2nd International Conference on Current Research Trends in Engineering and Technology
© 2018 IJSRSET | Volume 4 | Issue 5 | Print ISSN: 2395-1990 | Online ISSN : 2394-4099
Themed Section: Engineering and Technology

Recovery of Alum from Synthetic Sludge

Jadav Vishal[1], Mishra Bunty[2], Parmar Nidhi[3], Patil Chetan[4], Parmar Padmavati[5], Sorathiya Saket[6]

[1-5]Civil Engineering, Sigma Institute of Engineering, Bakrol - Vadodara

[6]Assistant Professor, Civil Engineering, Sigma Institute of Engineering, Bakrol - Vadodara.

ABSTRACT

Being in 21st century we can see the rapid growth of world, which is very quick. With increase in population, the demand for water is also increasing. We know very well that 70% of water on Earth is not potable. To make is consumable, we must purify water. Alum is widely used as coagulant in water purification process. In this process, alum is wasted in more amount than it is used. About 15-20% of the alum used is recovered. Rest of it is simply dissolved in water and thus goes waste. There are four ways to recover the alum used for water purification. They are – Acidic Method, Alkaline Method, Membrane Separation and Ion Exchange. Among these methods, Membrane Separation and Ion Exchange are quite expensive. Using these methods to recover large quantity of alum proves to be very costly and thus is impractical. These methods can't be used in places where money is short (for example – developing Nations). This is where acidic and alkaline methods come handy! These methods of alum recovery are inexpensive and very efficient. About 84% (maximum) of alum is recovered using these methods. It is an impressive amount! Recovered alum can be reused for water purification. Thanks to alum recovery, the sludge, which is in liquid state, gets converted into solid state. Due to this, levels of pollution is reduced greatly.

Keywords: Water purification, Waste recycling, alum recovery, alkalization, acidification, sludge.

I. INTRODUCTION

Water treatment plants are known to generate chemical sludges. These chemical sludges are a product of the various reactions taking place in the water treatment process. Disposing these sludges is an important and difficult task. Some of the characteristics of this chemical sludge are – organic debris, high moisture content, low solid content, rapid settle ability, difficult to dewater, insoluble in the pH range of natural water.

It has been a common practice to dispose these sludges into nearby sources of water such as rivers, lakes and other similar water bodies. But in modern times, due to increased environmental awareness, this practice has been stopped.

Chemical sludges are known to pollute the environment. One of the best ways to reduce its pollution potential is by reducing its volume. Volume of chemical sludges can be reduced with the use of – lagoons, drying beds, vacuum filtration, pressure filtration, freezing, centrifuges and recovery of alum and lime.

The main aim of this experiment is to study the effectiveness of alum recovery and reuse from the sludge. From the literature, it has been observed that the recovery method used at present is acidification of the sludge and removal of sludge to be used as a flocculating agent.

To find out the best pH for the sludge acidification process, we collected sludge from the water treatment plant and acidified it to pH values ranging from 1.0 to 3.5. After completing the acidification, sludge samples belonging to each pH value was collected and decanted. Amount of aluminium in each sample was measured. Later, the recovered alum was used as a flocculating agent.

Here are some of the limitations of the experiment performed by us – In our test, we used just one type of sludge. We collected a large sample and conducted our studies on it. But sludge and its properties change on a seasonal basis. It would have been batter had we collected various sludge samples over a year and studied them in the above-mentioned manner.

Water used in flocculation tests belonged to the same sample. Just as in the above point, quality water varies from one season to another. It would have been better if we had documented this fact.

To confirm the presence of alum in the recovered solution, atomic absorption spectroscopy was used. The mass balance of aluminium sulphate was not calculated.

Visual observations and turbidity measurements were used to ascertain the effectiveness of flocculation process. The analysis would have been better had we checked the colour and alkalinity.

As a result of our study, we found that the pH range of 1.0 to 2.5 is best suited for alum recovery. In this pH range, the alum recovered when used in flocculation process resulted in savings in material costs. The best savings occurred when the alum was recovered at pH 2.5.

II. METHODS AND MATERIAL

There are four types of methods to recover alum from synthetic sludge.

1. Acidification
2. Alkalization
3. Iron exchange
4. Membrane separation

The Iron exchange and Membrane separation methods are very costly so that these methods are not used.

Acidification: -

The basic concept of coagulant recovery is acid digestion process where sulphuric acid react with insoluble aluminum hydroxide to form dilute liquid alum.

$$2Al(OH)_3.3H_2O + 3H_2SO_4+2H_2O \rightarrow Al_2(SO_4)_3.14H_2O$$

The alum recovery by acid extraction (pH 1.0 – 3.0) can reach 70-90%.

This process is non-selective as it recovers along with alum all other substances that are soluble under high acidic conditions such as manganese, zinc, and lead.

Alkalization: -

This process is non-selective as it recovers along with alum all other substances that are soluble under high acidic conditions such as manganese, zinc, and lead.

A report of feasibility of coagulant recycling by alkaline reaction of aluminum hydroxide sludge by using sodium hydroxide (NaOH) and lime Ca(OH)2 at pH ranges of 11.4-11.8 and 11.2-11.6 respectively gives yield of aluminates at 80% with NaOH and 30% with Ca(OH)2 also reported 79 -90% recovery of alum using alkaline method at a pH of 12.0

III. LITERATURE REVIEW

Bhole A.G. and Parwate A.V.(2001) has analyse that Aluminium sulphate and polyalanine chloride are widely used as coagulants in water treatment plants. A chemical sludge containing aluminium hydroxide, adsorbed organic matter and other water insoluble impurities is obtained after the flocculation clarification process. In Portugal, an estimated amount of 66 000 ton/yr. (wet wt.) water treatment sludge is being disposed of on land or at municipal solid waste

(MSW) landfills Centrifuged chemical sludge from a water treatment plant using polyalanine chloride as coagulant was characterised in terms of humidity, volatile matter, Al, Fe, Mn, Cd, Cu, Cr, Pb, Ni and Zn. The dry sludge organic content is about 29%. The ratio dry sludge/sulphuric acid solution was varied between 0.5 and 2%, the pH ranged from 1.0 to 4.5, different stirring and settling times were established and the aluminium, iron and manganese dissolution was assessed [1]

Present study reveals that purification of water is a daily need based task,because only in the Bhopal the requirements of potable water supply is 90 MGD .Several treatment alum sludge cannot be discharged into surface water or landfill directly. It requires proper treatment before its disposal to either place.

A. O. Babatunde (2003) et. al. has examined that The adsorption equilibrium of a wide range of phosphorus species by an aluminium-based water treatment sludge (Al-WTS). Four kinds of adsorption-isotherm models, namely Langmuir, Freundlich, Temkin and Dubinin-Radushkevich, were used to fit the adsorption equilibrium data. In order to optimise the adsorption-isotherm model, correlation coefficient (R2) and four error functions were employed to facilitate the evaluation of fitting accuracy.
adsorption process in Adsorption equilibrium data are important to determine the adsorption parameters using adsorption isotherms.These fundamental data should be useful in designing and predicting practice.

Hi-soo moon and jie gon kim (2003): Alum sludge, which is a waste product from a potable water treatment process, was tested as an inexpensive alternate adsorbent for phosphorus in wastewater. The sludge was composed dominantly of sand size aggregates, and could remain stable in aqueous media. The majority of reactive Al in alum sludge was present as an amorphous phase, and seemed to be the major absorbent for P. The batch sorption test showed that the removal of P was influenced by the solubility of Al, Fe and organic carbon depending on pH condition. The acidic condition favoured the removal of P, and there was a side effect in the P removal process such as dissolution of Al and organic C at acidic (pH < 4) and alkaline (pH < 8) conditions. The pH range from 4 to 6 was effective for all inorganic and organic phosphates with a low solubility of Al and organic C.[1]

Prakhar Prakash and Arup K. SenGupta (2003): Conventional water treatment consumes large quantities of coagulant and produces even greater volumes of sludge. Coagulant recovery (CR) presents an opportunity to reduce both the sludge quantities and the costs they incur, by regenerating and purifying coagulant before reuse. Recovery and purification must satisfy stringent potable regulations for harmful contaminants, while remaining competitive with commercial coagulants. These challenges have restricted uptake and lead research towards lowergain, lower-risk alternatives. This review documents the context in which CR must be considered, before comparing the relative efficacies and bottlenecks of potential technologies, expediting identification of the major knowledge gaps and future research requirements.

For pressure driven semipermeable membrane process such as reverse osmosis and nanofiltrarion. The solvent water molecules permeate through the membrane in preference to electrolytes. On the contrary. For donnan membrane process, the specific ions and not the solvent migrate through the membrane under electrochemical potential gradient.

Prakhar Prakash and Arup K. SenGupta (2003): Fouling of membrane surfaces by particulate matter and large organic molecules is relatively common for pressure-driven membrane processes, namely, reverse osmosis (RO), nanofiltration (NF), and ultrafiltration (UF). Donnean membrane process (DMP) or Donnean

Dialysis is driven by electrochemical potential gradient across a semipermeable ion exchange membrane. Theoretically, DMP is not susceptible to fouling by fine particulates and/or large organic molecules. According to information available in the open literature, however, DMP has not been tried to treat slurry or sludge with relatively high concentration of suspended solids or large organic molecules. A series of laboratory tests confirmed that over 70% of alum is easily recoverable, and recovered alum is essentially free of particulate matter, NOM, and other trace metals. Most importantly, after repeated usage in the presence of high concentration of NOM and suspended solids, there was no noticeable decline in aluminium flux through the membrane.

Y. Yang and M. Bruen (2013): In this study, the efficiency of alum sludge for removing phosphorus from synthetic and municipal wastewater (MWW) was investigated. Orthophosphoric (OP) and condensed phosphorus (CP) were used as model pollutants. The maximum adsorption capacity for sludge A was found to be 4.86 mg/g for OP, and 4.21 mg/g for CP at 12 g/L of sludge dose, 90 min of contact time, and pH 4. For sludge B, Qo was 1.58 mg/g for OP and 4.71 mg/g for CP at 30 g/L of sludge dose, 80 min of contact time, and pH of 5.5. Results showed that pH of wastewater significantly affected adsorption capacity and better removal was achieved within pH range of 4.0–5.5. Optimized conditions for sludge A and B were applied on MWW which provided over 90% of OP and 70–80% of CP removal. Sludge B performed better than sludge A in case of domestic wastewater.

Adsorption equilibrium data are important to determine the adsorption parameters using adsorption isotherms. These fundamental data should be useful in designing and predicting adsorption process in practice.

B.Dassanayake (2015): Alum salts are commonly used in the water industry to promote coagulation in the production of clean drinking water, which results in the generation and accumulation of 'waste' by-product 'alum sludge' in large volumes. Effective and efficient management of alum sludge in an economically and environmentally sustainable manner remains a significant social and environmental concern with ever increasing demand for potable water as a result of rapidly escalating world population and urban expansion. Various intensive practices have been employed to reuse the alum sludge in an attempt to figure out how to fill the gap between successful drinking water treatment process and environmentally friendly alum sludge management for over the years. The laboratory result indicates that the optimum pH range for the acidification process is pH 1.0 -2.5.

Nida Maqbool and Aisha Asghar (2015): The residual Al/Fe content in clarifier sludge resulting from coagulant use is a valuable resource. Chemical conditioning is carried out in previous years to recover the Al/Fe coagulants. the type and concentrations of stripping agents. A jar test experimental procedure was used to evaluate the coagulation performance of the recovered coagulants in comparison with the commercial aluminium soleplate (AS). The results have shown that the liquid-ion exchange process will recover more than 95% of the Al from influent sludge and the recovered AS can be of the same quality and concentration as commercial AS. and can perform as well as the commercial AS for potable water treatment. This study focused on the adsorption equilibrium of a wide range of phosphorus species adsorbed by an allumunium based water treatment sludge. Four kinds of adsorption isotherm models were used to fit the adsorption equilibrium data. In order to optimise the adsorption isotherm model. [7]

IV. MAJOR FINDINGS

1. The acidification and alkalization methods are found to be beneficial for the recovering of alum

2. The total amount of 70-85 % of alum is recovered by the processes.

3. This recovering of alum cannot be done in the developing countries.

V. CONCLUSION

The results indicated from the laboratory that the optimum pH range for the acidification is Ph 1.0-2.5. the observation leading tonthis conclusion are as follows:

1. Maximum recovery of aluminium occurs in this Ph range.
2. The Ph values of 1.0 and 1.5 do not attempt to rebound. This is an indication that the reaction to convert the aluminium sulphate is essentially complete. The Ph values of 2.0 and 2.5 are not as easy to attain but appear to be more economical.

VI. REFERENCES

[1]. Bhole A.G. & Parwate A.V., "Alum Recovery by Alkaline Method of Aluminium Hydroxide Sludge", Jour IPHE,India, Vol-1, Pg10-18,2001.

[2]. Dhage S.S., Rao R.R., Andey S.P. and Paramsivam R., "Water Works Waste- A State of Art Review", Jour. IWWA, 16, 162-183,1984.

[3]. Fulton George P., "Alum recovery and Waste Disposal in Water Disposal in Water Treatment", US Patent 3959133,1976.

[4]. Hi-soo moon and jie gon kim, "Removal capacity of water plant alum sludge for phosphorus in aqueous solutions", Daejeon 305-350korea,2003.

[5]. Jung hyun kim, "Removal capacity of water plant alum sludge for phosphorus in aqueous solutions", Seoul 120-749, Korea,2003.

[6]. Keeley J. and Jarvis P., "Coagulant Recovery from Water Treatment Residuals: A Review of Applicable Technologies", Cranefield University, UK,2014.

[7]. Nida Maqbool and Aisha Asghar, "Reuse of alum sludge for phosphorus removal from municipal wastewater", Taiwan inst. Chem. Eng. ,2015.

[8]. Smita and kriti, "recovery of alum coagulant from water treatment plant sludge", international journal of advanced computer research, volume-1 Number -2 Issue-2, 2011.