Extraction of Zeolite from Flyash for Removal of Hardness from Borewell Water

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***Abstract*:-The environmental issues regarding hardness of water are growing day by day and has brought the requirement of eco-friendly and as well as economical alternatives for its removal. Our work focused on the treatment of water only for removal of hardness. The material selected, should be such a bulk amount waste, so its usage, not only counteract the expensiveness issue but also helps to tackle waste management for that particular waste. Fly Ash is such an alternative which is cheap, as waster material of power plant, has multipurpose use in treatment of hard water. Though the use of Fly Ash is high in concrete technology and concrete products yet the quantity generated is such that it waste disposal is yet an issue. As fly as contains SiO_2, Al_2O_3, and calcium oxide which resembles the compostion of zeolite, which can be extracted and used for removal of hardness of water economically and solve much more problem of solid waste disposal**

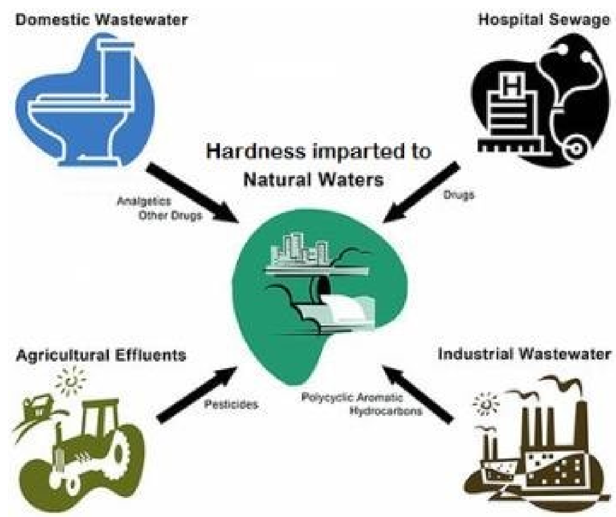
***Keywords:* Fly ash, extraction, zeolite, proximate analysis, Hardness**

I. INTRODUCTION

Domestic wastewater contains all the materials composed of human body wastes (faeces and urine) together with the water used for flushing toilets etc also resulting from personal washing, laundry, food preparation and the cleaning of kitchen utensils.

Industrial wastewaters are generally much more polluted than the domestic wastewater or even commercial wastewaters. The still, however, several industrialists try to discharge their effluents into natural river streams, through unauthorized direct discharges. Such a tendency, on the part of industries may pollute the entire river water to a grave extent, thereby making its purification almost an impossible task. It, therefore, becomes, necessary, for the industry to treat their wastewaters in their individual treatment plants, before discharging their effluents either on land or lakes or rivers, or in municipal sewers. The characteristics of the produced wastewater will usually vary from industry to industry, and also vary from process to process even in the same industry, but most having hardness problem.

The secret parameter that remains untreated which is not measured visually is hardness *i.e.* presence of calcium and magnesium ions. Though the levels for domestic and industrial are varied in nature but the harmfulness remains the same when are unprotected to the nature in nearer to higher limits. This picture showing the sources of water to become it as hard.



The primary natural sources of hardness in water are dissolved polyvalent metallic ions from sedimentary rocks, seepage and runoff from soils. Calcium and magnesium, the two principal ions, are present in many sedimentary rocks, the most common being limestone and chalk. They are also common essential mineral constituents of food. As mentioned above, a minor contribution to the total hardness of water is also made by other polyvalent ions, such as aluminium, barium, iron, manganese, strontium and zinc.

Fly ash, also known as "pulverized fuel ash", is one of the residues generated by coal combustion and is composed of the fine particles that are driven out of the boiler with the flue gases. Ash that falls in the bottom of the boiler is called bottom ash.

Fly ash is generally captured by electrostatic precipitators or other particle filtration equipment before the flue gases reach the chimneys of coal-fired power plants, and together with bottom ash removed from the bottom of the boiler is known as coal ash.

Depending upon the source and makeup of the coal being burned, the components of fly ash vary considerably, but all fly ash includes substantial amounts of silicon dioxide (SiO_2) (both amorphous and crystalline), aluminum oxide (Al_2O_3) and calcium oxide (CaO), the main mineral compounds.

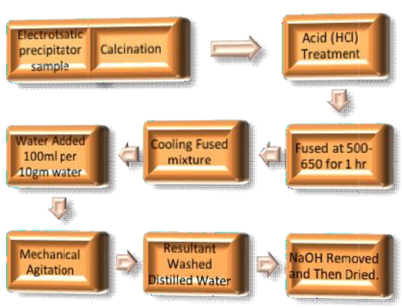
In the past, fly ash was generally released into the atmosphere, but air pollution control standards now require that it be captured prior to release by fitting pollution control equipment. About 43% is recycled, often used as a pozzolana to produce hydraulic cement or hydraulic plaster and a replacement or partial replacement for Portland cement in concrete production. Pozzolans ensure the setting of concrete and plaster and provide concrete with more protection from wet conditions and chemical attack.

Zeolites are hydrated aluminosilicate minerals made from interlinked tetrahedra of alumina (AlO_4) and silica (SiO_4). In simpler words, they're solids with a relatively open, three-dimensional crystal structure built from the elements aluminum, oxygen, and silicon, with alkali or alkaline-Earth metals (such as sodium, potassium, and magnesium) plus water molecules trapped in the gaps between them. Zeolites form with many different crystalline structures, which have large open pores (sometimes referred to as cavities) in a very regular arrangement and roughly the same size as small molecules. As fly ash contains SiO_2, Al_2O_3, CaO as a constituents, which make the composition of zeolite, hence can be extracted from fly ash can be utilized for futher study for removal of hardness of water economically.

II. MATERIALS AND METHODS

Proximate Analysis:

The proximate analysis represents the determination of moisture, ash, volatile materials and fixed carbon in the sample. The first three are determined experimentally and the results are expressed in percentage and thefixed carbon is determined by subtracting the total total percentage of moisture, ash and volatile materials from hundred. Proximate analysis of the samples was carried out as per standard procedure.



Extraction of Zeolite:

The raw fly ash samples are collected from electrostatic precipitator (a unit in the thermal power plant). The unburnt carbon (4–6%) along with other volatile materials present in fly ash was removed by calcinations at 800 (± 10) °C for 2 hrs. Fly ash samples were further treated with hydrochloric acid to increase their activity in zeolite formation.

The acid treatment helped to dealuminate the fly ash and removed iron to a certain extent, thereby increasing the activity, thermal stability and acidity of the zeolite, all aiming for better catalytic applications.

Mixture of sodium hydroxide and fly ash (calcined and HCl treated) in a pre-determined ratio, was milled and fused in a stainless steel tray at different temperatures ranging from 500-650 °C for 1 h. The sodium hydroxide to fly ash ratio (by weight) was varied from 1.0. The resultant fused mixture was then cooled to room temperature, ground further and added to water (10 g fly ash/100 ml water). The slurry thus obtained was agitated mechanically in a glass beaker for several hours.

The resultant precipitate was then repeatedly ashed with distilled water to remove excess sodium hydroxide, filtered and dried. The sodium hydroxide added to the fly ash not only works as an activator, but also adjusts the sodium content in the starting material.

Mullite and a- quartz present in the fly ash are the sources of aluminium and silicon, respectively, for zeolite formation.

III. RESULTS AND DISCUSSION

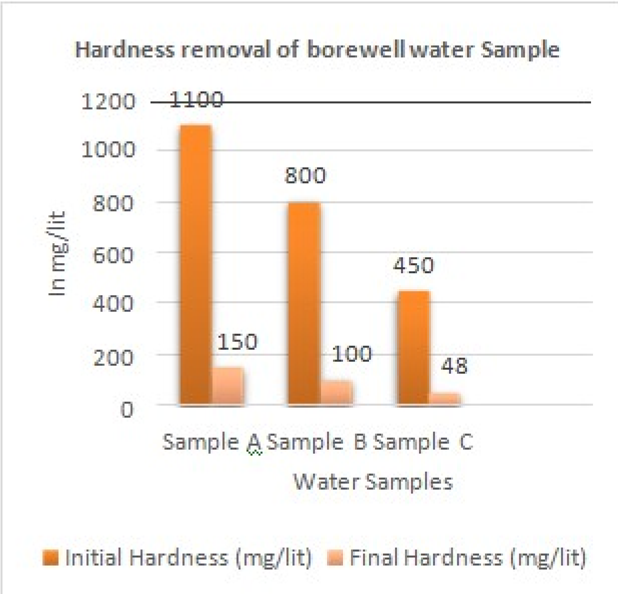
Proximate analysis result for fly ash of electrostatic precipitator are as moisture content is1.098%, Volatile matter is 0.345%, Ash content is 98.51% and carbon content is 0.047%

Removal of Hardness by using newly synthesized Zeolite

Zeolites adsorb a number of organic substances. Depending on the diameter of the molecules, these are either adsorbed in the micro porous sieve like structure. The capacity of the adsorption is strongly dependent on the circumstances at which the adsorption is performed.

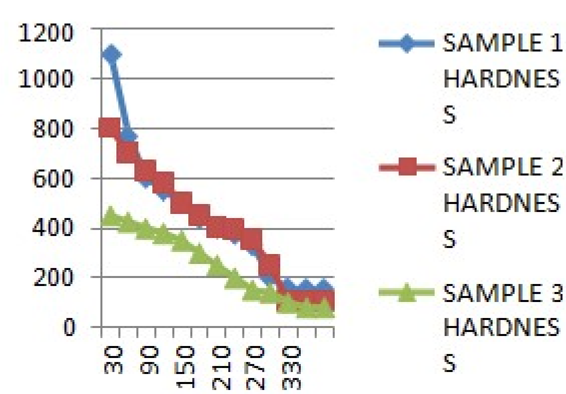
The adsorption property by zeolites is related to detention time, quantity of zeolites, and temperature with quantity of sample water.

From studies it is observed that the more the contact period more is the removal efficiency of the hard water upto certain extent. A single volume of water that comes under contact through more and more layer of zeolites will give better efficiency. The exchange of ions take place in the zeolite and hard water, enables it to trap the Magnesium and Calcium ions.



Effect of contact time on percentage removal:

Batch experiments suggested for the and comparison of the rates with the prevent available rates of Zeolites in India as so as to get comparison with the Laboratory prepared Fly Ash Zeolite. Inspite, of this it is found by approximate samples with known initial concentration. The samples kept on shaker for different contact times ranging from 30 minutes to 360 minutes. 360 minutes is seen to be optimum as for result. Then samples were filtered and analysed for the hardness removal. It was observed that percentage removal increases with contact time up to 360 min. period and thereafter it remains constant. This is because of attainment of equilibrium between the adsorbate in the solution and the one adsorbed on the solid. The optimum adsorption is constant respectively. Percentage removal for sample1 at end of cycle is 86.36, for sample 2 is 87.5% and less for sample-3 is 82.5%.



Effect of adsorbent dose on percentage removal

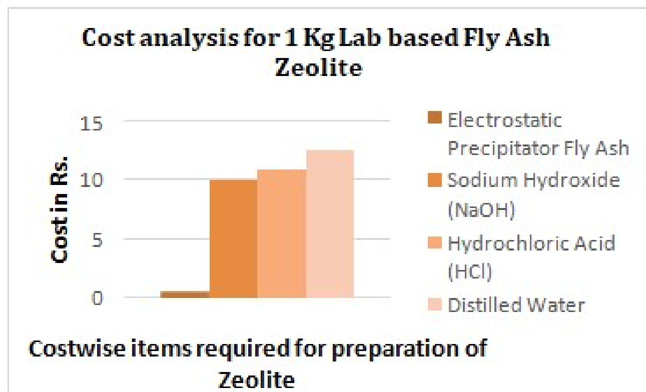
Effect of adsorbent dose on percentage removal of adsorbate is indicative. For this, experiments suggests that were carried out in the conical flasks with effluent with known initial concentration. To the given sample effluent, various quantities of adsorbents were added and kept on shaker. The effluent was filtered and sample was analysed for the pollutant. It was observed more the adsorbate dose more is hardness removal efficiency. Adsorption phenomenon is similar to ion exchange process. The pH of the aqueous solution has significant effect on adsorption by the adsorbent.

Economy attains

The generation of 1000 gm fly ash based zeolite cost about Rs.43/- .Dated as on 19 /04/2019. The items required for the generation of fly ash based zeolite and their cost respectively.

Table showing the cost required for making zeolite from fly ash

Sr. no.	Material or chemicals used	Quantity	Cost of the total quantity
1	Electro precipitated Fly ash	1kg	Rs. 1.0
2	NaOH(Sodium Hydroxide)	1kg	Rs. 20
3	HCl(Hydrochloric acid)	73ml	Rs. 21.9
4	Distilled Water	5 lit.	Rs.25
	Total		Rs. 66.9 i,e for 2Kg
	Therefore, cost of	1Kg	33.45/-



This graph is showing Cost analysis for 1Kg Lab based Fly Ash Zeolite Cost analysis and comparison of the zeolites with the available global zeolites always represents a challenge in calculating the rate analysis. The laboratory prepared rate analysis shows the rate for 1 Kg sample when the materials bought are not for whole sale price. The global distributor is china which has officially different company online retail outlets having price for 1 ton i.e. the minimum quantity required to be purchased. Thus, it is a difficult issue to sort out the rates including the prevalent import taxes, travel and transport allowances to be include for the preparation and comparison of the rates with the prevent available rates of Zeolites in India as so as to get comparison with the Laboratory prepared Fly Ash Zeolite. Inspite, of this it is found by approximate estimate that the cost of the Laboratory prepared Fly Ash Zeolite is far less than the other commercial types of zeolites. It is obvious that the rates calculated for 1Kg is going to be far very less for 1ton as the materials procured will be for retail rates only. Hence, inspite of the fact the rates found to be less for the Laboratory prepared Fly Ash.

IV. CONCLUSION

The study validates that zeolite extracted from fly ash is promising alternative to the conventional hard water remedies. Removal of hardness from borewell water by zeolite extracted from fly ash is a function of contact time and eolite dosage. The prototype is a suggestion which can be implemented the times the need of the water is to be treated. It is observed that the fly ash from Thermal power plants can be properly utilized for the extraction of Zeolite. It is suggested that further more exploration is required to understand its broader scope.

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