

STUDY OF FLUORIDE CONTENT IN GROUNDWATER OF CHANDRAPUR REGION AND FLUORIDE REMOVAL BY ADSORPTION TECHNIQUES

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Abstract— Fluoride is a persistent and non – biodegradable pollutant that accumulates in soil, plants, wildlife and in a human beings. Therefore, removal of fluoride, using best technique with optimum efficiency is needed. The present survey highlights on efficiency of different materials for the removal of fluoride from water. The study assess the suitability of inexpensive leaf adsorbents, moringa seeds and pottery clay to effectively remediate fluoride contaminated water. In present study, the various low cost adsorbents are used for the removal of fluoride from water. Fluoride is the essential element for dental health and growth of bones as well whereas excess quantity of fluoride creates a problem of human health. It is very much essential to control the excess level of fluoride concentration (WHO) <1.5 mg/L. Several methods and techniques were used by researchers throughout the decades for the control of fluoride ion. Hence it is very much essential to study all the low cost techniques to remove the unwanted substances from the water.

Keywords—Fluoride, Groundwater analysis, fluorosis, adsorbents

INTRODUCTION

Fluoride is an essential constituent for both humans and animals depending on the total amount ingested or its concentration in drinking water. The presence of fluorine in drinking water, within permissible limits of 1.0 to 1.5 mg/l, is beneficial for the production and maintenance of healthy bones and teeth, while excessive intake of fluoride causes dental or skeletal fluorosis which is a chronic disease manifested by mottling of teeth in mild cases, softening of bones and neurological damage in severe cases. Chandrapur being the most polluted city in India (Indian Express, dated:-November 2016) hence all the ecological parameter should be checked. Chandrapur city have a large number of coal mines, open cast mines, ferro alloy plants, thermal power station. All these leads to a lot of mining work going on. Hence it is inferred that there must be groundwater contamination. Groundwater contamination could be due seepage of various metals, ions. Fluorspar is metallic mineral found in various places in Chandrapur which is the major source of fluoride seepage in ground water. Hence fluoride content analysis for Chandrapur region is required to be done. Fluoride contamination in groundwater has been recognized as one of the serious problems worldwide.

Scarcity of pure water is well known. The water may be polluted by natural sources or by industrial effluents. We can say healthy environment is the cost of healthy life. If the quality is sufficiently degraded, it becomes unusable and the effect is the same as a quantitative loss. The control of water quality has become overriding consideration in providing adequate water supplies for continuous use. The World Health Organization (1996) has set a guideline value of 1.5 mg/l as the maximum permissible level of fluoride in drinking waters. However, it is important to consider climatic conditions, volume of water intake, diet and other factors in setting national standards for fluoride. As the fluoride intake determines health effects, standards are bound to be different for countries with temperate climates and for tropical countries, where significantly more water is consumed, continued global growth, health and welfare.

Indian scenario of fluoride Affected areas State

No.	State	Affected Area (%) [Min – Max Range]	Range of Fluoride in Groundwater in mg/L [Min – Max Range]
1	Andhra Pradesh	50 – 100%	0.4 to 29
2	Gujarat	50 – 100%	0.15 to 13
3	Rajasthan	50 – 100%	0.1 to 14
4	Bihar	30 – 50%	0.2 to 8.12
5	Chhattisgarh	30 – 50%	0.9 to 8.8
6	Delhi	30 – 50%	0.2 to 32.46
7	Haryana	30 – 50%	0.23 to 48
8	Jharkhand	30 – 50%	0.5 to 14
9	Karnataka	30 – 50%	0.2 to 7.79
10	Madhya Pradesh	30 – 50%	1.5 to 11.4
11	Maharashtra	30 – 50%	0.11 to 10
12	Punjab	30 – 50%	0.4 to 42.5
13	Tamil Nadu	30 – 50%	0.1 to 7.0
14	Uttar Pradesh	30 – 50%	0.2 to 25
15	Assam	< 30%	1.6 to 23.4
16	Jammu & Kashmir	< 30%	0.5 to 4.21
17	Kerala	< 30%	0.2 to 5.40
18	Orissa	< 30%	0.6 to 9.20
19	West Bengal	< 30%	1.1 to 14.47

Table 2: Status of Fluoride and Area Affected as Percentage in the States of India and the Range of Fluoride in Groundwater as mg/L

MATERIALS AND METHODOLOGY

Materials are collected locally. The main objective of the project is to make use of locally available cheap products for removal of fluoride from water. Hence Tulsi, Moringa seeds, used tea leaves and pottery clay collected and tested.

3.2 Collection and preparation of Adsorbents

3.2.1 Tulsi leaves

Tulsi leaves plucked from the plant. Washed with the tap water and dried at room temperature without exposure to sun. Grinded in the mixer and sieved from a 600 micron stainless steel sieve.



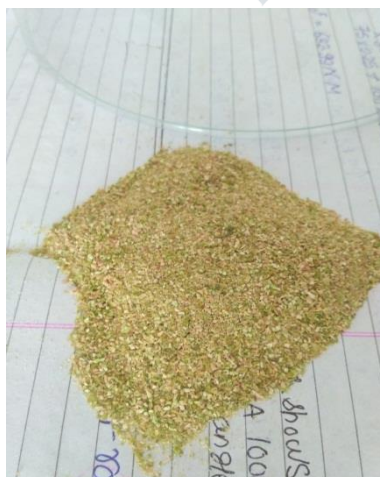
Fig. 3.1 Grinded Tulsi leaves

3.2.2 Moringa Seeds

Moringa oleifera (Drumsticks) washed with tap water, peeled off to take out the seeds. The seeds dried at room temperature without exposure to sun. Grinded in the mixer and sieved from a 600 micron stainless steel sieve.



Fig 3.2 Drumstick [a]whole b) Seeds c) Grinded



3.2.3 Tea Leaves

Used tea leaves collected. Dried at room temperature without exposure to sun. Grinded in the mixer and sieved from a 600 micron stainless steel sieve.



Fig. 3.3 Grinded tea Leaves

3.2.4 Pottery Clay

Pottery clay collected from a local pottery maker. All the lumps removed from the sample and manually tamped for uniformity of clay. Dried in the sunlight.



Fig. 3.4 Grinded pottery clay

LABORATORY WORK AND CALCULATION:

For the analysis and to find the optimum dose of various adsorbents used in the project, the varying amount of adsorbents are taken to know the interrelation between amount of adsorbent and removal of fluoride from water. Groundwater from various places of Chandrapur region is taken and analyzed for the natural fluoride content in the water.

Adsorbents are mixed in with with varying amount such as 10 mg/lit, 5 mg/lit, 2.5 mg/lit, 1.25 mg/lit, 0.625 mg/lit.

The samples are collected from various localities of Chandrapur.

Sample 1. Near Ramala Talav, Chandrapur

Natural fluoride content = 4 mg/lit

1. Adsorption using moringa seeds

Adsorbent dose in mg/lit	10	5	2.5	1.25	0.625
Fluoride remained in water in mg/ lit	2.4	2	1.6	3	3.3
% removal of fluoride	40	50	60	25	17.5

2. Adsorption using Tulsi

Adsorbent dose in mg/lit	10	5	2.5	1.25	0.62
					5
Fluoride remained in water in mg/ lit	2.3	1.8	1.3	1.6	1.8
% removal of fluoride	42.5	55	67.5	60	55

3. Adsorption using Tea Leaves

Adsorbent dose in mg/lit	10	5	2.5	1.25	0.625
Fluoride remained in water in mg/ lit	3	1.8	1	1	1.5
% removal of fluoride	25	55	75	75	50

4. Adsorption using Pottery clay

Adsorbent dose in mg/lit	10	5	2.5	1.25	0.625
Fluoride remained in water in mg/ lit	2	1.5	1.4	0.7	0.4
% removal of fluoride	50	62.5	65	82.5	90

Sample 2. Groundwater collected in Babupeth Locality, Chandrapur**Natural fluoride content= 2.9 mg/lit**

1. Adsorption using moringa seeds

Adsorbent dose in mg/lit	10	5	2.5	1.25	0.625
Fluoride remained in water in mg/ lit	1.9	1.3	0.9	1.4	1.8
% removal of fluoride	34.46	55	68.96	51.72	37.93

2. Adsorption using Tulsi

Adsorbent dose in mg/lit	10	5	2.5	1.25	0.625
Fluoride remained in water in mg/ lit	1.9	1.5	1.3	1.8	2.1
% removal of fluoride	34.4	48.27	55.17	37.93	27.58

3. Adsorption using Tea Leaves

Adsorbent dose in mg/lit	10	5	2.5	1.25	0.625
Fluoride remained in water in mg/ lit	2.5	1.7	1.2	1	1.3
% removal of fluoride	13.79	41.37	58.62	65.57	55.17

4. Adsorption using Pottery clay

Adsorbent dose in mg/lit	10	5	2.5	1.25	0.625
Fluoride remained in water in mg/ lit	1.5	1.1	1.0	0.6	1.2
% removal of fluoride	48.27	62.06	65.51	79.31	58.62

Sample 3. Groundwater collected at Tukum Locality, Chandrapur

Natural fluoride content= 2.0 mg/lit

1. Adsorption using moringa seeds

Adsorbent dose in mg/lit	10	5	2.5	1.25	0.625
Fluoride remained in water in mg/ lit	1.5	1.2	1	1.3	1.5
% removal of fluoride	25	40	50	35	20

2. Adsorption using Tulsi

Adsorbent dose in mg/lit	10	5	2.5	1.25	0.625
Fluoride remained in water in mg/ lit	1.4	1.1	0.7	0.9	1.4
% removal of fluoride	30	40	65	55	30

3. Adsorption using Tea Leaves

Adsorbent dose in mg/lit	10	5	2.5	1.25	0.625
Fluoride remained in water in mg/ lit	1.5	1.4	0.8	0.6	1.4
% removal of fluoride	25.7	30.	60	70	30

4. Adsorption using Pottery clay

Adsorbent dose in mg/lit	10	5	2.5	1.25	0.625
Fluoride remained in water in mg/ lit	1.3	1.1	0.6	0.5	1.20
% removal of fluoride	35	45	70	75	40

Sample 4. Groundwater collected at CSTPS, Urjanagar, Chandrapur**Natural fluoride content= 3.4 mg/lit**

1. Adsorption using moringa seeds

Adsorbent dose in mg/lit	10	5	2.5	1.25	0.625
Fluoride remained in water in mg/ lit	1.8	1.5	1.3	1.8	2.4
% removal of fluoride	47	55	61.7	47	29

2. Adsorption using Tulsi

Adsorbent dose in mg/lit	10	5	2.5	1.25	0.625
Fluoride remained in water in mg/ lit	2.	1.8	1.2	0.6	2.1
% removal of fluoride	41.1	47	64.7	52.9	38.23

3. Adsorption using Tea Leaves

Adsorbent dose in mg/lit	10	5	2.5	1.25	0.625
Fluoride remained in water in mg/ lit	2.8	1.7	1.1	1.1	1.5
% removal of fluoride	17.6	50	67.64	67.64	55.88

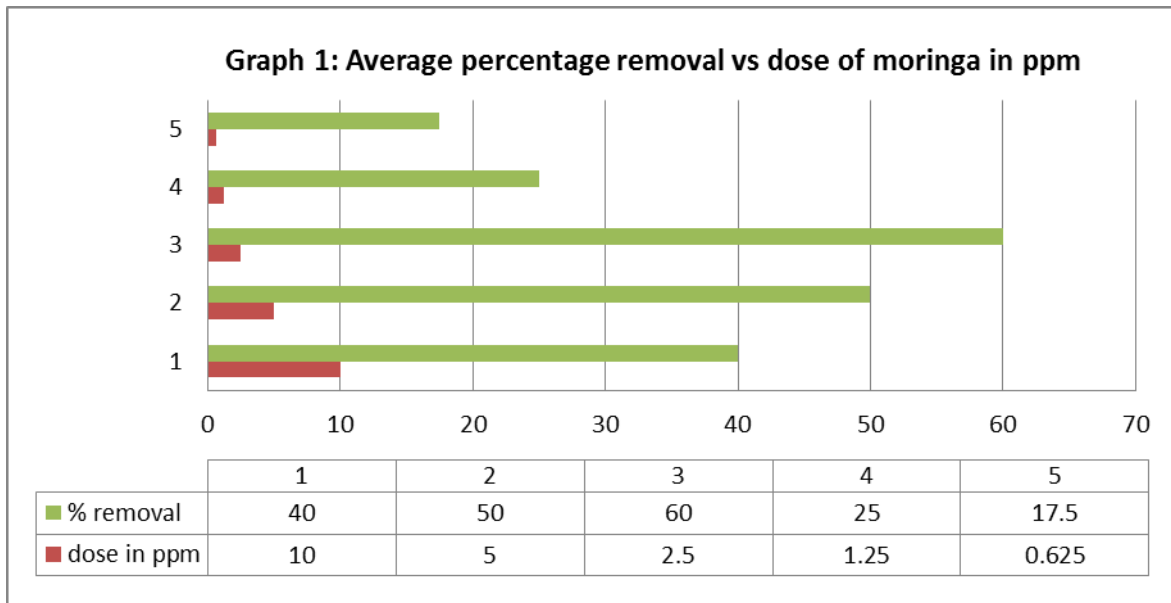
4. Adsorption using Pottery clay

Adsorbent dose in mg/lit	10	5	2.5	1.25	0.625
Fluoride remained in water in mg/ lit	1.7	1.5	1.0	0.6	1.3
% removal of fluoride	50	55	70	82.35	61.76

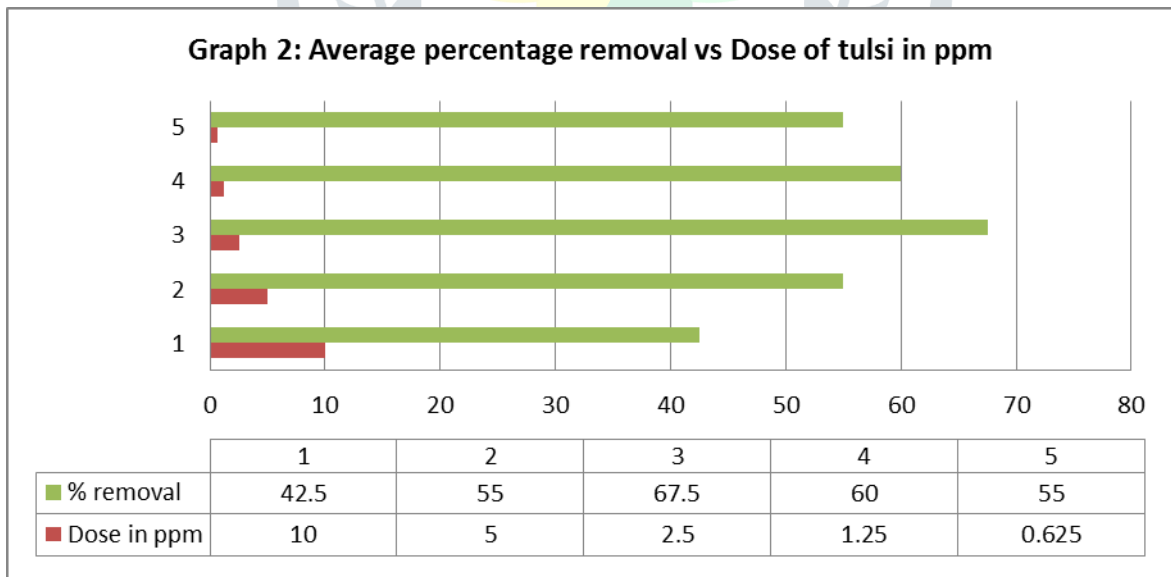
RESULT AND DISCUSSION:

Fluoride is the most sought after mineral in water. The main problem with the fluoride is that very low amount as well as very high amount of fluoride present in water leads to serious health hazards to human as well as to animals. It is like a two way sword which needs to be handled very cautiously. The safe amount of fluoride recommended by various state run organizations is different. Hence it is not very clear about the exact amount of fluoride which is actually beneficial for the intake.

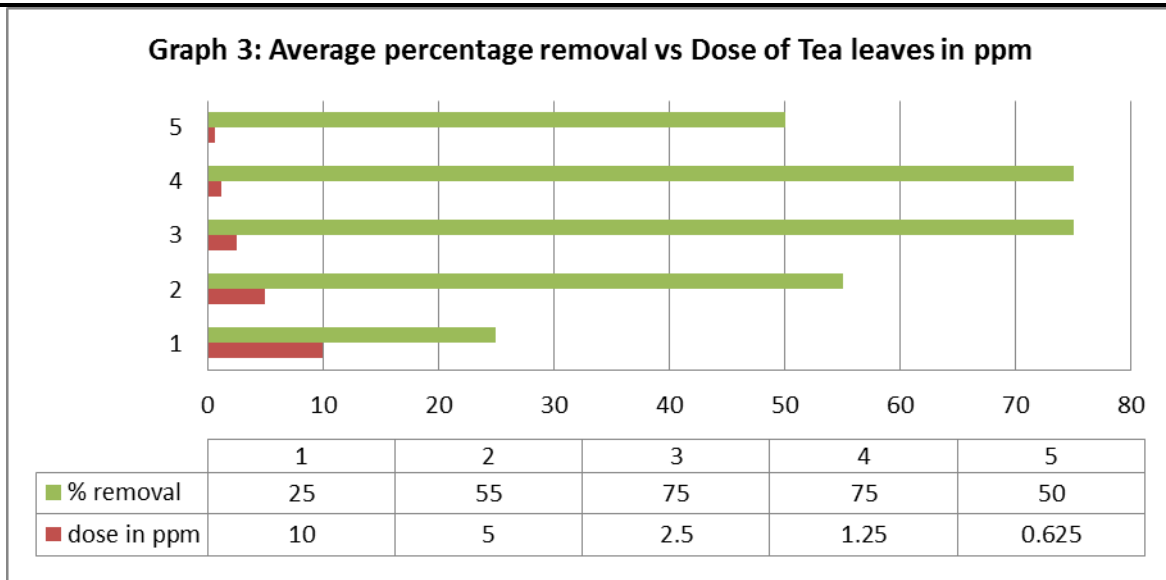
In this project various natural low cost adsorbent were tested for the removal of the fluoride from the groundwater. The following graphs shows the average percentage removal of fluoride using various natural adsorbent.



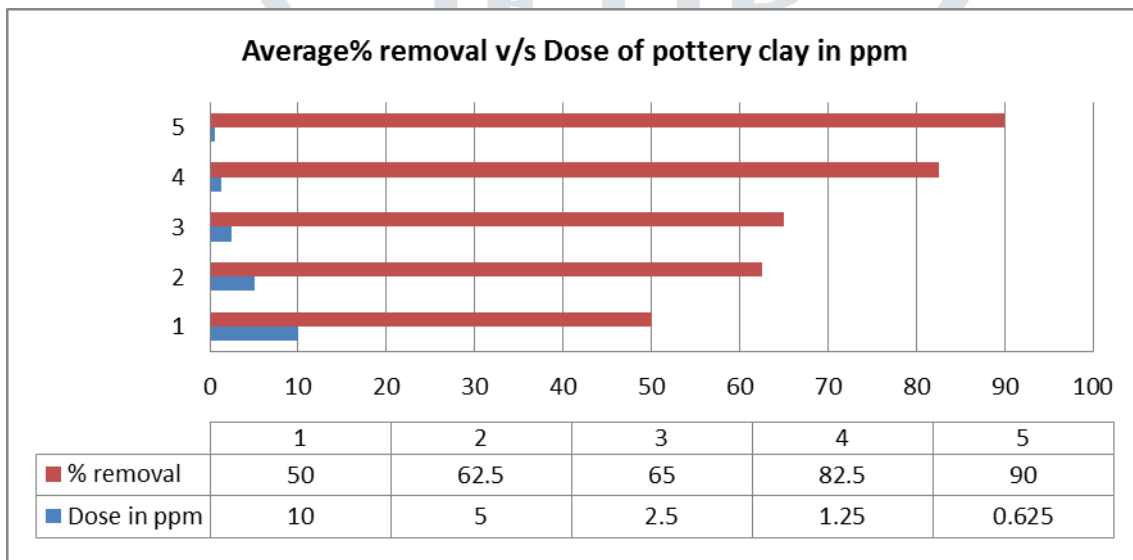
Graph 1: Average percentage removal of fluoride v/s dose of moringa in ppm



Graph 2: Average percentage removal of fluoride v/s Dose of tulsi in ppm



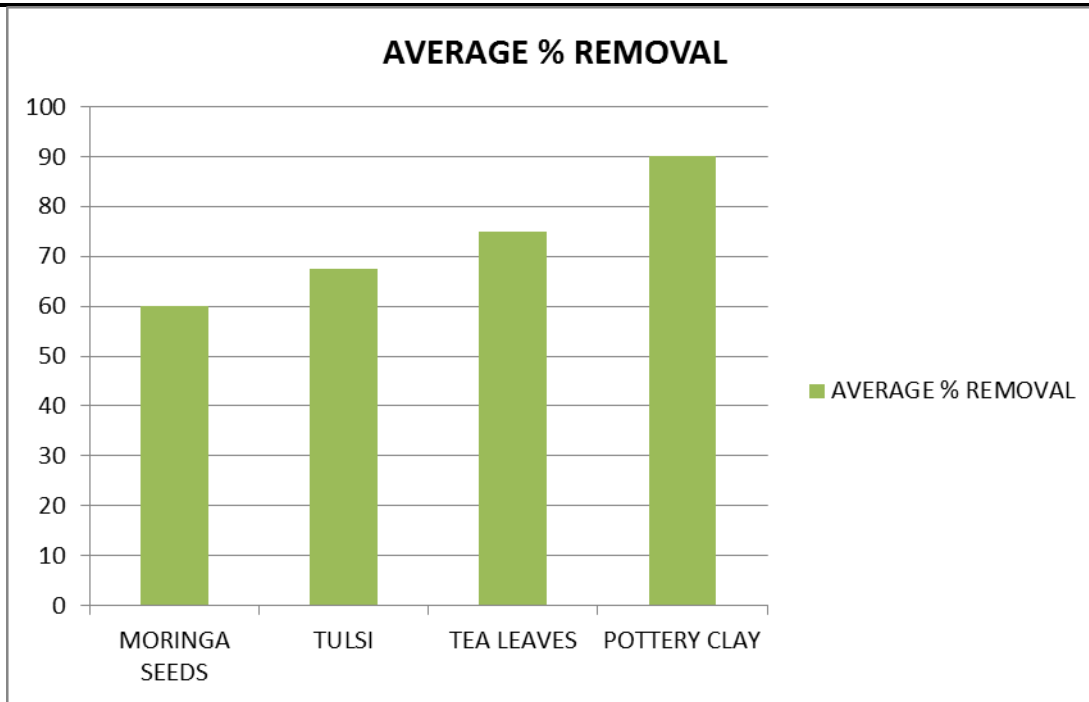
Graph 3: Average percentage removal of fluoride v/s Dose of Tea leaves in ppm



Graph 4: Average percentage removal of fluoride v/s Dose of Pottery clay in ppm

The graphs which are plotted shows the key relation between the dose of various adsorbent and % removal of the fluoride. These graphs are helpful in understanding the optimum dose of adsorbent to be added for the removal fluoride from the water. The optimum dose for the various adsorbent tested is as follows

Sr. no.	Adsorbent	Optimum Dose
1	Moringa Seeds	2.5 mg/lit
2	Tulsi	2.5 mg/lit
3	Tea leaves	1.25 mg/lit
4	Pottery clay	0.75 mg/lit



Graph: Comparing % removal of various adsorbent

CONCLUSION

Based on the present study following conclusions are drawn

- 1) The main objective of the project is to provide a adsorbent which locally available as well as cheap in nature. Hence various adsorbents have been tested hereby.
- 2) From the study it can be stated as, low cost bio-adsorbents can be effectively used for removal of fluoride from water.
- 3) Moringa Seeds (drum sticks), Tulsi, Tea leaves, Pottery clay all these have shown good fluoride removal capabilities. As discussed in the result section the pottery clay have shown the best result among the others.
- 4) From the various adsorbent tested, it can stated that removal of fluoride depends upon the surface area of adsorbent. The more the surface area, more will be removal. As surface area increases removal efficiency increases.
- 5) Further study suggests that the optimum dose for various adsorbent is different for a particular adsorbent. It depends on various physio-chemical nature of the water.
- 6) The fluoride removal efficiency may vary according to many site-specific chemical, geographical and economic conditions.
- 7) According to study pottery clay has the fluoride removal efficiency of 90%. The Efficiency can be increased by using more finer pottery clay.
- 8) These adsorbent material is locally available but requires Pre-treatment to raw material before using for removal of fluoride.
- 9) Adsorption capacity was more in the pH range of 6-8. Optimum time of contact was found 8 hrs.
- 10) The removal increased with time and adsorbent dose, but with higher initial concentration decreased with time and adsorbent dose.

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