Nano-impregnated Activated Carbon as Sorbents to Remove Heavy Metal Ions in Contaminated Water

Abstract

Wastewater containing heavy metal ions is considered as the serious environmental problem in human society. Adsorption as the widely used method plays an important role in wastewater treatment, which is based on the physical interaction between metal ions and sorbents. With the development of nanotechnology, nanomaterials are used as the sorbents in wastewater treatment; Rajah Filter Technics have proved that nanomaterials are the effective sorbents for the removal of heavy metal ions from contaminated water due to their unique structure properties. Three kinds of nanomaterials are presented research, including Nanocarbon materials, nanometal particles, and polymer-supported nanoparticles. For heavy metal ions, all these nanomaterials show high selectivity and adsorption capacities. Besides, the adsorption isotherm model and adsorption kinetics are introduced briefly to understand the speciality of our blocks.

Introduction

Different contaminants are released to wastewater with the rapid industrialization of human society, including heavy metal ions, organics, bacteria, viruses, and so on, which are serious harmful to human health. Among all water contaminations, heavy metal ions, such as Pb^{2+}, Cd^{2+}, Zn^{2+}, Ni^{2+} and Hg^{2+}, have high toxic and non biodegradable properties, can cause severe health problems in animals and human beings. These wastewater with heavy metal ions are discharged into natural water directly, not only threat the aquatic organisms, but may be enriched by precipitation, adsorption, and harmed human health through the food chain. Thus, the removal of such toxic metal ions from wastewater is becoming a crucial issue.

Heavy metal ions could be eliminated by several traditional techniques:

- Including chemical precipitation.
- Reverse osmosis
- Electrochemical treatment techniques.
- Ion exchange
- Membrane filtration
- Coagulation
- Extraction,
- Irradiation and
- Adsorption

Adsorption:

Due to its low cost-effective, high efficiency, and simple to operate for removing trace levels of heavy metal ions, adsorption technology is regarded as the most promising one to remove heavy metal ions from effluents among these techniques mentioned above. Several types of materials, such as activated carbons, activated Nano material and polymer supported nanomaterials have been researched to adsorb metal ions from aqueous solutions. Although traditional sorbents could remove heavy metal ions from wastewater, the low sorption capacities and efficiencies limit their application deeply.

Nano-impregnated Activated Carbon as Sorbents to Remove Heavy Metal Ions in Contaminated Water

To solve these defects of traditional sorbents, nanomaterials are used as the novel ones to remove heavy metal ions in wastewater. Materials with the particle size between 1 nm to 100 nm are defined as nanomaterials. With novel size- and shape-dependent properties, nanomaterials have been extensively investigated. In recent development of nanoscience and nanotechnology has shown remarkable potential for the remediation of environmental problems. Compared with traditional materials, nanostructured adsorbents have exhibited much higher efficiency and faster rates in water treatment.

Comparative Study of other normal filters against with Nano Carbon Rajah filters.

Objective: The aim of this study was to test normal carbon blocks and Rajah Filter Technics made blocks and test their comparative performance of Lead Reduction.

Sample Details

Sample Name : NORMAL STD 10" Pb and Rajah STD 10" Pb Blocks

Product Code : PURE Pb 10"

Sample Details : 248mm L X 70mm OD

Capacity of Block : Target life study

Flow Rate : 3.8 LPM

Lead Reduction Study

This test is performed as per NSF/ANSI-42 protocol. The filters were run at flow rate 3.8LPM up to r target life of the product.

Test water conditions:

Total dissolved solids (TDS)	200-500 mg/L
Turbidity	<1NTU
pH	8.5 ± 0.5
Total Organic Carbon	>1.0 mg/L
Target Influent	150ppb ± 10ppb
Acceptable limit	<10ppb
Temperature	20 ± 2.50 C (68 ± 5degree F)

Nano-impregnated Activated Carbon as Sorbents to Remove Heavy Metal Ions in Contaminated Water

Chemical properties of the Carbon:

Iodine Value, mg/g	1100
CTC	60
Mesh Size	40 X 140
Micron rating	1-5 micron

Flushing time:

The system/unit is flushed in accordance with the manufacturer's instructions using test water. The system is challenged using appropriate influent challenge water and a set pressure of 60 ± 2 psi.

Test Run: 50% ON / 50% OFF cycle

Results Data Summary:

Gallons	**Litres**	**Influent**	**Normal Block Effluent**	**Rajah Filter Block Effluent**	Normal block Reduction Level	Rajah Filter Block Reduction Level
		150ppb ± 15ppb	**<10ppb**	**<10ppb**	%	%
50	189.25	155.00	1.00	0.01	99.35	99.99
100	378.5	152.00	1.50	0.02	99.01	99.99
250	946.25	149.00	1.80	0.08	98.79	99.95
500	1892.5	156.00	3.00	0.07	98.08	99.96
1000	3785	153.00	6.00	0.10	96.08	99.93
1250	4731.25	155.00	8.00	0.20	94.84	99.87
1500	5677.5	156.00	10.00	0.80	93.59	99.49
1750	6623.75	152.00	11.00	1.00	92.76	99.34
2000	7570	151.00	15.00	1.90	90.07	98.74
3000	11355	157.00		2.50	100.00	98.41
4000	15140	152.00		3.70	100.00	97.57
5000	18925	154.00		4.80	100.00	96.88
5500	20817.5	156.00		6.00	100.00	96.15
6000	22710	152.00		7.80	100.00	94.87
6500	24602.5	149.00		9.00	100.00	93.96
8000	30280	150.00		9.80	100.00	93.47
10000	37850	152.00		10.20	100.00	93.29

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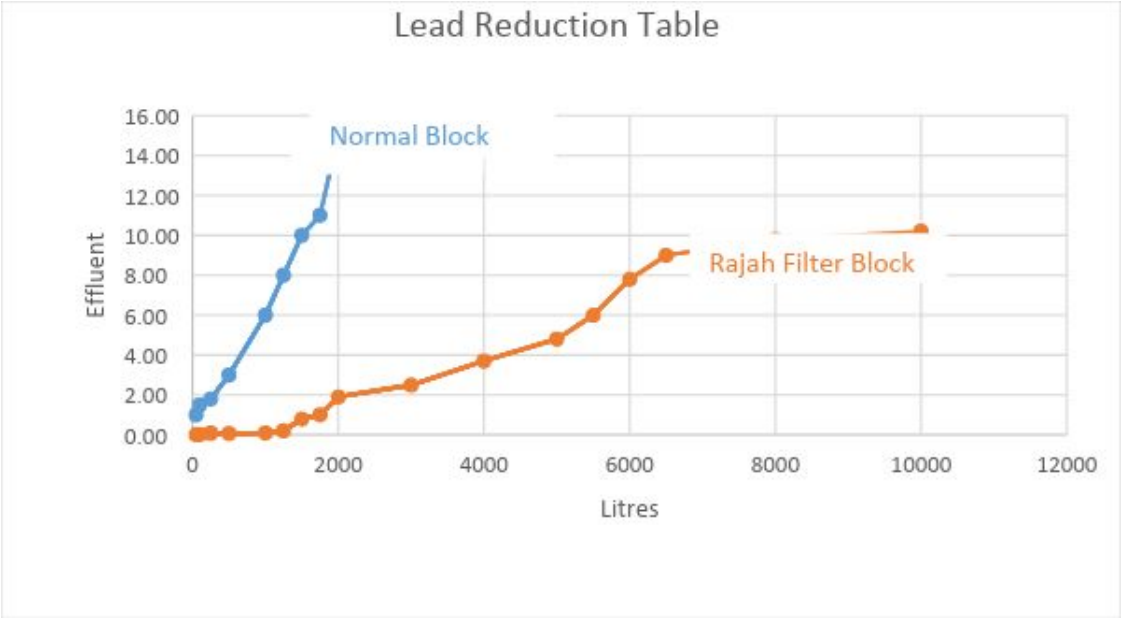

Flow Diagram of Lead reduction of Normal Block and Rajah Filter Blocks.

Conclusion

- Normal made blocks passed till 1500L and test was failed due to the more than the acceptance limit.
- Rajah Filter Technics blocks passed till 10000 L and the test was stopped due to clogging of the blocks.

Advances in the Rajah R&D team and engineering are providing new opportunities to develop more cost-effective and environmentally acceptable water treatment technology. Nanomaterials have a number of physicochemical properties that make them particularly attractive for wastewater purification. Performance results have indicated that nanomaterials as sorbents are useful tools for heavy metal removal, due to their unique structure and surface characteristics. These materials are capable to remove heavy metal ions at low concentration, with high selectivity and adsorption capacity. These properties of nanosorbents make them ideal materials for wastewater treatment technology.