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SYNTHESIS OF AEROGEL USING ORANGE PEEL FOR REMOVING OIL AND GREASE WITHOUT SKIMMING TANK IN AUTOMOBILE WASTE WATER

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Abstract - *Treatments using aerogels are the attractive approach that can be used to clean up petroleum hydrocarbons because it is simple to maintain, applicable over large areas, and leads to complete destruction of the biodegradable organic contaminants. It is one of the newest and fastest growing applications in the present environmental biotechnology. Automobile service station contains a lot of chemicals and that water should be properly treated. An aerogel adsorbent material should exhibit high adsorption capacity, high selectivity, low density, good recyclability and environmental friendliness. Here aerogel using orange peels has been applied for oil adsorption in filter media avoiding the skimming tank treatment process and the treatment effects are noticed with respect to thickness and reuse. Due to its low apparent density, high porosity and specific surface area, particularly, the inherently hydrophobic nature of carbon in aerogel makes it suitable to separate oily compounds mixed with water. Aerogel bed is taken with respect of thickness as 2cm thickness, 1cm thickness and without aerogel bed and efficiency in the reuse of the aerogel. It is noted that as the thickness increases the efficiency increases and in case of reuse, as the number of reuse increases there is a slight variation in the efficiency.*

Key Words: Bioremediation, Adsorbent, Aerogel, Orange peel, Skimming tank…

1. INTRODUCTION

Professional car wash systems create wastewater that can have a great impact on the environment, if not properly managed and discharged. Contaminants in the wastewater Includes, oil and grease, fatty acids, detergents, phosphates, hydrofluoric acid, etc… Professional car washes are an easy way for consumers to remove dirt and grime from their vehicles. Growth of urban population has increased the demand for fresh water sources and its rapid depletion has been a concern to ecologists. However, car washing is a highly water-consuming process and involves the use of chemicals, generating potentially toxic wastewater effluents [1]. Aerogels are synthetic porous materials derived from sol-gel materials in which the liquid component has been replaced with gas to leave intact solid nanostructures. Recently aerogels based on natural or synthetic polymers, called polymer or organic aerogels, have been widely explored due to their visible porous structures and unique properties, such as high specific surface area, low density, low thermal conductivity and dielectric constant [3]. In addition, there is a continuous effort to optimize the way to recycle/reuse the aerogels with saturated oil adsorption. It is known that the oily compounds with low boiling points can be recovered by distillation easily, and the adsorbed liquids with high boiling points undergo a direct combustion for the reuse of adsorbents. In this context, the thermal stability of aerogel is important during the practical operation.

Three-dimensional aerogel using orange peels has been applied for oil adsorption here due to its low apparent density, high porosity and specific surface area, particularly, the inherently hydrophobic nature of carbon in aerogel makes it suitable to separate oily compounds mixed with water. The oil and grease content in the effluent results in the bad working condition of the treatment units. Proper maintenance is needed for all the units otherwise there will be much more problems relating to the working and maintenance of the units. Generally skimming tanks are used for the removal of oil and grease. By the application of the aerogels skimming tanks can be avoided and the process can be carried out using the insertion of aerogel bed in the flowing water which absorbs all the grease and oil since they are hydrophobic to water and hydrophilic to oil. Aerogel using orange peels has been applied for oil adsorption here due to its low apparent density, high porosity and specific surface area, particularly, the inherently hydrophobic nature of carbon in aerogel makes it suitable to separate oily compounds mixed with water.

1.1 Objectives of the study

The main objectives of this study is to synthesis aerogel by using orange peel, to develop a treatment plant with aerogels, to implement a new method to remove oil and grease without skimming tank, to calculate variation in efficiency due to thickness, to find out the efficiency of aerogel after the reuse.

1.2 Scope of study

This project deals with the carbon based aerogel production using orange peel. A carbon aerogel have high porosity, large surface area, high selectivity, chemical inertness and excellent recyclability. Micro porous aerogel have been used as sorbent materials, but they take a long time for degradation, which causes environmental and ecological risk. In addition, they have brittle mechanical properties and are relatively long and complicated preparation method. The high surface area, low density, excellent exibility, good chemical stability, environmental friendliness and large pore volume of carbon materials make them suitable candidates for water filtration, water/oil separation, oil spill cleanup, wastewater treatment, gas separation and purification process etc... Aerogels can be easily transported and easily degradable more over here aerogels used are ecofriendly hence it is more easy for handling and also reduces environmental and ecological risk. It also deals with the adoption of treatment process without the skimming tank and hence a new method can be adopted for the treatment process which in turn reduces the time consuming with more efficiency.

2. MATERIALS AND METHODS

Due to the excellent performance, aerogel is considered to be a promising new material. Cellulose is the renewable and biodegradable natural polymer. Aerogel prepared using cellulose has the ability of renewability, biocompatibility, and biodegradability of cellulose, while also having other advantages, such as low density, high porosity, and a large specific surface area. The aerogels for the treatment process is synthesized from orange peel and it is the main material used here.

2.1 Sample Collection

Water drainage is the primary problem associated with a car wash. Much soap contains harmful chemicals that degrade water quality. The pollution problem is only compounded when the soapy water is mixed with the grime, dirt and grease removed from a vehicle. Here the effluent was collected from BRD car world Thaloor in Thrissur district

Fig -1: Effluent

2.2 Orange Peel

The orange peel is collected from the nearby merchants. The orange peel was washed in acetone and distilled water and kept for oven dry for 2 weeks. The cellulose based material separately grinded and sieved in 75nm sieve was taken. On the other hands orange peel contains high pectin content these pectin content in orange peel result in the increased absorption of the oil since pectin is hydrophobic to water and hydrophilic to oil. Orange peels are highly porous in nature and hence it will absorb more oil since the absorption capacity is high. This orange peel is also ecofriendly and hence it can be easily used and decomposed

Fig -2: Orange peel

2.3 Production of Aerogel

For the treatment of automobile service station waste water the primary process is the production of aerogels for that the orange peel collected from the merchants are dried and powdered, this powder was immersed in 4% sodium hydroxide with solid liquid ratio of 1:15 and this mixture was kept at 40°C for 6 hr under stirring. The filtrate was washed in distilled water and the obtained material was dried at 60°Cfor 24 hr in oven. the suspension was frozen for 24hr under 18°Cand it is then freeze dried in freeze dryer at a temperature 55°Cfor 24 hr to obtain sponge aerogel. The production of the aerogel is a complex procedure and when gel formation is not occurred properly during the initial stage agar or gelatin can be applied for the thick consistency of the gel.

Fig -3: Aerogel

2.4 Experimental Setup

The experimental set up includes a screening tank, sedimentation tank, filtration tank and collecting water tank. Sedimentation time is given as 3 hr. Filtration is one of the steps in the water treatment process. The filter materials used are Sand pass through IS 2.36mm sieve, Aggregate retain on IS 20mm sieve, Aggregate pass through IS 10mm sieve and aerogel. Screening is done by a mesh inserted in the screening tank with open square holes of 0.5cm sides. 15 liter of effluent is passed through the screening tank first and the floating waste materials had removed by this process. And the settling particles are removed by the sedimentation process. Both the sedimentation tank and screening tanks are rectangle in shape with length 40cm width 30cm and height18 cm having 1200 cm^2 and volume of 21600cm^3. The screening is made by fine screens because most of the particles in the effluent is fine. Collecting tank and filtration media is of 30 cm diameter circular tank with30 cm height and having are of 706 cm^2 and capacity of 21205cm^3 with a velocity of 0.7 cm/s. here the aerogel bed is used in 2cm thickness, 1 cm thickness and a set of reading without the aerogel bed is taken for finding out the effect of thickness. In the case of reuse the aerogel is reused 3 times after washing with the detergents and dried. 2cm thick aerogel bed is taken for finding out the efficiency of orange peel aerogel in the reuse.

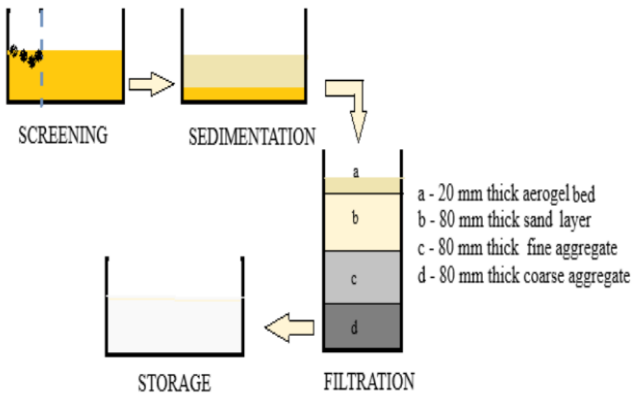

Fig -4: Experimental setup

3. RESULTS AND DISCUSSIONS

Aerogel using orange peels had been synthesized and applied for oil adsorption here due to its low apparent density, high porosity and specific surface area, particularly, the inherently hydrophobic nature aerogel makes it suitable to separate oily compounds mixed with water. The aerogel produced are light weight in nature and it is flexible the colour of this aerogel is not pure white in colour it is in the form of creamy appearance. Meanwhile the immersion of this aerogel with oil and water mix it is clearly visible that the aerogel absorbs only the oil and there is no absorption of the water.

3.1 Characteristics of Effluent

Although there is no universal definition of 'marginal quality' water, for all practical purposes it can be defined as water that possesses certain characteristics which have the potential to cause problems when it is used for an intended purpose The result of various experiments are shown below,

Table -1: Initial Characteristics of effluent

Parameters	Initial Characteristics Of Waste Water
pH	3.48
Turbidity (NTU)	321
BOD (mg/l)	3032
COD (mg/l)	456
Sulphate (mg/l)	456
Alkalinity (mg/l)	135
Oil and grease (mg/l)	831

From the table it is clear that there is necessity for the treatment of automobile service station effluent. Allowing this water to flow through the soil or any water resources will leads to the pollutions on water or soil. Also leads to unhealthy condition and effect the hygiene condition.

3.2 Influence of Aerogel Thickness

Aerogel made from the orange peel has a thickness of about 2cm. Thickness is necessary for more absorbance of the oil content. It has a great role in the absorbing capacity of the aerogel. The aerogels can be made with any thickness here the aerogel was made by 2 cm thickness. Comparison of the result was made with aerogel bed thickness of 1 cm and 2 cm in filter medium with respect to zero thickness ie, no aerogel bed used in filter media.

The table clearly says that as the thickness of the aerogel bed increases the oil absorbing capacity also increases. Also there is difference in other parameters too. When the aerogel bed is not used the water is alkaline in nature and when the bed is inserted the alkaline nature get altered and changed in to acidic. But the value belongs to the drinking water specification more over there is variation in turbidity, as aerogel bed is used the turbidity, BOD, COD, alkalinity Oil and grease content of the water get reduced.

Table -2: Influence of aerogel thickness

Parameters	Without Aerogel	With 1cm Thick Aerogel Bed	With 2cm Thick Aerogel Bed
pH	5	5.3	6
Turbidity	20	13	12

(NTU)			
BOD (mg/l)	180	76	73
COD (mg/l)	170	164	156
Sulphate (mg/l)	59	50	46
Alkalinity (mg/l)	92	85	70
Oil and grease (mg/l)	125	20	16

From the table it is clear that skimming tank can be replaced by aerogel for removing oil and grease.

3.3 Removal Efficiency With Respect To Thickness

The removal efficiency of orange peel aerogel with respect to thickness is shown in the table 3.

Table -3: Removal Efficiency With Respect To Thickness

Characteristics	Efficiency (%)		
	Without aerogel	1cm thick	2cm thick
Turbidity(NTU)	93	95	96
BOD(mg/l)	94	97	98
COD(mg/l)	62	64	65
Sulphate(mg/l)	87	89	90
Alkalinity(mg/l)	31	37	48
Oil and grease(mg/l)	84	97	98

From the table it is clear that the efficiency of orange peel aerogel is much more. While noticing the efficiency it is found that the efficiency increases with the increase in the thickness. The main property of aerogel is the absorption of the oil and grease and it is noticed that there is a wide.

Variation absorption capacity in in zero cm thickness and 2cm thickness, as thickness increases the efficiency is increased. All the parameters shows increased efficiency when thickness increases. The efficiency is lower for the COD and alkalinity but there is a wide reduction in the value from the effluent characteristics. The COD value effluent that we got is sufficient for the disposal in inland surface water as per CPCB. In the case of alkalinity the obtained value is nearer to the neutral value and it is good for inland surface water or irrigation purpose.

3.4 Reuse of Aerogel

One of the main properties of this orange peel aerogel is that it can be reused again. The orange peel once used for the treatment is washed in detergent water and used again for other treatments.

Table -4: Reuse of aerogel

Parameters	Observed Value After Reuse			
	Fresh Aerogel	1st Reuse	2nd Reuse	3rd Reuse
pH	6	5.9	5.9	5.7
Turbidity (NTU)	12	14	15	15
BOD (mg/l)	73	76	79	85
COD (mg/l)	156	158	160	162
Sulphate (mg/l)	46	47	49	52
Alkalinity (mg/l)	70	75	78	80
Oil and grease (mg/l)	16	20	24	30

The table above shows the variation of parameters in the reuse of the aerogel. It is noted that there is a slight variation of effluent parameters.

3.5 Removal Efficiency With Respect To Reuse

The removal efficiency of orange peel aerogel with respect to reuse is shown the table 5. It is clearly visible that the efficiency of the aerogel is reduced by the reuse but there is no huge variation in the efficiency in the reuse. The slight variation in the efficiency is due to the washing and reuse of the aerogel. While washing there is a chance of sticking of old particles in the aerogel and it reduces the efficiency. Moisture condition also depends on the aerogel efficiency is the aerogel remains in a wet condition it will affect the efficiency of the reuse. From the table it is clear that the aerogel can be reused several times and there will not be wide variation in the property of the aerogel. This reuse of the aerogel helps in the maintenance of the aerogel and also in controlling the cost of the treatment process. If it is not necessary this aerogels can be burned and can destroy. These aerogel are degradable and hence this can be destroyed easily.

Table -5: Removal efficiency with respect to reuse

Characteristics	Efficiency (%)			
	Without reuse	1st reuse	2nd reuse	3rd reuse
Turbidity(NTU)	96	95	95	95
BOD(mg/l)	97	97	97	96
COD(mg/l)	65	65	64	64
Sulphate(mg/l)	89	89	89	87
Alkalinity(mg/l)	48	44	42	40
Oil and grease (mg/l)	98	97	97	96

The efficiency of the aerogel in reuse depends upon the method of washing of the aerogel, the quality of washing, the quality of detergents used, proper cleaning of aerogel, and proper drying of the aerogel.

4. CONCLUSIONS

The sample collected from the automobile service stations contains higher pollutants than the general standards discharge of environmental pollutants as per central pollution control board (CPCB). Turbidity, BOD, COD, Sulphates, alkalinity, oil and grease are very high in the initial stage. This study has successfully relieved with the production of orange peel aerogel and its treatment with respect to the thickness and reuse. Orange peel aerogel are used in the filtration tank and noticed that orange peel aerogels are efficient in replacing skimming thank treatment. Filtration media with and without aerogel for the treatment of effluent is used. It is noted that, efficiency is more for the filtration media with aerogel comparing with the filtration media without the aerogel bed. Thickness of the aerogel bed is made with 2cm and 1cm and the treatment of effluent is done with this aerogel bed thickness. It is noted that as thickness of the bed increases the efficiency increases. The value of the BOD is reduced in the filtration media without aerogel. However the oil and grease content is very high during that treatment process. The considerable decrease in the oil and grease is noted with respect to the increase in the thickness of the aerogel. Further treatment for the oil and grease is not necessary.

In the case of reuse of the aerogel it is noted that the efficiency of the aerogel varies with respect to each reuse. But there is no enormous decrease in the efficiency of the aerogel. Here there is a slight increase in the characteristics of the waste water collected after each reuse. This variation of the aerogel occurred due to the washing of the aerogel which results in changes in the property of the aerogel. Also it depends upon the proper quantity and quality of the detergent used. Hence the purifier used should be of good quality.

REFERENCES

[1] Memory Tekere "An assessment of the physicochemical properties and toxicity potential of carwash effluents from professional carwash outlets in Gauteng Province" Vol. 3, Dec2015, Issue 02. South Africa Department of Environmental Sciences, UNISA Florida Campus,

[2] Hirasaki, "Most common surfactants employed in chemical enhanced oil recovery, Department of petroleum engineering curtain university" 2 June 2017, volume 3 issue, Pages 197-21

[3] Wang shishza and xiznu, "low cost bamboo fiber for adsorption" Chinese Academy of Sciences Xinjiang Technical Institute of Physics & Chemistry, april 2015.

[4] Hayase g and Kanamori" Synthesis of Marshmallow-like Macroporous Gels Usable under Harsh Conditions for the Separation of Oil and Water". Angew. Chem. Int. Ed. 52, 1986–1989 (2013).

[5] Choi H. M. and Clou, R. M. "Natural sorbents in oil spill cleanup". Environ. Sci. Technol. 26, 772–776 (1992).

[6] Dalton R, "Extent and frequency of vessel oil spill in US marine protected areas" Mar. Pollut. Bull. 60, 1939–1945 (2010).

[7] A. C. Pierre and G. M. Pajonk, "Chemistry of aerogels and their applications," Chemical Reviews, vol. 102, no. 11, pp. 4243–4266, 2002.

[8] Silica Aerogel: Synthesis and Applications 2010

[9] A. Venkateswara Rao, N. D. Hegde, and H. Hirashima, "Absorption and desorption of organic liquids in elastic superhydrophobic silica aerogels," Journal of Colloid and Interface Science, vol. 305, no. 1, pp. 124–132, 2007.

[10] Pekala, R. W. "Organic aerogels from the polycondensation of resorcinol with formaldehyde". Journal of Materials Science. 24 (9): 3221–3227. Archived from the original on 28 April 2015. Retrieved 29 April 2015