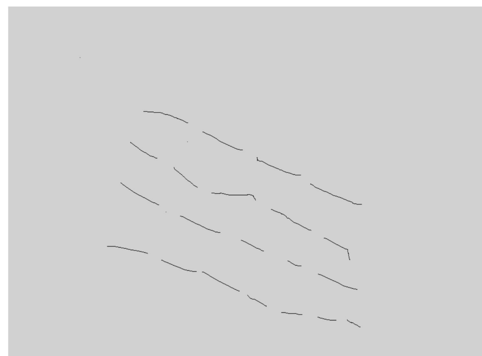


Fig 2: Photograph showing selective adsorption (H-Hair ,O-Oil)

It is due to the selective adsorption of oil, due to its higher affinity toward hair that is attributed to higher adhesive forces between oil and hair as compared to that between hair and water. It can be seen, that oil displaces water from hair surface and gets adsorbed. It can also be inferred that it is physical adsorption from the multi layer of oil seen on such of hair.

II) Macro-level study :

From Fig. 3 it is inferred that the percentage of oil in extract increases as the feed concentration is increased. From fig 4, it is inferred that as concentration increase efficiency increases. Also it is inferred that as bed width increases for a given concentration efficiency decreases. This may be due to channeling. Also it is seen that the volume of oil adsorbed is completely indendent of bed with. It depends upon mass and adsorbing capacity of hair. But this was true at very small width and is bound to vary once the model is scaled up. The quantity of water trapped in the bed in any case is lower than that of oil.

Table No.1: Concentration of oil in feed verses Concentration of oil in extract

Sr.No	% of Oil in feed	% of oil extract 3 cm	% of oil extract 4.5 cm	% of oil extract 7.5 cm
1	0.00	0.00	0.00	0.00
2	5.00	0.26	0.36	0.45
3	7.5	0.35	0.45	0.54
4	10.00	0.43	0.52	0.61
5	12.5	0.44	0.53	0.62
6	15.0	0.42	0.52	0.60
7	25.0	0.51	0.58	0.63
8	30	0.61	0.68	0.72
9	32.5	0.68	0.74	0.77
10	35.00	0.75	0.8	0.82
11	37.5	0.83	0.87	0.89
12	40.00	0.94	0.96	0.97

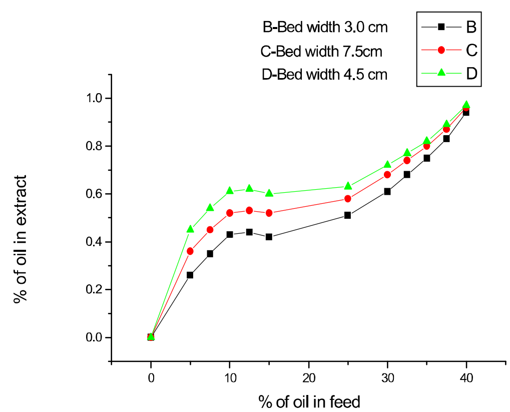


Fig No; 03 Concentration of oil in feed vs concentration of oil in extract

Table No.2: Concentration of oil in feed verses Concentration of bed

S.No	% of Oil in feed	% of oil efficiency 3 cm	% of oil efficiency 4.5 cm	% of efficiency 7.5 cm
1	5.00	97.8	92.8	91.0
2	7.5	95.33	94.0	92.8
3	10.00	95.7	94.8	93.9
4	12.5	96.4	95.7	95.04
5	15.0	97.2	96.53	96.00
6	20.0	97.95	97.6	97.25
7	25.00	97.96	97.68	97.48
8	30	97.96	97.73	97.60
9	32.5	97.90	97.72	97.63
10	35	97.95	97.7	97.65
11	37.5	97.78	97.68	97.62
12	40	97.65	97.62	97.57

$$\textbf{Efficiency} = \frac{\text{\% Intial Concentration - \%Final Concentration}}{\text{\% Intial Concentration}} \times 100$$

$$\textbf{For reading 1 Effiency} = \frac{5 - 0.26}{5} \times 100 = 94.8\ \%$$

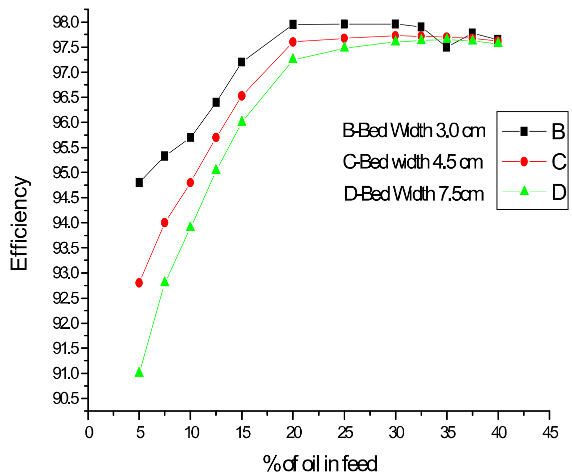


Fig No 04 Coeentration of oil in feed vs Efficiency

Table 3 Calculation of Freundlich Isotherm for removal of oil from oily water

Sr No:	Sample Dose	Hair Adsorbant C1			Hair Adsorbant q			Log c1			Log q		
		3 cm	4.5 cm	7.5 cm	3 cm	4.5 cm	7.5 cm	3 cm	4.5 cm	7.5 cm	3 cm	4.5 cm	7.5 cm
1	1	2.08	1.99	1.41	0.63	0.52	0.95	0.32	0.3	0.15	-0.2	-0.28	-0.02
2	2	1.86	1.77	1.25	0.60	0.54	0.95	0.27	0.25	0.1	-0.22	-0.26	-0.02
3	3	1.58	1.41	1.00	0.57	0.54	0.93	0.20	0.15	0.0	-0.24	-0.26	-0.03
4	4	1.41	1.12	0.79	0.52	0.86	0.91	0.15	0.05	-0.1	-0.28	-0.27	-0.04
5	5	1.25	1.00	0.60	0.50	0.52	0.91	0.10	0	-0.16	-0.30	-0.28	-0.04
6	6	1.17	0.89	0.50	0.47	0.50	0.89	0.07	-0.5	-0.30	-0.32	-0.30	-0.05
7	7	0.89	1.70	0.35	0.45	0.47	0.88	-0.05	-0.15	-0.45	-0.34	0.32	0.055
8	8	0.70	0.56	0.31	0.44	0.44	0.87	-015	-0.25	-0.5	-0.35	0.34	0.06
9	9	0.56	0.50	0.28	0.43	0.42	0.87	-0.25	-0.30	-0.55	-0.36	0.37	0.06
10	10	0.45	0.31	0.22	0.43	0.41	0.87	-0.34	-0.50	-0.64	-0.36	0.38	0.06

Logq = log kf + (1/n) * log ct

Where Kf & n are constant

Fig 01; Bed width of 3 cm

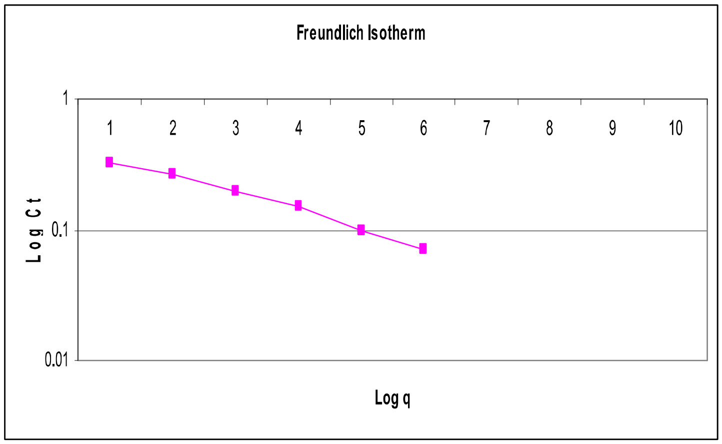


Fig 02; Bed width of 4.5 cm

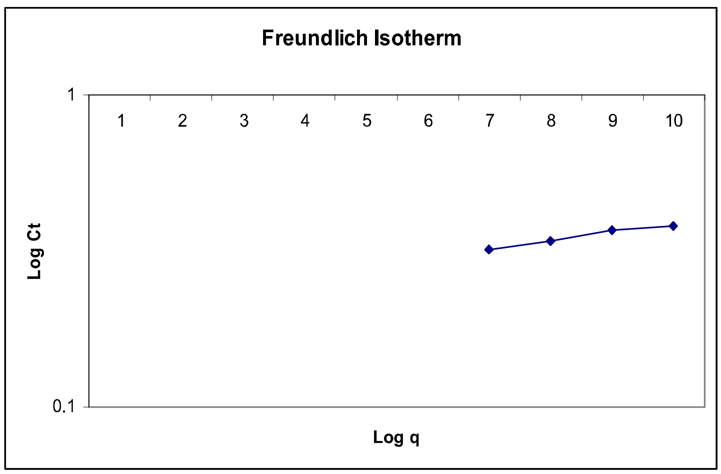
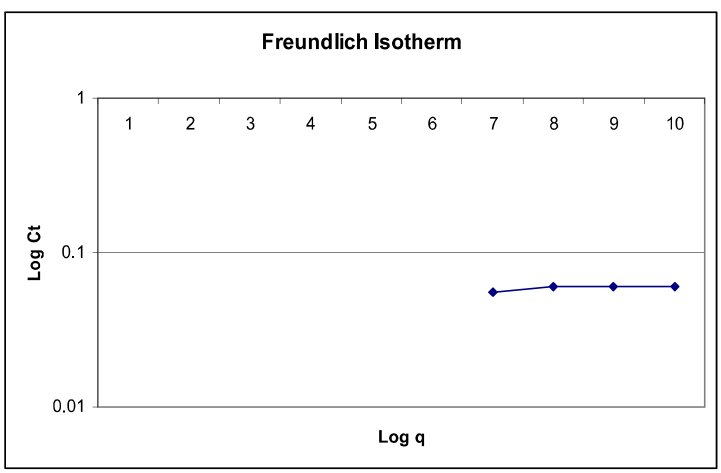


Fig 03; Bed width of 7 .5cm



DISCUSSION

From above observation table & graph we compare these with standard graph. We found same nature of graph with the published article on as hair adsorbent. So it confirmed by Freundlich's isotherm which is straight line as predicted by the adsorption phenomenon.

9 CHEMICAL ENGINEERING ASPECTS

This work has various engineering Aspects as the project consists of two part viz. (1) Preparation of hair adsorbent (2) Removal of oil from oily water.

Following are the chemical engineering aspects :

1) Preparation of hair adsorbent :

During the preparation of hair adsorbent, the hair adsorbent has to be treated with warm water them allow to dry it. We cut the hair in the proper size about 2cm. Long each and we weight the hair about 9gm. and prepare a different bed sizes like 3cm., 4.5cm. & 7.5 cm. Dia. We take for this purpose a large reactor having inert reactions with oil can be used.

a) Heat Transfer operation :

In this no adequate heating source is to be utilized.

b) Chemical Reaction Engineering :

During the pretreatment, the decomposing matter is to be removed which involves chemical reaction kinetics. Also the hair adsorbent is to be prepared for making it surface active. Thus the preparation of active surface of hair adsorbent involves chemical reaction.

c) Mechanical Operation :

After washing with warm water and are to be dried and cut into adequate hair size. All the operation mentioned above are mechanical operation of chemical engineering.

2)Removal of Oil from Oily water :

a) Mass Transfer Operation :

Since water is taken in large concentration then oil it is more probable for water to be adsorb in large quanties than oil. But reverse it found to be true when experiment are conducted moreover when the phenomena is studied under optical microscope it is seen that oil replace water from the hair surface it can be explain in terms of selective physical adsorption. Adhesive forces between oil and hair are greater than these exists between water and hair thus separation 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, non-cellular partition.

b) Fluid Mechanics :

Oily water is pumped from lower tank to the column, which then passes through the packed bed of the hair adsorbents. Their require measurement of flow, fluid velocity, head loss due to friction in packed bed. The head loss due to piping is calculated and on which the desired parameter of the pump are decided.

Process equipment and plant design :

Size of the column is designed considering the thin cylinder and pressure of fluid is not high. The length of the column is designed considering bed high and flow rate of water. The economic length and diameter can be calculated for mass use considering the fundamentals of process design.

10. SCOPE AND FUTURE STUDY

Based on the result of the present investigations, following suggestion made for further research work.

- Studies on hair as adsorbent is take place after that treating with used as fuel pillets.
- Utilities of these hair as adsorbent material for the treatment of other industrial effluent can be explored by details experiments.
- Research work can be directed towards the removal of phenols, organic acid using these non-conventional adsorbent.
- The oil adsorption of potentially wasted hair fibers could produce valuable solutions for our wanton society. We have investigated the ability of human hair to adsorb a variety of potentially hazardous oils that have the possibility of being spilled in terrestrial or aquatic environments.
- These oils included motor oils, heating oils and crude oils. We established the absorbency properties of brunette, blond and black hair pigments and measured the ability of the hairs to capture the oil in affected areas.
- We have also determined the best size to make our pantyhose pouches to put the hair in so we can contain the hair in one area.

- We investigated the many possible uses of the oil adsorbed hair and contained oil and the ability of the oil to be reclaimed from the pantyhose and from the hair.
- We determined the best hair type for adsorption and the amount of hair to place in what type of pantyhose by determining the best ration of oil to water solution to adsorb to its greatest ability. Using this we gained the knowledge and feasibility of creating pellets from oil soaked hair and sawdust. This generates and alternative fuel source, which resulted in burning the pellet in wood burning pellet stoves.

11. CONCLUSION

This process of separation of oil from water by human hair as an adsorbing medium is found to be very efficient at laboratory scale. A critical point of view is kept throughout the experimentation and every care is taken to minimize the human as well as instrumental errors. Even if the process does not reduce the concentrations to micro levels it can still reduce the cost drastically by reducing the amount of demulsifying agents required. The above efficiencies are calculated for emulsified oil but it is as efficient for separation of free oil. It is found from the preliminary studies that the efficiency of the process increases if multistage arrangement is employed. Still the search is no for a solvent that can be used to regenerate the bed economically. Different qualities of hair could not be tested due to the inherent difficulty in retrieving same quality of hair. this problem will also be faced if the model is scaled up. We are also in a continuous quest for an equation that will govern the process and for that extensive experimentation is being carried out. It is a new venture and still a lot of experimentation needs to be done to validate it as an efficient process chemically as well as economically. Work is being done to find critical conditions, economic validity and process control. It is just a sincere effort to study a new phenomenon with a critical view and derive creating inferences.

Our project resulted in a triple win-win situation of the elimination of the waste hair, cleansing environmental areas of spilled oil with human hair and producing a fuel pellet from the recovered materials. Our project turned our to be a success for the environment and for the scientific elimination of hazardous and expensive oil spills that are devastating to our environment. This method of cleaning up oil spills is a more efficient and a less costly way to protect our environment. An added benefit of our project has been the discovery of a fuel pellet, which generates more heat that the standard fuel pellet on the market today. Waste hair is a good material for adsorbing spilled oil that comes into direct contact with it. Approximately 50% of the adsorbed oil can be recovered from the oil soaked hair by pressing it. Fuel pellets made from the oil soaked hair produce more heat than commercially produced wood pellets. Our hair filled pouches were not good at absorbing oil spilled into topsoil.

Waste hair is an effective adsorption medium for oil spills in a marine or fresh water environment and could be used for industrial spills where the oil is not able to drain into the topsoil.

Compared to existing methods, our oil recovery process is low cost, effective, and used friendly. It uses waste products as compared to new ones and is able to recover a significant amount of spilled oil for reuse. Remaining oil soaked hair can be made into an excellent alternative fuel source instead of being discarded.

NOMENCLATURE

q	=	Amount of adsorbent adsorbed per unit weight of adsorbent at any time.
q_e	=	Amount of adsorbent adsorbed per unit weight of adsorbent at equilibrium.
Q_0	=	Langmuir monolayer capacity(molg-1)
b	=	Langmuir constant
C_0	=	Initial adsorbate conc. (mg/lit)
C_t	=	Conc. of adsorbate at any time.
C_e	=	Conc. of adsorbate at equilibrium
RL or r	=	Separation factor
m	=	Mass of adsorbate per unit volume of particle free adsorbate solution (gm/lit)
BOD	=	Biochemical oxygen demand (mg/lit)
COD	=	Chemical oxygen demand (mg/lit)
Kf	=	Freundlich adsorption constant.
K_{ad} or K	=	Helferich or lagergren rate constant.
t	=	time in min.
%E	=	%Extractionofadsorbate.

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