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DEVELOPMENT OF EXPERIMENTAL SETUP FOR EXTRACTION OF CARBON NANOTUBES FROM CO_2 EMISSION OF INDUSTRIAL EXHAUST

Narendra P. Mali*, Prasad S. Kawade & Mohan Dusane*****
Department of Civil Engineering, Vidyavardhini's College of Engineering & Technology, Vasai Road, Palghar, Maharashtra

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Abstract:

Nowadays, one of the greatest problems that the world facing is environmental pollution, which is causing grave and irreparable damage to the natural world and human society with about 40% of deaths worldwide being caused by water, air and soil pollution. India is the fourth largest country in the world generate nearly about 2,454,968 Kilo tonnes of carbon dioxide per year. In order to reduce the carbon emission we have come up with a material named as carbon Nanotubes (CNT's). Carbon Nanotubes (CNT's) are special materials with great potential in various civil engineering Structure. Herein we convert the waste gases coming out from the industrial and automobile (Vehicular) exhaust and furnaces into a Nano-material called Carbon Nanotubes which is three thousand times stronger than steel and one sixth of its weight. This paper will discuss in detail the synthesis processes of Carbon Nanotubes and also its successful application in concrete.

Key Words: Carbon Emission, Carbon Nanotubes, Nanomaterial, Durability, High Strength & Synthesis

Introduction:

Nanotechnology is one of the most up-to-date and the fastest growing fields of science. Huge potential has been predicated for nanotechnology in material science and construction. The various types of nonmaterials are nanofibers, nanorods, nanotubes, nanofoams, nanopores etc. Out of which, this paper comprises of carbon nanotubes. Carbon nanotubes are allotropes of carbon and are belongs to fullerene structural family having cylindrical nanostructure. Due to some extraordinary properties Such as thermal conductivity, mechanical and electrical properties, carbon nanotubes has potential applications in nanotechnology, electronics , optics and other fields of material science and technology.

The carbon nanotubes is having long and hollow structure with walls formed by one atom thick sheet of carbon called graphene. The carbon Nanotubes is classified as Single Walled Nanotubes and Multi Walled Nanotubes. The Single Walled Nanotubes consist of single rolled layer of graphene whereas Multi Walled Nanotubes consist of multiple rolled layers of graphene. The important aspects of carbon Nanotubes are its light weight, high surface area, small size with high aspect ratio and good tensile strength. Carbon nanotubes are considered as strongest material in nature having very high tensile strength ranges from 11 to 63 GPa. The tensile strength of carbon Nanotubes is hundred times greater than that of steel at one sixth of the weight. The carbon Nanotubes are characterized by thermal stability upto 2800°C. In addition carbon Nanotubes are packed together by van der waals attraction forces during production.

The process of production of Carbon Nanotubes from carbon dioxide (co2) emission of the industrial outlet is beneficial from the environmental as well as economical point of view. It will reduce the emission of carbon dioxide from factories like Rice Mill, Steel or metal or cement plant etc. and will improve the quality of air.

The paper comprises of preparation of Catalytic substrate (Cement Sand Substrate) and its installation on industry exhaust or chimney. As it develops a large-scale production of the CNT, the costs associated will tend to decrease and its application in the construction will start occurring more naturally.

Literature Review:

In 1952 L. V. Radushkevich and V. M. Lukyanovich published clear images of 50 nanometer diameter tubes made of carbon in the Soviet Journal of Physical Chemistry. This discovery was largely unnoticed, as the article was published in the Russian language, and Western scientists' access to Soviet press was limited during the Cold War. Carbon Nanotubes have been produced and observed under a variety of conditions prior to 1991. A paper by Oberlin, Endo, and Koyama published in 1976 clearly showed hollow carbon fibers with nanometer-scale diameters using a vapour-growth technique.

In 1979, John Abrahamson presented evidence of carbon Nanotubes at the 14th Biennial Conference of Carbon at Pennsylvania State University. The conference paper described carbon Nanotubes as carbon fibers that were produced on carbon anodes during arc discharge. In 1981, a group of Soviet scientists published the results of chemical and structural characterization of carbon nanoparticles produced by a thermocatalytical

disproportionation of carbon monoxide. The authors suggested that their "carbon multi-layer tubular crystals" were formed by rolling graphene layers into cylinders.

In 1991 Sumio Lijima Discovered hollow nanometer size tubes composed of graphitic carbon and offered first conclusive proof of single walled CNT. True identity of discoverers of CNT is subjected to controversy as it was observed that multi walled CNT was discovered in 1952.Vivek nair (2012) Specified a highly economical process for large scale production of carbon filaments by a low temperature synthetic method from industrial and auto mobile flue gas emission.

Design Data:

In the process of synthesizing Carbon Nanotubes from Industrial Exhaust firstly we need to select appropriate industry. Because this process cannot be performed anywhere. Best suited industries for the process of developing Carbon Nanotubes from Industrial Exhaust are Rice Mill Industry, Cement Manufacturing Industry and Metal Industry. In our case we work at Metal Industry. Then after we need to visit the industry to examine the exhaust dimensions, so that accordingly we can prepare the Catalytic Substrate.

Dimensions of the Exhaust are as follow:-

1. Dimensions of Chimney:

- ✓ Height Of Chimney = 15.14 M
- ✓ Diameter Of Chimney = 0.42 M

2. Dimensions of Chimney Projection:

- ✓ Length of Projection = 15 cm
- ✓ Diameter of Projection = 10 cm

Dimensions of Catalytic Substrate are depends on the Projections of the exhaust. We have prepared that catalytic substrate manually hence dimensions are not uniform.

- ✓ Length of Handle to hold catalytic substrate = 30 cm

- ✓ Thickness of SiO2 = 1 mm

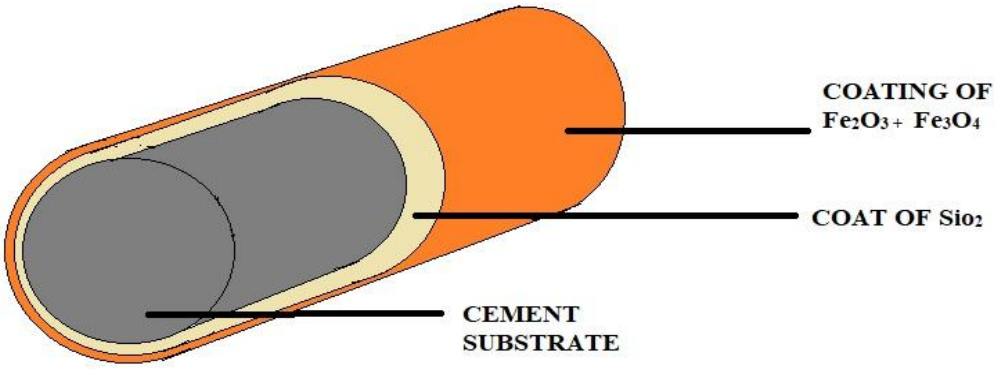

Table 1: Size of Catalytic Substrates

Job No	Length (Centimeters)	Diameter (Centimeters)
1	21	3.5
2	15	3.5
3	18.5	3.5
4	18	3.7

Process of Synthesizing Carbon Nanotubes:

Materials:

As we discussed about requirements in experiment section, based on that material consist of following which required to make catalyst and substrate or we can say catalytic substrate; which are Ordinary Portland cement of 53 grade of ULTRATECH cement was used in used conforming to I.S. 269- 2015 having specific gravity 3.15 and Silica sand (SiO2) composed solely of silicon and oxygen. Found most commonly in the crystalline state, was broken down into fine granules having colour varying from brown to grey and sieve size less than 2.36mm is used. Along with this Ferrous oxide (Fe_2O_3) and Ferric Oxide (Fe_3O_4) is coated over the cement sand substrate by the action of heat.

Preparation of Catalytic Substrate:

- ✓ **Preparation of Cement Sand Substrate:** The cement mortar is prepared with proportion of 1:2 (1 part of cement: 2 part of sand). Then spread required quantity of ordinary Portland cement over sand and thoroughly mix them in dry condition till mixture looks uniform in colour. A small depression on top of heap is provided and added required amount of water so as to give it required consistency, to the centre of heap. Mixed whole mass thoroughly for 2 to 3 minutes by means of shovel. And Casting of cylindrical substrate using prepared mortar by keeping hole throughout the length of Cylinder, so as to insert a steel bar of 6 mm diameter which serves as a handle to hold the substrate.
- ✓ **Coating Silica Sand:** The inert surface which is required on substrate is preferably a silica sand layer. After casting cylindrical substrate of mortar immediately coat the layer of silica sand over surface of substrate as the surface of substrate is wet. The silica sand (Sio2) layer of a uniform thickness of 1 mm should be coated on surface Of substrate by keeping in mind the silica sand should be properly stick on surface. Then allow the substrate to dry in air so that silica sand should be properly coated on substrate.
- ✓ **Coating Fe2O3 and Fe3O4:** The sand covered cement substrate is coated with a catalyst. The sand covered cement substrate is coated with alpha form of ferrous oxide (Fe3O4) and gamma form of ferric oxide (Fe2O3) magnetic nano particles in ratio of 3:7. The magnetic nano particles of alpha and gamma form of iron oxide are coated over an inert substrate by laminar flow in a uniform layer of thickness 0.1 mm to 0.2 mm.
- ✓ **Heating of Catalytic Substrate:** The sand covered cement substrate coated with solution form of catalyst is required to heat in muffle furnace at 500°C. The muffle furnace is set to 500°C by adjusting the current. Place the substrate in furnace by using tong. The heating of substrate is continue for 5 to 6 minutes by keeping constant temperature of 500°C till the catalyst impregnated into SiO2 pockets. The substrate is removing from muffle furnace using tong and allows it to cool in room temperature.

Procedure CNT's Extraction Operation:

The extraction of carbon Nanotubes is carried out under the flue gases coming out from Chimney. Iron oxide magnetic nano particles coated over silica coated cement substrate are introduced at Centre of chimney through the outlet projected from chimney. The catalytic substrate is exposed to flue gas emission for a period of 5 to 6 minutes. The magnetic nano particles of catalyst thus attract the carbon dioxide and the layer of carbon

filaments will form on surface of catalytic substrate. Then Scrap the material i.e carbon nanotubes from the substrate properly and collect it in a sampling bag. Thus the on cycle of process is completed.

As the catalyst is recyclable the same catalyst is thus regenerating using a magnet and can be used efficiently for about 4 cycles.

Collection of Carbon Nanotubes:

After the period of 5-6 Minutes the carbon filaments accumulated on the job is collected and the process is continued for the 4-5 times with the same catalytic substrate. The Quantity of Carbon Nanotubes Collected from the each job is mentioned below,

Table 2: Quantity of Carbon Nanotubes Collected

Sample	Cycle 1 (Gms)	Cycle 2 (Gms)	Cycle 3 (Gms)	Cycle 4 (Gms)	Total (Gms)
Job 1	9.25	11.25	10.125	10.125	40.75 Gms
Job 2	8.99	8.25	7.82	8.139	33.179 Gms
Job 3	11.52	11.70	9.98	10.77	43.37 Gms
Job 4	10.73	9.88	12.15	11.03	43.79 Gms
					161.09 Gms

Precautions:

- ✓ The inert substrate selected from alumina, cement coated with Sio2, Zeolite, Titanium, Silicon, Glass, Glass wool or ceramic brick.
- ✓ A recyclable catalytic composition comprising a combination of alpha form of ferrous oxide and gamma form of ferric oxide magnetic nanoparticle in the ratio 1 :4, 3:7, 1 :1, 7:3 and 4: 1 embedded onto the inert substrate at about 500°C till the catalyst is impregnated into the inert substrate.
- ✓ The flue gas comprises carbon dioxide, carbon monoxide, methane, ethane, hydrocarbons, petroleum gases, nitrogen , hydrogen , water vapor, sulphur dioxide , fly ash , carbon particles, either alone or mixture thereof.
- ✓ Inserting the coated inert substrate into path of fuel gases in furnace for about 5 to 6 minutes in absence of ash.
- ✓ The process of production of carbon filaments is cost effective, industrially feasible and results in high yield and purity of carbon filaments.
- ✓ The catalytic substrate is recyclable and can be used effectively for about 4 cycles.
- ✓ The process are used for industries which gives out carbon emissions such as Rice Mills. Thermal power stations, Petrochemical industries, Sugar cane mills, Steel, glass and metal processing industries.
- ✓ The inert substrate is in the shape of a boat, cylinder, disc or crucible.
- ✓ The porous and rough nature of substrate promotes growth of carbon filaments.
- ✓ The alpha and gamma iron oxide nanoparticles is embedded on to inert substrate by laminar flow at 500°C and further air dried in hot plate in sun light.
- ✓ The maximum use of flue gas is made by increasing size of substrate and making it cylindrical.

Conclusion:

The Carbon Nanotubes which are directly harvested from the exhaust of the industries will have tremendous effect on the environment if carbon dioxide leave into atmosphere. As due large amount of harmful greenhouse gases that are being emitted in the atmosphere and also a large amount of these pollution comes

from cement industries which accounts for about 5% of the total pollution. Due to this the temperature of the planet is increasing. Moreover the amount of oxygen is also reducing if this issue is not solved then there might be serious consequences in future. So, if we use this technique to produce a valuable material from the waste gases coming from the industrial outlet. It will cause a great contribution to reduce air pollution and improve the air quality.

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