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Effluent Treatment by Multi Walled Carbon Nano Tubes

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ABSTRACT

The Industries which are using hazardous chemicals have the potential to pollute water resources through the discharge of the effluent to rivers and other water bodies. Thus the demand for developing technologies leading to an effective removal of this effluent has become a great challenge. Advancements in nanoscience and engineering are giving new opportunities to develop more cost-effective and environmentally acceptable water treatment technologies. Carbon nanotubes (CNTs) are emerging as potential adsorbents because of its well defined cylindrical hollow structure, large surface area, high aspect ratios, hydrophobic wall and easily modified surfaces. Large scale and Low cost synthesis of CNTs using Acacia Concinna (mimosaceae) at 700^{0}C in an inert atmosphere using chemical oil vapour deposition method (COVD) is reported. The morphology of CNTs was studied using SEM, XRD, FTIR etc and are used for the effluent treatment.

Keyword: Multi Walled Carbon nanotubes, Acacia Concinna, Effluent treatment, Chemical Vapour Deposition

I. INTRODUCTION

Now days, due to stringent environmental rules [1] and regulations, most of the Mineral processing and Metal finishing industries are facing severe problems in the disposal of waste water produced at large scale. There is a possibility of formation of complex ions with waste waters containing ammonia, fluoride, or cyanide ions along with heavy metals. Carbon nanotubes (CNT) adsorption technology has potential to remove the bacterial pathogens, natural organic matters (NOM), and cyanobacterial toxins from water systems [2]. By using filters made of carbon nanotubes, pollutants could be removed more effectively from contaminated water as compared to common charcoal filters. CNTs have a very large surface area [3] that gives them a high capacity to retain pollutants such as water-soluble drugs. A team at the University of Vienna found that at concentrations likely to occur in the environment, the tubes removed 13 tested Polycyclic Aromatic Hydrocarbons (PAHs) from contaminated water. It is very useful in Environmental Science Technology [4].

Plant based oils are an important source for large scale [5] and low cost synthesis of Multi walled carbon Nanotubes (MWCNTs) using Chemical Oil Vaporization technique. The present study is aimed to synthesize low cost bio-adsorbent materials [6,7] in the form of MWCNTs and study its ability to purify wastewater.

II. METHODS AND MATERIAL

Preparation of MWCNTs:

The low cost production of MWCNTs was obtained by heating Acacia Concinna (mimosaceae) at 700^{0}C for about 4 hrs in an inert atmosphere of nitrogen by using Chemical Oil Vapour Deposition (COVD) method. The schematic diagram of indigenously developed apparatus to synthesize the desired material is shown in Fig.1

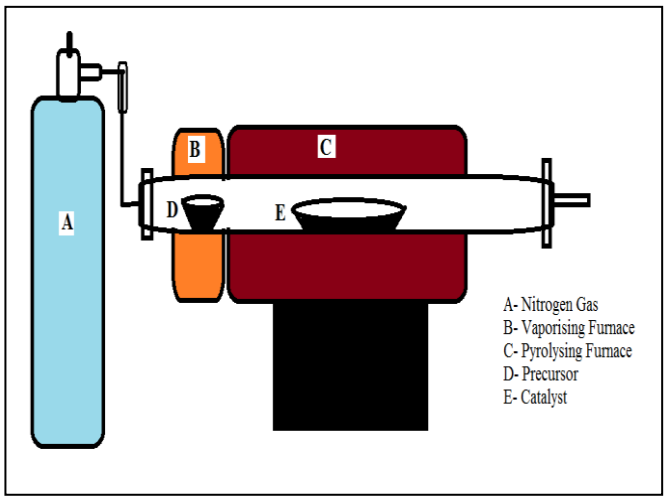

Fig. 1 Schematic diagram of CVD furnace used for synthesis of CNT

The catalyst plays an important role in the synthesis and has a large impact on the diameter of MWCNTs. Iron nano particles obtained by urea decomposition method using Ferric Nitrate are used as catalyst for the synthesis of MWCNTs.

Purification:

As grown MWCNTs was purified using dilute Hydrochloric acid and Nitric acid by reflux method. The purified MWCNTs are used for effluent treatment.

Characterizations:

The obtained materials were analysed compositionally by SEM. A JEOL-6360 SEM with a probe current of 1 nA was used for this purpose. The energy range for sample scanning was 0-20 KeV. The XRD was recorded for a good quality sample by Phillips PW 3710 X-ray diffractometer using CuKα line. The range of 2θ values was from 10^o-80^o. To confirm the nature of the synthesized nanoparticles and their purity Fourier Transform Infrared spectroscopy (FTIR) studies were performed. FTIR analysis was done on Jasco 4100.

Effluent treatment:

The column has been packed with MWCNTs. The packing materials consists of a height of 15cm and diameter 4 cm of the Pyrex glass tube (column) with a length of 46 cm (Fig. 2). The different parameters such as pH, Conductivity and TSA have been studied. The parameters which affect the rate of adsorption such as MWCNTs, temperature, pH, ionic strength, metal ion concentration etc, were also studied and optimized.

Fig 2 Experimental column packed with MWCNTs

III. RESULTS AND DISCUSSION

The SEM image shows an existence of Carbon nano tube which is Multi walled in nature [8, 9]. The effective diameter of the tube appears to be 36.6 nm as seen in the following image [Fig. 3].

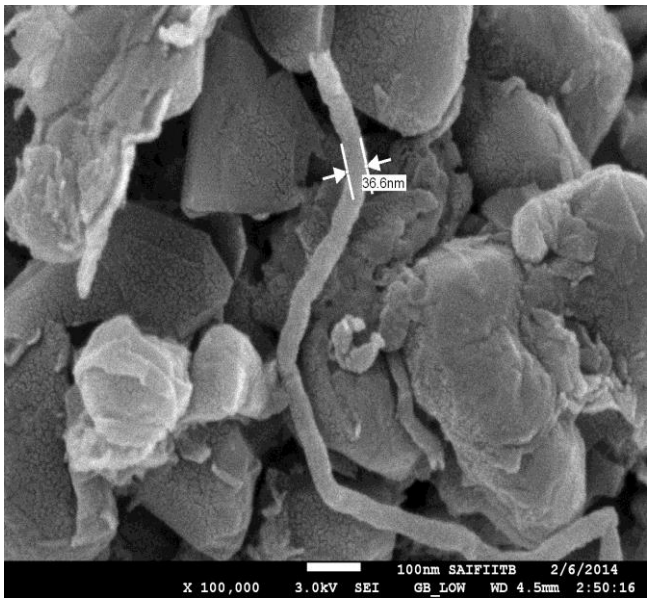

Fig 3 SEM Image of MWCNT obtained from Acacia Concinna oil by CVD method

The Characteristic peaks in the XRD plot correspond to the Crystalline Caron material. The obtained plot matches with the plots reported by the researchers for the Multi Walled Carbon nano Tubes.

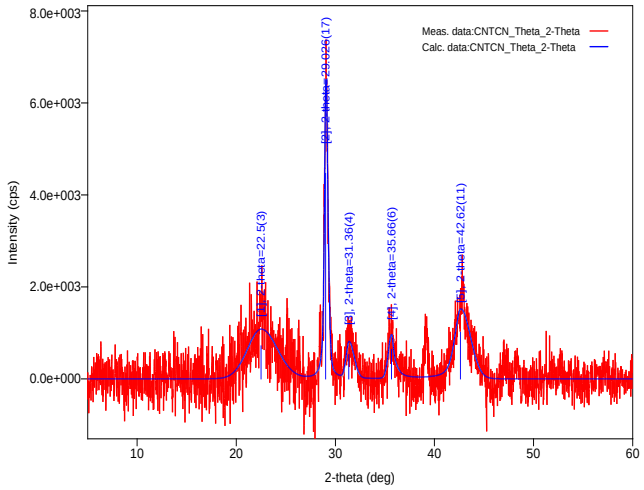

Fig 4 XRD Image of CNT obtained from Acacia Concinna by CVD method

From FTIR analysis it is evident that MWCNTs obtained from oil shows that wave numbers ranging between 3551-1021cm^{-1}, it indicates presence of several functional groups such as Hydroxide (3428 cm^{-1}), Carbonyl (1573 cm^{-1}), C-N str (1420 cm^{-1}) C-H str. (2921 cm^{-1}) . 1420 cm^{-1} is also attributed to MWCNTs vibration mode. (Fig.5)

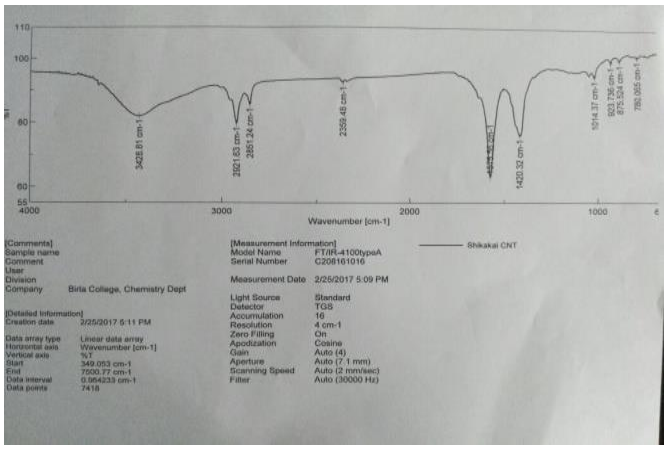

Fig. 5 FTIR Spectra of the obtained MWCNT

The pH of effulent is found to 5.9**,** Therefore, it is not potable for drinking purposes (as per the BIS – 10500 (2004-2005) 6. 5 to 8.5 desirable limit for drinking water) [10]. The pH of CNTs treated effluent water sample was found to be 7.35 which are within the limits of the expected pH for the drinking water.

According to BIS 10500 (2004-2005), desirable limit the dissolved solids in drinking water is 500 mg/l. The amount of dissolved solids in the sample before filtration was found to be 0.028 mg/l whereas after dissolving the Carbon nano materials in the water and subsequent filtration the amount of dissolved solids in the sample was found to be 0.012 mg/l. Hence, it can be said that the purified water sample can be used for drinking purpose and does not require further treatment. Conductivity of waste water sample is 0.170 ms/cm and CNTs treated effluent water sample is found to be 0.164 ms/cm. The table 1 shows a comparison of several parameters of effluent before and after CNTs treated.

Table 1 Comparison of parameters of effluent before and after treatment

Parameter studied	Effluent sample	CNTs treated effluent sample
PH	5.9	7.35
Conductivity	0.170ms/cm.	0.164 ms/cm.
Total Solids	0.028 mg/l	0.012 mg/l

.

Fig 6 Colour comparison of the effluent before and after treatment

IV. CONCLUSION

The low cost production of multi walled carbon Nano tubes (MWCNTs) using plant based oil is an important source for large scale synthesis. MWCNTs using Acacia Concinna oil were pyrolysed at 700°C in an inert atmosphere of nitrogen by using Chemical Vapour Deposition method (CVD). The catalyst used in this large scale production plays an important role in the diameter of MWCNTs. Fe catalyst obtained by co precipitation method gave the uniform diameter of MWCNTs. The MWCNTs as prepared by can be used as the adsorbent for the treatment of effluents from water sample.

The pH of CNTs treated effluent was found to be within the limits of the expected pH for the drinking water. The amount of dissolved solids in the sample was found to be 0.012 mg/l and the Conductivity of CNTs treated effluent sample was found to be 0.164 ms/cm. From the above results we conclude that MWCNTs are can be most suitable material for the effluent treatment.

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