The Reuse of Dewatered alum sludge collected from Water Treatment Plant for Phosphorous Removal in Domestic Waste Water

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Abstract

Alum sludge is released from the Water Treatment Plant. In this study a group adsorption studies was carried out for the removal of phosphorous in domestic wastewater. Dewatered alum sludge which was collected from a Water Treatment Plant in bengaluru, was subjected for domestic wastewater adsorption tests for the removal phosphorous concentration. The behavior of adsorption studies were investigated by varying different dose of alum sludge, effective size of alum sludge and the pH of the solution prepared for the adsorption studies. The results showed that pH plays a major role not only in the adsorption process but also in the adsorption capacity of the alum sludge. In this study Phosphorus is often present in low concentrations in domestic wastewater almost solely as phosphates, including organic phosphate, inorganic phosphate and polyphosphate Phosphorous release to the surface lake or river water is of environmental concern, because phosphorous is an essential, often limiting, nutrient for growth of organisms in most ecosystems, and therefore it is a major cause of eutrophication of the surface water. The utilization of industrial wastes or industrial alum sludge or by-products from industries or water treatment plant for phosphorus removal has been given a great attention in recent days. Several waste materials or by-products studied by different researchers include: fly ash, blast furnace slag, red mud, spent alum sludge, and aluminum- and iron-rich residues, etc. The removal mechanism is mainly either adsorption or precipitation. The major advantage of using these wastes or by-products for wastewater treatment is cost effectiveness (Zeng et al, 2006).

The purpose of this study is to test the adsorption behaviour of dewatered alum sludge collected at water treatment plant for phosphorous removal in domestic wastewater. Groups of experiments were conducted to investigate the effects of dosage amount of alum sludge and particle size of dewatered alum sludge, as well as pH on phosphorus adsorption rate. Adsorption capacity was then studied.

Langmuir adsorption isotherm was best fitted with experimental data (R^2=0.97-0.99). The maximum adsorption capacities was found to be 1.25 to 20.28 mg/g when the pH of the domestic waste water was varied from 8.5 to 4.3, respectively. It can be concluded from this study that dewatered alum sludge collected from water treatment plant can be reused as an adsorbent for the removal of phosphorous from domestic wastewater.

Keywords

Adsorption, Dewatered Alum sludge reuse, Domestic wastewater

1. INTRODUCTION

2. Materials and Methodology

The Dewatered Drinking Water Treatment Alum Sludge used has an adsorbent in this study was collected from water treatment plant in the discharge pit of alum sludge where nearly 3-5 Tons of alum sludge is discharged every day.Alum sludge is dewatered by Centrifuge in the water treatment plant. The collected alum sludge was air dried and was kept in Hot air oven @ 110° c for 24 hours and gently ground with pestle and motor, the powdered sludge waspassed through a 600µmmsieve to provide the testing sludge (adsorbent) then later alum sludge was sieved with different sieves to obtain different range of particle sizes.The morphology was examined by SEM and the chemical composition of powdered dewatered alum sludge was examined by XRD.

Domestic waste water used for this adsorption was collected from domestic waste water discharge pit/manhole in the SJCE campus,Mysuru which had initial phosphorous concentration of 13mg/l to 15mg/l.

3. Experimental procedure

Adsorption experiments were conducted using 250 ml conical flasks. Differentdosage amount of 100mg, 250mg, 350mg and 500mg of alum sludge were added to 100ml domestic waste water whose initial phosphorous concentration was 13mg/l to 15mg/l in a series of conical flasks. The prepared conical flasks were placed on an orbital shaker at 200 rpm for adsorption periods of 1hr, 2hr, 4hr, 6hr and 8hr. After completion of the adsorption test the suspensions in flasks were filtered through whatman filter paper to separate the sludge and the liquid. Table1.Chemical composition of alum sludge sample

The phosphorous concentration and pH of the liquid after the adsorption test were respectively monitored using a spectrophotometer and a pH meter. Effect of pH on adsorption was conducted by series of adsorption tests at fixed amount of sludge addition with different pH of suspension from 4.3 to 9.0 adjusted by using either 0.01M sulfuric acid or 0.1M sodiumhydroxide. Adsorption tests were also conducted with the same amount of sludge additionbut varied particle sizes.

4.Results

To identify the adsorption ability of dewatered alum sludgeas an adsorbent for the phosphorous removal in domestic wastewater, a series of adsorption tests were conducted with different dose amounts of alum sludge. Adsorption behaviour wasmonitored by measuring the residual phosphorus concentration against the adsorption period till the equilibrium concentration of phosphorous removal was reached. It is noted from Fig. 1 that the different amount of sludge shows the same trend of adsorption behaviour, increasing the adsorbent resulted in an increase in phosphorus removal from domestic wastewater.Itis clear that 500mg/l dose of alum sludge and at 8hrs contact time maximum removal of phosphorous was found.

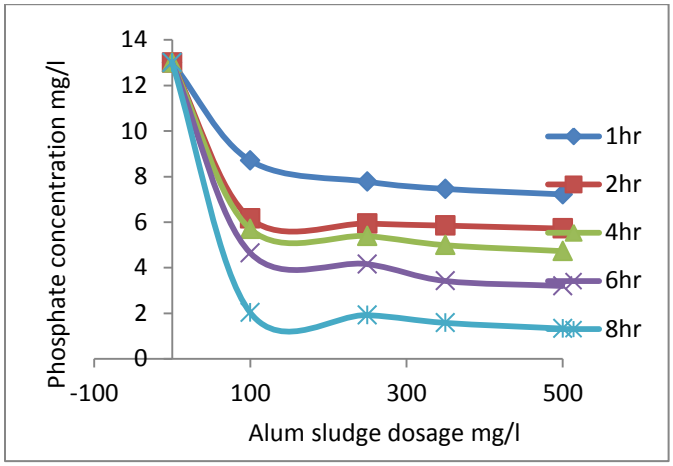
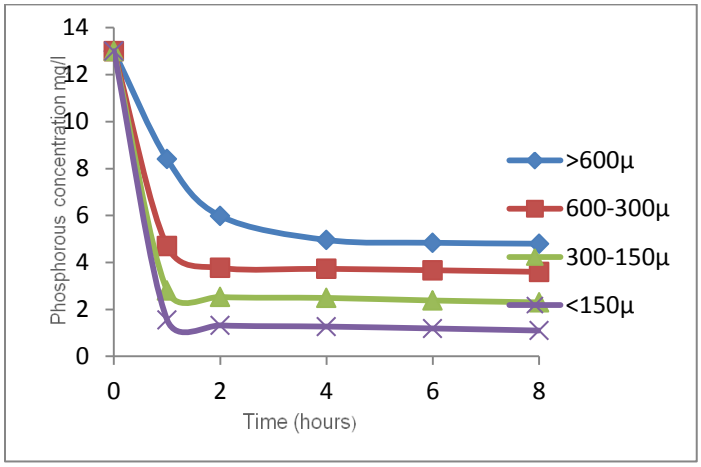


Fig.1 Residual phosphorous concentration with adsorption period at varied sludge amount

Fig. 2 presents the effect of sludge particle size on adsorption behaviour. It is observed clearly that the fine grain of sludge will bring about a better adsorption process, which leads to the rapid reduction of phosphorus in suspension. Here alum sludge dose of 500mg/l was kept constant and sludge sieved with <150µm removed rapid amount of phosphorous concentration from domestic waste water at 8hrs of adsorption period.

Element	Weight%	Weight % Error
C	17.19	± 0.69
O	56.88	± 0.66
Mg	1.04	± 0.08
Al	5.91	± 0.19
Si	13.23	± 0.20
Ca	1.73	± 0.14
Fe	4.01	± 0.38

Fig.2 Effects of particle size on adsorption behavior (sludge amount 500mg/l)



The effect of pH on adsorption behaviour was examined and the results of the study are shown in Fig. 3, it is noted that the greater amounts of phosphorus are captured in acidenvironment while the rapid reduced adsorption of phosphorus occurred in alkaline environment i.e., when the pH of the solution was maintained at 8.5 where m dose of 500mg/l and size of particle of <150µm was kept constant.

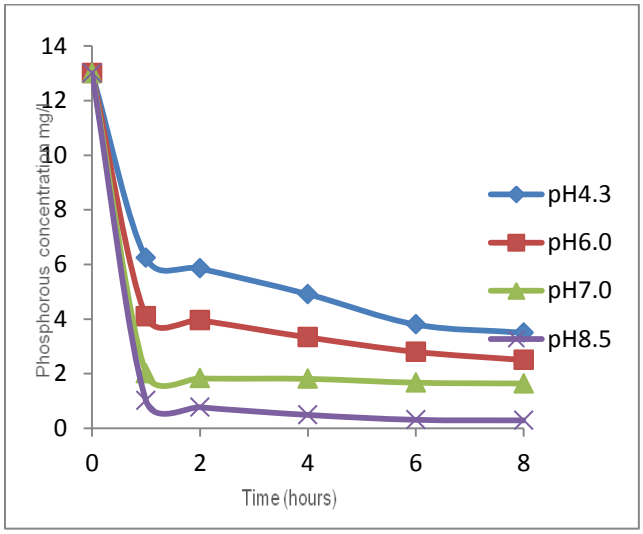


Fig.3 Effects of pH on adsorption behavior (sludge amount 500mg/l, particle size <150µm)

Fig. 4 shows the adsorption capacity in terms of Q_0 (mg/g-sludge) as a function of pH of phosphorus suspension. Here, the adsorption capacity was determined experimentally and the data were computed using the Langmuir isotherm in the linear form of

$$\frac{C_e}{\frac{x}{m}} = \frac{1}{Q_0}C_e + \frac{1}{Q_0 b}$$

Where, x/m is the mass of phosphorus adsorbed per unit mass of sludge; b is a constant related to the energy of the adsorption-desorption process; $Q_0$is the maximum adsorption capacity(mg/g of sludge); and $C_e$is the equilibrium concentration of phosphorus (mg/l) in suspension afteradsorption.(Yang et al,2006) It is seen from Fig. 4 that the adsorption capacity decreases from 20.28 to1.25mg/g-sludge when the pH of the phosphate suspension increases from 4.3 to 8.5.

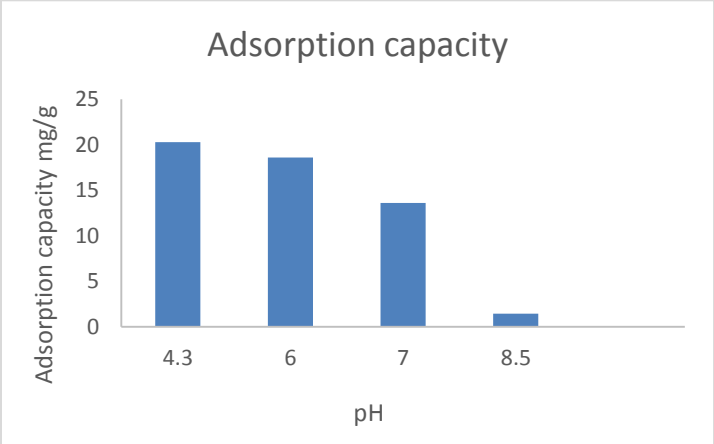


Fig.4 The adsorption capacity of alum sludge in domestic waste water at different variation of pH values

5. Discussion

SEM images generally represent the physical morphology of the particles. From the observation of SEM images SEM of alum sludge represents non–uniform, irregular shaped, agglomerated particles with non-uniform distribution of minute particles. Due to non-uniform distribution of particles after the adsorption process the surface area increases resulting in rapid increase of adsorption of phosphorous removal from both synthetic and domestic waste water.

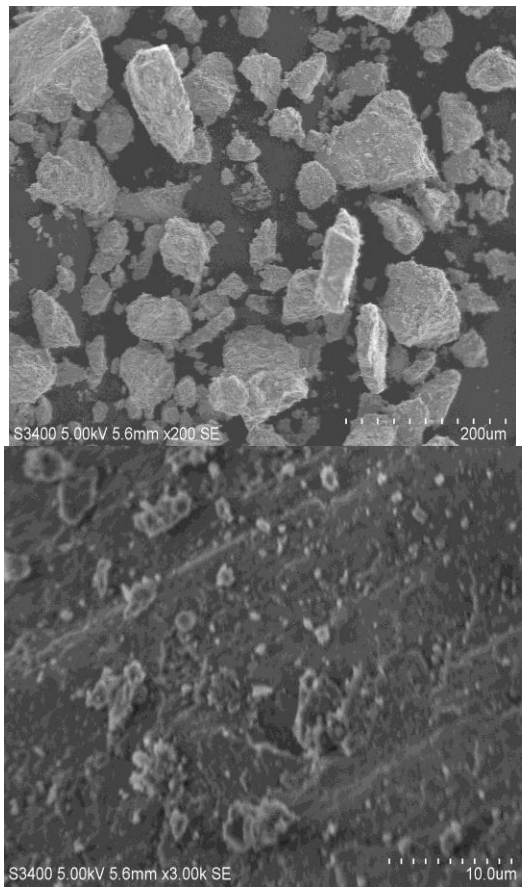


Fig.5SEM images of alum sludge

CONCLUSION

It has been demonstrated in this study that the water treatment plant dewatered alum sludge has the adsorption ability for phosphorus removal. Its adsorption capacity is identified experimentally to be 1.25 to 20.28 mg/g of sludge depending on pH of the phosphorus solutions. The results showed that the pH plays a key role in adsorption process. Alum sludge has a higher phosphate adsorption capacity in acid pH region than in alkaline pH region (4.3 and 6).Amount and particle size of alum sludge have the important effects on adsorption behavior (500mg/l and <150μm).Large quantity and fine grain of sludge will lead to the enhanced adsorption process for phosphorus removal.The dewatered alum sludge from the drinking water treatment plant can be reused in various application such as a wetland, for various civil engineering applications and for the adsorption of different domestic waste water parameters.

References

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