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A Review: Studies of Defluoridation of Water by Using Low Cost Adsorbent

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Abstract: Natural water contains fluoride in varying amounts. Fluorine is the 13th most abundant element of earth's crust, represents about 0.3 g/ kg of earth's crust. It occurs mainly in forms of chemical compound such as Sodium Fluoride (NaF) or Hydrogen Fluoride (HF) which is present in minerals fluorspar, topaz & cryolite. According to the World Health Organization suggested the optimum level of Fluoride is 0.3 to 0.7 mg/ L & the maximum level is 1.5 mg/ L. There are many methods have been developed for removal of fluoride from drinking water. These methods can be broadly classified into four basic groups; (1) Ion-Exchange or Adsorption methods, (2) Coagulation & Precipitation methods, (3) Electro-chemical defluoridation or Electro-Dialysis, (4) Reverse Osmosis. It has been reviewed the batch study process has been adopted to study the defluoridation of water using alum impregnated on brick powder. Alum and brick, when used individually are effective materials to cause defluoridation of water. But both the materials have certain limitations. Comparison of adsorption by Alum impregnated brick powder was made with adsorption by brick powder. Different parameters for instance, effect of pH, effect of dose and contact time of adsorbed fluoride is being studied and optimized. Fluoride removal was found to be 48.73 and 56.4 % from groundwater samples having 2.16 and 1.21 mg/L fluoride to 0.6 to 0.21mg/L respectively under the optimized conditions. Alum impregnated on brick powder has higher efficiency than the defluoridation by brick powder.

Keywords: Defluoridation, Adsorption, Brick powder (BP), Alum impregnated on brick powder (AIBP), Groundwater.

I. INTRODUCTION

Natural water contains fluorides in varying amounts of fluorine. 13th most abundant element of the Earth's crust represents about 0.3 g/ Kg of Earth's crust. It occurs mainly in the form of chemical compounds sodium fluoride or hydrogen fluoride which is present in minerals fluorspar, fluorapatite, topaz and cryolite. Fluoride is enters in the ground water by natural process especially soil at foot of mountains is particularly likely to be the high in fluoride from the weathering and leaching of bed rock with high fluoride content [1].

It considered that probable source of high fluoride; in Indian water is that during weather and circulation of water in rocks and solids, fluorine is leached out and dissolved in ground water. Tile fluoride content of ground water varies greatly depending on the type of rocks from which they originate. Among the various materials responsible for high concentration of fluoride the fluorapatite Ca3(PO4)2.CaF2 and CaF2 is important however, the most important being the fluorite and the leaching of fluoride from the metamorphic rocks hornblende gneiss of proterozoic age [4]. The optimum level suggested by WHO is 0.7 mg/ L from infancy to 16 years.

According to WHO, the maximum acceptable concentration of fluoride icons in drinking water is 1.5 mg/L. Most unfluoridated water contains less than 0.3 mg/ L [2].

TABLE-I International and National Drinking Water Standards of Fluoride Contents.

Fluoride guideline value drinking water standards	Recomm-ended minimum value (mg/ L)	Maximum value (mg/ L)	Reference
WHO	0.5	1.5	WHO, 1993.
Primary	0.5	4.0	US EPA, 1985
Agency for safety food	--	1.5	Statute, 2007

TABLE-II Physiochemical Properties of Common Forms of Fluoride

Property	Sodium fluoride (NaF)	Hydrogen fluoride (HF)
Physical state	White, crystalline powder	Colourless liquid or gas with biting smell.
Density (g/ cm^3)	2.56	0.0015
Water solubility	42 g/ L at 10 ^{O}C	Readily soluble below 20 ^{O}C
Acidity	---	Strong acid in liquid form; Weak acid when dissolved in water.

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II. SOURCES OF WATER POLLUTION WITH FLUORIDES

Water is vitally important to every aspect of our lives water is a risk because of the possible input and transmission of infectious pathogens and parasitic diseases we use clean water to drink, grow crops for food and operate factories. The most common pollutants in water are chemicals (pesticides, phenols, heavy metals and bacteria) [5]. The sources of water pollution with fluorides are above all industrial waste waters from the production of aluminium, copper and nickel, steam generating stations, then phosphate minerals treatment, production and usage of phosphorus fertilizers, usage of Fluor–based pesticides, production of glass, cement, glues and adhesive means. Transport and form of fluorides in water depends on environment pH value, water hardness and the presence of ion changeable substances, such as alumina.

III. EFFECTS OF FLUORIDE

In India, the states of Andhra Pradesh, Bihar, Chhattisgarh, Haryana, Karnataka, Madhya Pradesh, Maharashtra, Orissa, Punjab, Rajasthan, Tamil Nadu, Uttar Pradesh and West Bengal are affected by fluoride contamination in water. This involves about 9000 Villages affecting 30 million people [3]. Low levels of fluoride are required for humans as it has beneficial effects on tooth structures. However, ingestion of excessive fluorides, mainly through drinking water causes dental, skeletal and non-skeletal fluorosis. Long term ingestion of excessive fluoride has a chloride has a chronic effects on the kidneys. Primary drinking water standards are those that must be enforced- secondary drinking water standards are non-enforceable guideline regulating contaminants that may cause cosmetic effects (such as skin or tooth discoloration) or aesthetic effects (such as taste, odour or colour) in drinking water.

IV. PREVENTION OF FLUOROSIS

Dental fluorosis is irreversible and therefore treatment is sophisticated and expensive. Thus the prevention of fluorosis is best and is the only form of treatment in India. Excessive fluoride content of water can be reduced to a desired limit by precipitation and adsorption. The adsorption methods are involves the contact of time the fluoride containing water with a suitable adsorbent. Various substances such as activated carbon, activated alumina, activated bauxite, zeolite, hydroxypatite, serpentine, etc., have been used for fluoride removal from water [6].

V. MATERIALS AND METHOD

Bricks utilized as adsorbent were purchased from the market. Bricks were washed with water dried. This bricks crushed and ground in jaw crusher and pulveriser analysed using sieves to obtain particles in the size 50-150 μ m. These bricks powders were washed with water several times with distilled water till clear water was obtained and was dried in oven at 100 ^{O}C for 3 hrs. Lab grade Alum used in the study was taken from laboratory and was used in powdered form. Approx. 2 gm of Alum was mixed in 1 litter of distilled water and the Bricks powder was put in the solution for 24 hrs and the bricks powder containing Alum was dried under sunlight. Through this method a new adsorbent Alum Impregnated Bricks Powder (AIBP) is ready for experimental use in experiment of fluoride detection. The comparison of the defluoridation capacity of Alum impregnated bricks powder made with that of the bricks powder [7].

Water sample has been collected of 500 ml which contains the fluoride naturally. This 500ml groundwater is filled in the 500ml conical flask at room temperature. These flasks, along with the test solution and 50 gm of adsorbent and shake well for few minute and keep it for desired contact time. At the end of desired contact time filter the sample using filter paper and filtrate is analysed for residual concentration of fluoride by spectrophotometer. The batch study being conducted to determine the optimum conditions and to study the dose of adsorbent and contact time on test solution. While the doe of adsorbent and contact time being studied by varying dose and contact time respectively.

VI. SUGGESTIONS FOR FUTURE WORK

There are many more adsorbents, which can be used for defluoridation purposes. Hence, further study can be done on other adsorbents as well. Future work also involves, studying the effect of hydrodynamic conditions on the adsorption efficiency, reduce the contact time of the operation. In the semi batch experiment, further study can be carried out to determine the variation of volumetric flow rate, volume of water sample and final concentration of fluoride with time.

VII. CONCLUSION

In the present study, a new adsorbent AIBP has been studied for removal of fluoride. The purpose of the study is to prepare the low cost adsorbent which is conveniently used for defluoridation locally. This process is works on principles of adsorption. Alum impregnated bricks powder (AIBP) and bricks powder (BP) is used as an adsorbent. Overall, it is inexpensive to test fluoride concentration in drinking water by spectrophotometer at government laboratories in all over India. Bricks and alum is very inexpensive material for preparation of adsorbent and it is locally available. Hence from the above study it is conclude that the bricks and alum is potentially good. adsorbent of fluoride locally. The adsorption capacity of Alum impregnated bricks powder (AIBP) is higher than bricks powder (BP).

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