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Removal of Cr(VI)From Polluted Water Using Carbon Nanofiber and Activated Carbon

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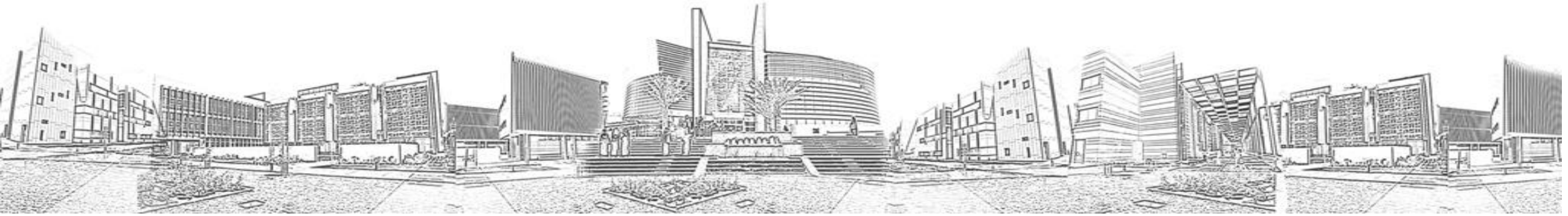
Introduction

- Cr in water is found as Cr(IV) and Cr(III).
- Cr(IV) is hazardous and carcinogenic and mutagenic to humans.
- However, Cr(III) is not hazardous and traces of it is needed for humans.
- According to WHO guidelines, the Cr in drinking water should be below 50 µg/L.



Sources of Cr(IV) in Groundwater

Natural Sources: Natural occurring from aquifer system composed of ultramafic rocks which known to be enriched with Cr relative to other rock type and contains FeO.

Anthropogenic contamination: from industrial activities, such as electroplating, textile dyeing, lather tanning, metallurgy and and coal ash ponds.

Techniques Used for Removal of Cr(VI) from Polluted Water

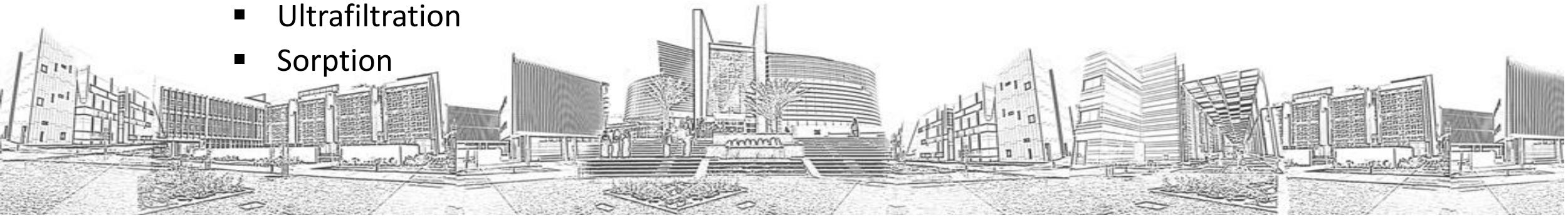
Cr(VI) could be treated by reduction to Cr(III) or removal

Reduction:

- Electrochemical reduction
- Photochemical reduction

Removal:

- Precipitation
- Osmoses
- Revers osmoses
- Filtration
- Ultrafiltration
- Sorption



Sorption

Sorption is the most effective techniques for removing Cr(VI) due to its efficiency and no energy requirements.

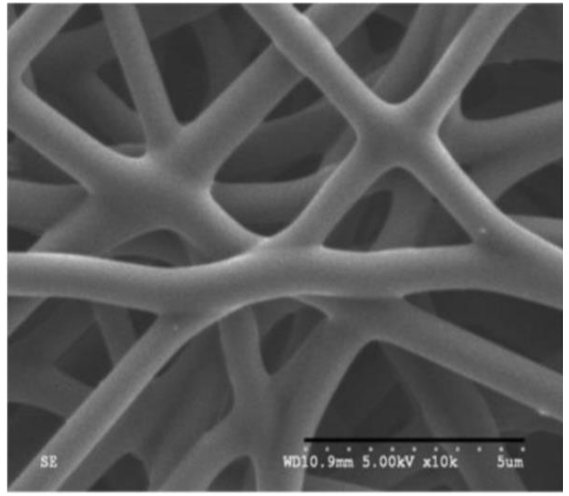
- The search for cost effective adsorbent is significant especially for treating large volume of polluted water with low concentration of pollutants.

Sorbent is classified as:

- Ion exchangers (Oxides, resins,)
- Industrial wastes as red mud from aluminum industry
- Biomasses as agriculture wastes
- Carbon based materials (Activated carbon, Carbon nanotube, Graphene oxide and carbon nanofibers)

Activated Carbon and Carbon Nanofiber

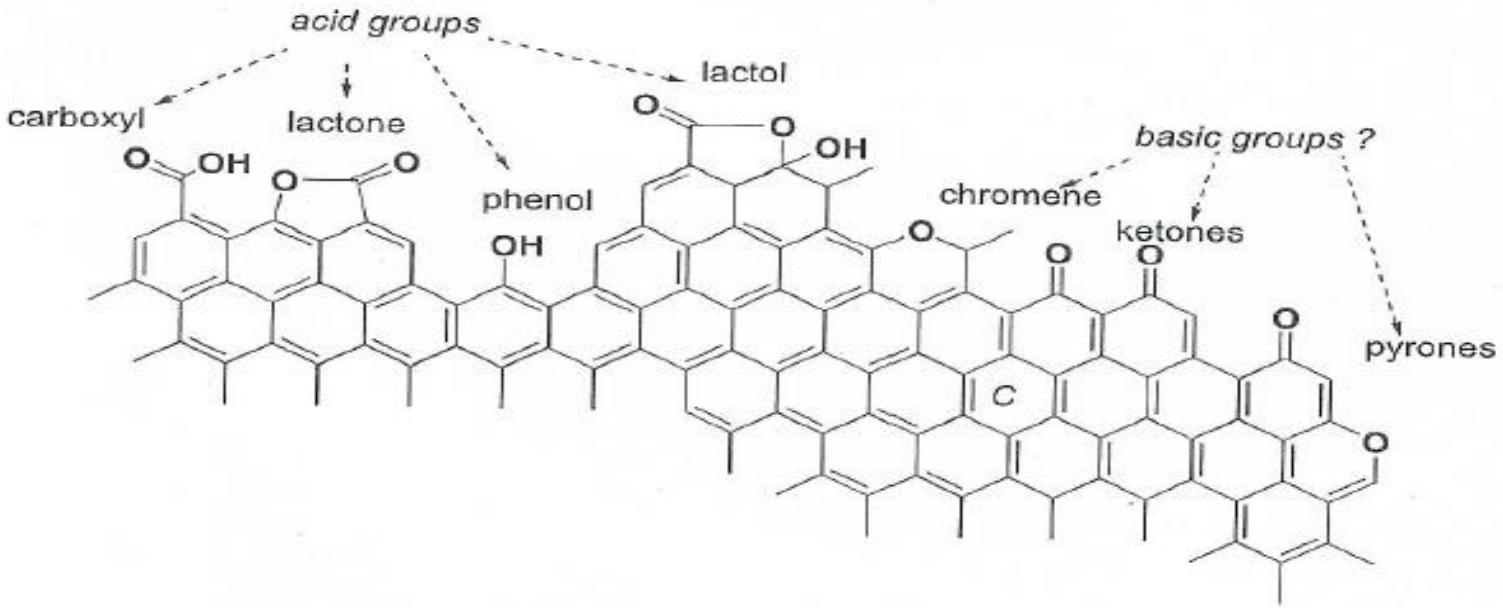
Activated Carbon is used for water purification systems due to its chemical stability, thermal stability and simplicity of controlling the surface functional groups, surface area and porosity.



The properties of the activated carbon depend on its precursors and method of activation and preparation.

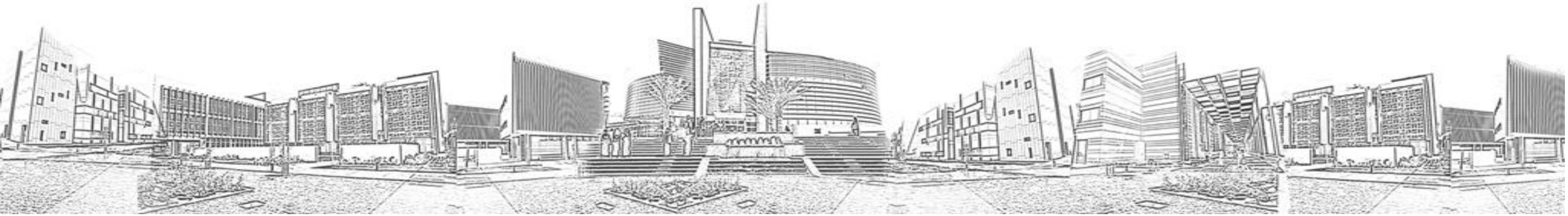
Carbon nanofiber: Fibers with a carbon content of at least 92 wt% made from a polymeric precursor or from carbon allotrope building blocks.

The acidic and basic function group on the surface of Carbon based materials

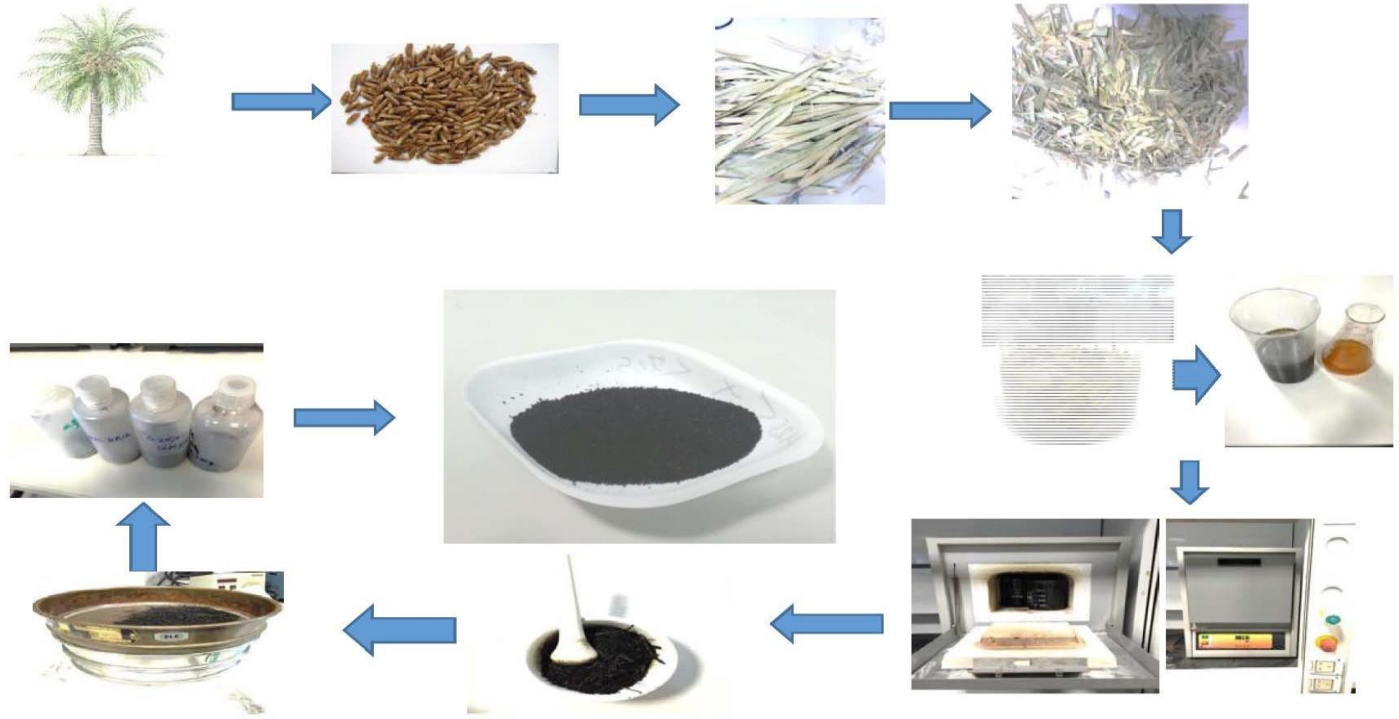


Objective of the Study

- In the present study, agricultural waste generated from date palm trees is used for preparation of activated carbon and Carbon nanofiber because UAE has about 40 million date palm trees, which generate million of tons of agricultural wastes .
- The main practice for this waste is incineration.



Experimental Works – I- a-Preparation of Activated Carbon

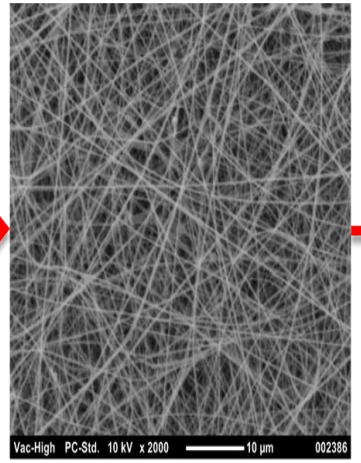


4 Different sizes of Activated Carbon

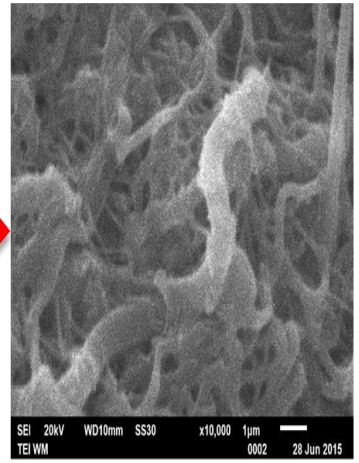
Experimental Works – I –b Preparation of carbon nanofiber

Lignin

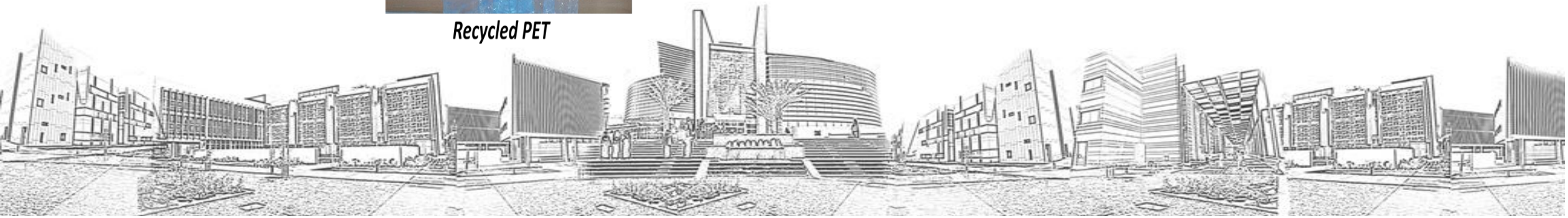
Recycled PET



Electrospun nanofibers

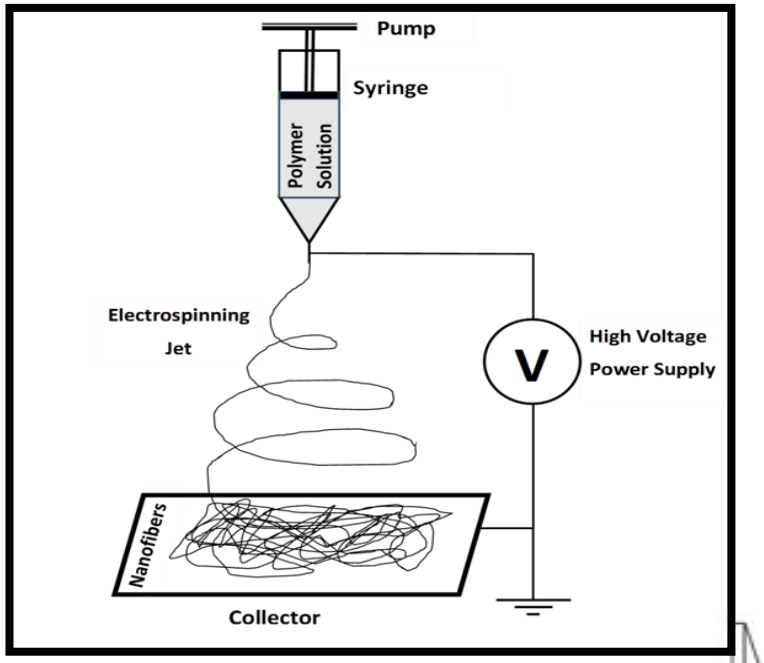


Carbon nanofibers



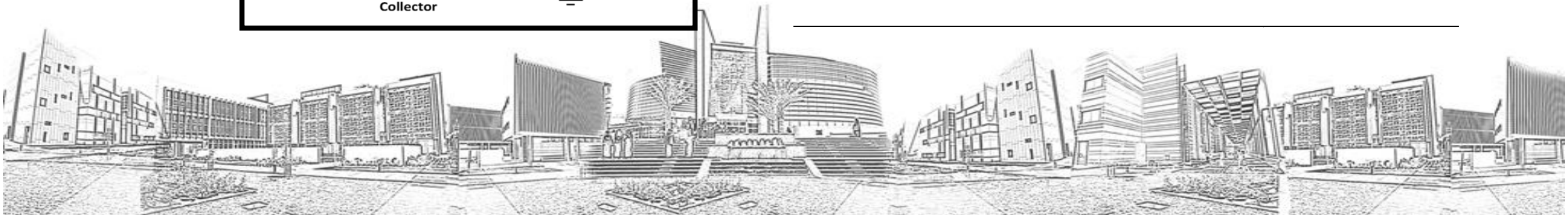
Experimental Works: II-b-preparation of carbon nanofiber

Electrospinning



Factors affecting on the diameter of carbon nanofibers

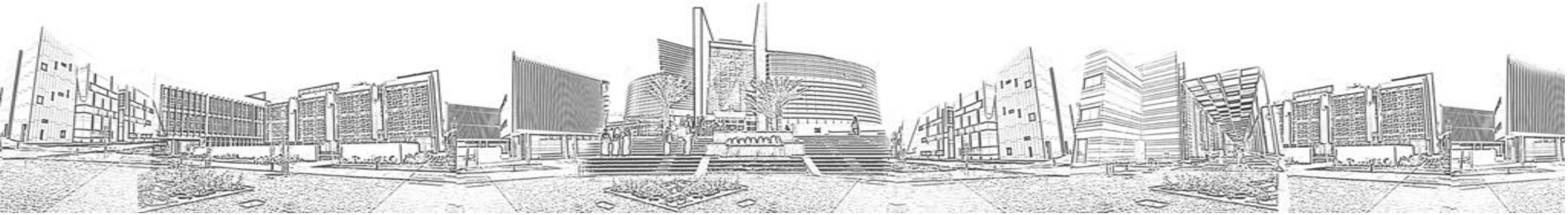
Factores	Experimental Range
Flow rate (µL min^{-1})	0.1 – 2
Spinning distance (cm)	7 – 20
Voltage (kV)	20 – 30
Concentration of both polymers in the solution (% w v^{-1})	15 – 25
Lignin mass ratio in the polymer blend (wt%)	20 – 50



Experimental Works: II- Characterization

The prepared activated carbon and carbon nanofibers were characterized by :

- **SEM and EDX**
- **FT-IR**
- **Iodine number**
- **Methylene blue**
- **pH_{pzh} of point of Zero charge**
- **Total surface area**

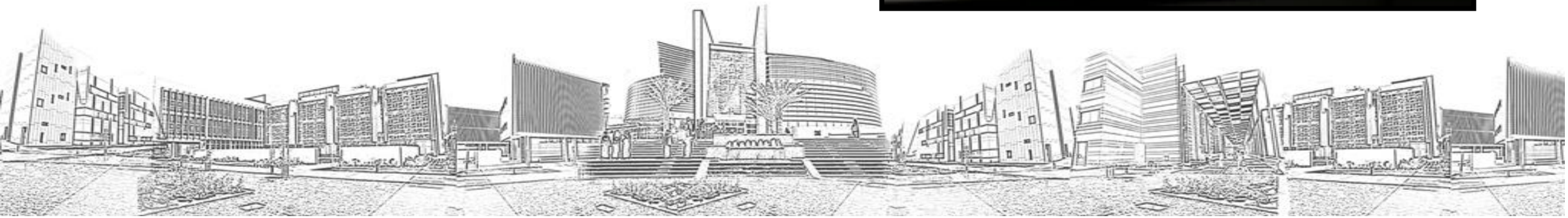


Experimental Works III-Adsorption of Cr(VI) on the prepared adsorbent

- Adsorption experiments were carried out by equilibrating definite weight of adsorbent with definite volume 100 ppm Cr(VI) ions.
- The adsorption capacity was measured by:

$$qs = \frac{(\mathrm{Co} - \mathrm{Ce}) \times \mathrm{V\ (L)}}{\mathrm{m\ (g)}}$$

- The effect of pH and temperature on adsorption capacity were studied.



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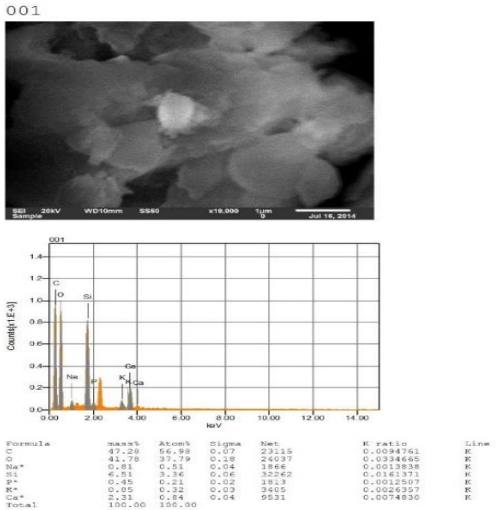
Results and Discussion

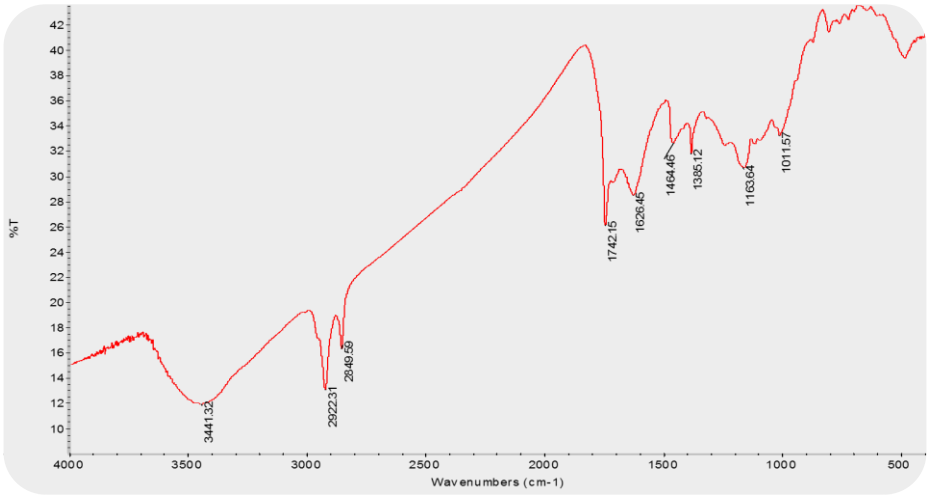
Characterization of Activated Carbon activated by boric acid Activation

SEM and EDX of



Formula	mass%	Atom%	Sigma	Net	K ratio	Line
C	47.28	56.98	0.07	23115	0.0094761	K
O	41.78	37.79	0.18	24097	0.0334665	K
Na*	0.81	0.51	0.04	1866	0.0013838	K
Si	6.51	3.36	0.06	32262	0.0161371	K
P*	0.45	0.21	0.02	1813	0.0012507	K
K*	0.85	0.32	0.03	3405	0.0026357	K
Ca*	2.31	0.84	0.04	9531	0.0074836	K
Total	100.00	100.00				

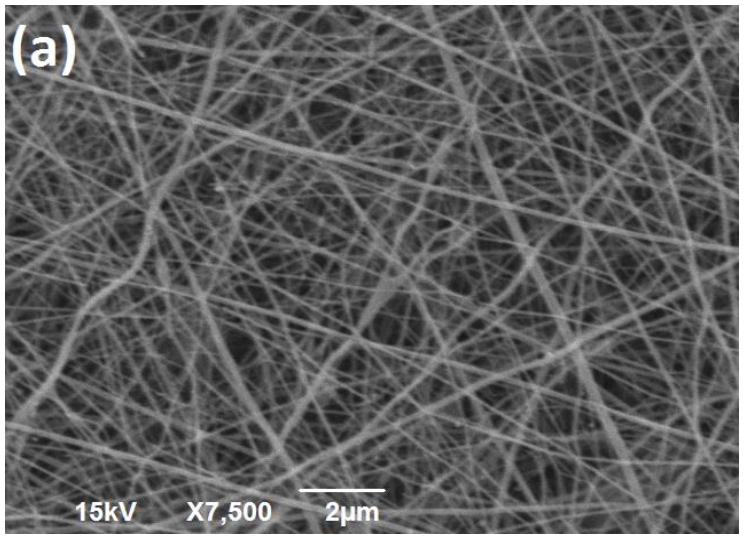
FT-IR of AC



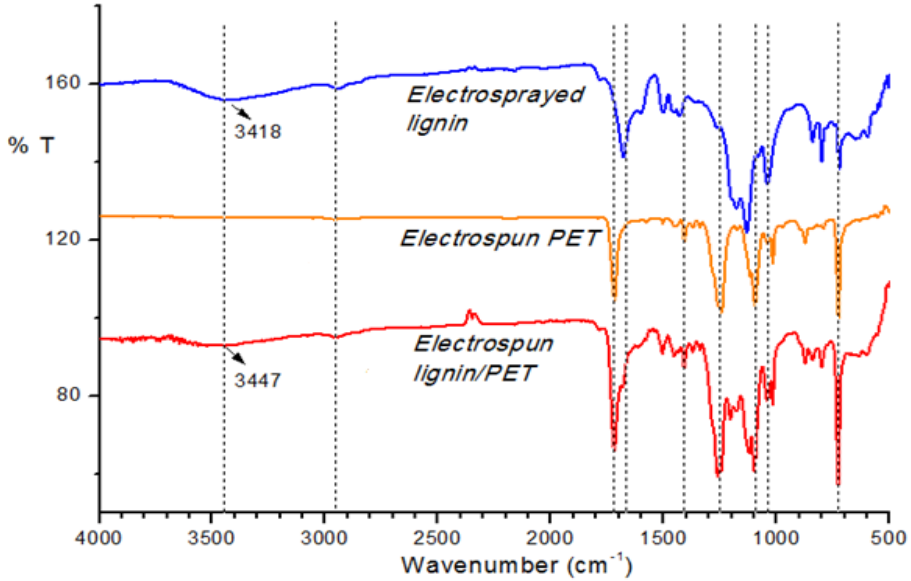
Results and Discussions

Characterization of Carbon Nanofiber

Carbon Nanofiber



FT-IR shows Weak intermolecular interactions rather than hydrogen bonding between PET and Lignin



Results and Discussions

Characterization of Activated Carbon and Carbon Nanofibers

Activated Carbon

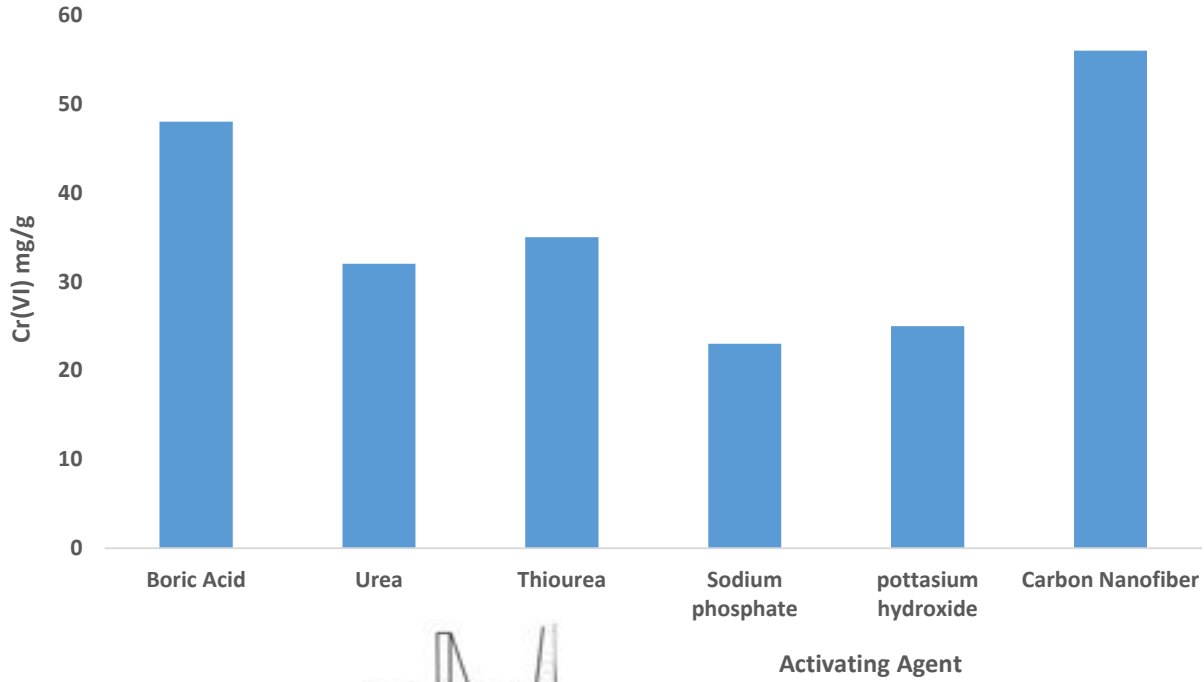
- **Iodine Number: 150 mg/g** – indication of presence of micro pores in the prepared activated carbon
- **Methylene blue number: 87mg/g** – indication of presence of meso pores in the prepared activated carbon
- **pH of point of Zero Charge: 4.1** – indication of the surface of the prepared activated carbon is positively charged at pH lower than 4.1; and negatively charged above than 4.1.
- **Total surface area**: 38m^2/g

Carbon Nanofiber

- **Iodine Number: 360 mg/g**
- **Methylene blue number: 44mg/g**
- **pH of point of Zero Charge: 4.9**
- **Total surface area**: 80m^2/g

Results and Discussions

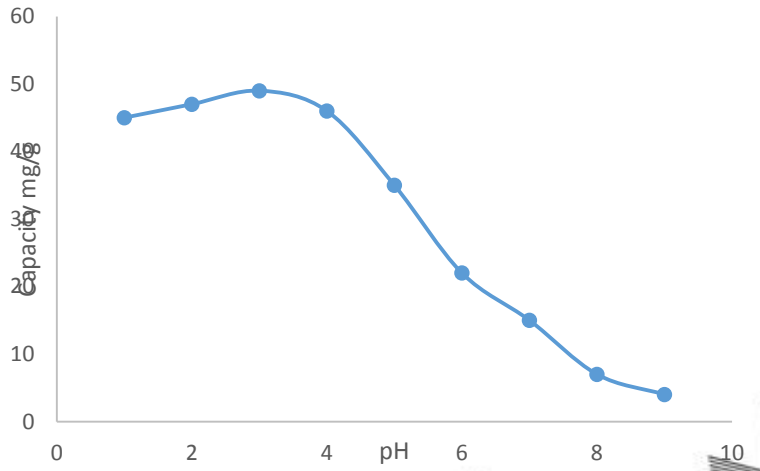
Adsorption Capacity of Carbon Nanofiber and Activated Carbon Prepared by Different activating agent to Cr(VI)



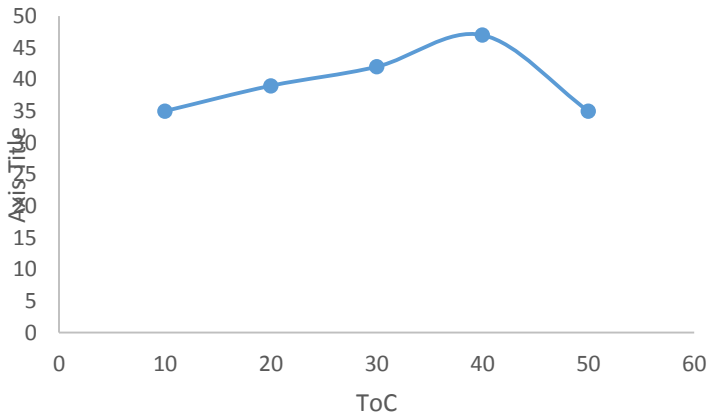
Results and Discussions

Adsorption Studies Effect of pH and Temperature on Adsorption capacity of Boric Acid Activated Carbon

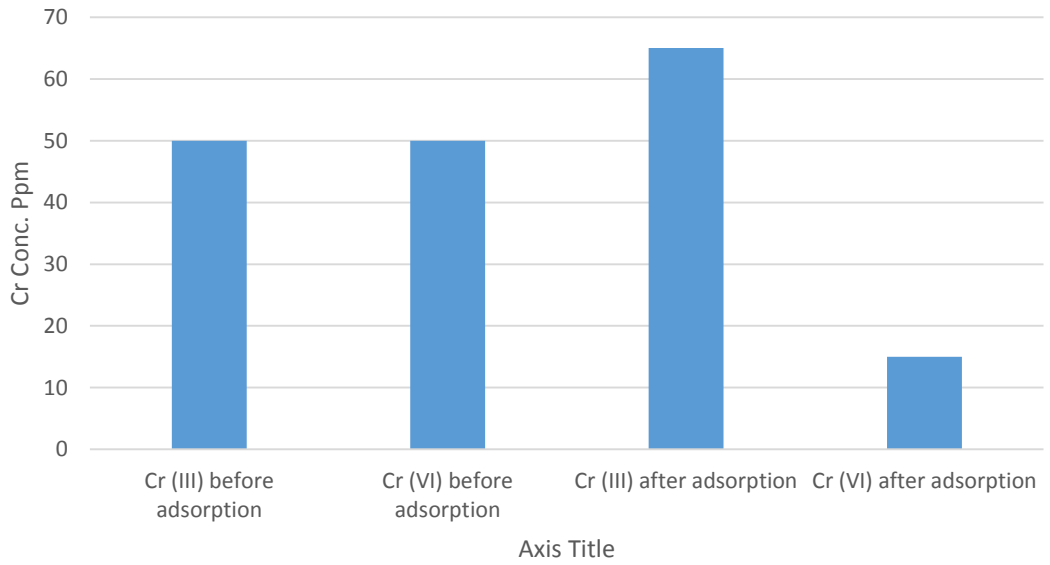
Effect of pH at room temperature and adsorbent dose of 1 gm /L and Cr(VI) Conc. 100ppm



Effect of Temperature at pH 3, adsorbent dose 1 g/L and Cr(VI) Conc. 100ppm



Adsorption of mixture of 50 ppm Cr(VI) and 50 ppm Cr(III) at pH 3 , room temperature and adsorbed dose 1g/L



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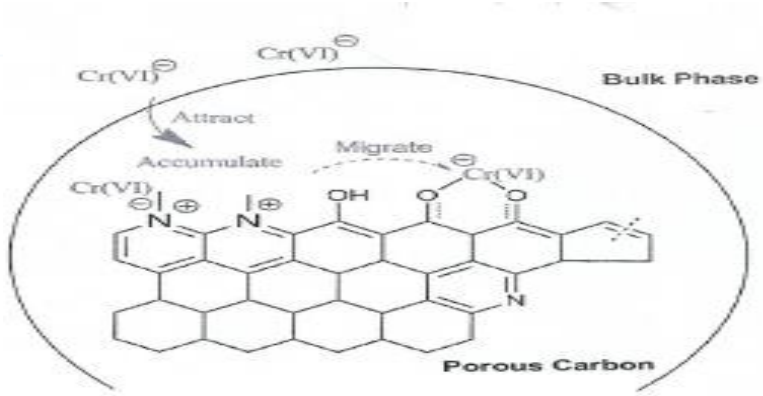
Suggested Mechanism of Adsorption and Reduction of Cr(VI) on the surface of activated carbon



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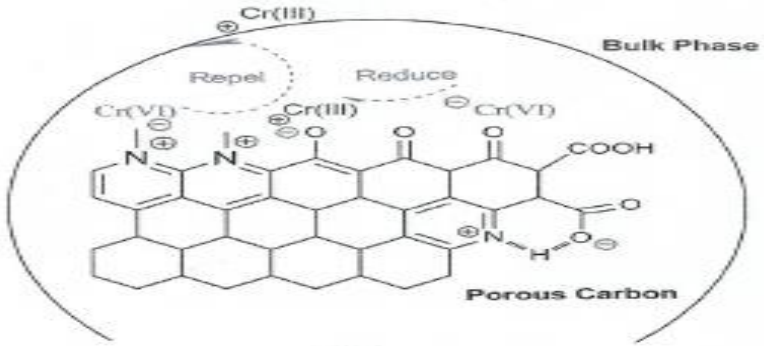

(2)

Conclusions

- Activated Carbon and Carbon nanofiber could be prepared from low cost materials.
- The prepared activated carbon and carbon nanofiber prepared by boric acid activation could be efficiently used for removal of Cr(VI).
- The adsorption of Cr(VI) is high at pH lower than 5.
- The adsorption capacity increases with increasing temperature.
- Cr(IV) is reduced to Cr(III) on the surface of activated carbon.

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Thank You for Listening