# TO STUDY OF DIFFERENT RESEARCH METHODOLOGY ON CHARACTERIZATION & REUSE OF DRINKING WATER TREATMENT PLANT (DWTP) WASTE ALUM SLUDGE

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## Abstract:

*In this study, Drinking water treatment plant alum sludge produced at water treatment plants and has long been treated as a waste. Aluminum sulphate is the most widely used coagulant in drinking water treatment. Today, large amounts of alum sludge are being produced from water treatment plants all over the world. Drinking water treatment plant alum sludge from a different Drinking water treatment plants were studied for its capacity for removal of phosphorus (P) from synthetic wastewater. Orthophosphate is used as a model pollutant in synthetic wastewater as well as sewage wastewater. Alum sludge from local treatment plants was collected, dried, and processed before use. Batch experiments were performed to determine PO4-P removal under equilibrium conditions. Sludge dose, contact time, and pH were optimized for synthetic wastewater. Adsorption efficiencies' of P were determined by using Langmuir and Freundlich adsorption isotherm models.*

**Keywords:** *Landfill, Dumpsites, Alum Sludge, Drinking Water Treatment Plant waste, Reuse of Sludge, Phosphorus removal*

**INTRODUCTION:**

Phosphorus (P) is a naturally occurring element essential to life on earth; however, there are concerns regarding long term sustainability and reliability of supply [28]. Phosphorus is a major nutrient needed by living microorganisms for their physiological processes and aquatic plants. Municipal wastewater is a significant source of phosphorus disposal into surface water. There is widespread phosphorus pollution from these wastewater systems [12].

Drinking water treatment plant sludge is a by-product of drinking water purification processes. It is generated when chemical coagulant (alum or iron salt) is added to the raw water during the water treatment process (coagulation, flocculation, clarification) to remove particles, color and impurities especially from raw waters with high turbidity.

As a result of this operation, several million tons per year of water clarifier sludge are produced all over the world [23]. In common practice, water treatment sludge is either discharged into waterways or disposed to landfills [24].

Disposal of waste from the water treatment plant is one of the major issues most treatment plants find it difficult to overcome due to the constant generation of this waste [32].The proper disposal, regeneration, or reuse of spent alum sludge has then become a significant environmental issue[23].

**OBJECTIVE:**

The objective of the study was to study the different research methodology on Characterization & Reuse of Drinking Water Treatment Plant (DWTP) waste Alum sludge.

**SCOPE:**

The study majorly focuses on to study the different research methodology on Characterization & Reuse of Drinking Water Treatment Plant (DWTP) waste Alum sludge.

Reuse of dewatered Al-based sludge cake as the main substrate in a reed-bed system for P- enriched wastewater treatment, the removal of dye from textile industry effluent using Al-based DWTP sludge, the use of waterworks sludge for the treatment of wastewater from a vegetable oil refinery, use of Al-based DWTP sludge for particulate removal in primary sewage treatment, using a large number of insoluble aluminum hydroxides in the sludge as a coagulant in chemical coagulation are few examples of reusing Al-based DWTP sludge [14].

Furthermore, various techniques have been developed to regenerate alum from the sludge, such as acidification, membrane separation and alkaline treatment, but these processes are generally expensive. So, probably the best way to take advantage of this sludge is reuse [6].

**STUDY AND SUMMARY OF LITERATURES:**

**1. Effectiveness of drinking water treatment sludge in removing different phosphorous species from aqueous solution. M. Razali, Y.Q. Zhao, M.Bruen**

In this literature, the adsorption of three phosphate species (14.7 mg% PO43-/L orthophosphate, 10.8 mg % PO43-/L polyphosphate, 3.3 mg% PO43-/L organic phosphate) by an Irish DWTS was studied using laboratory batch tests with phosphate concentrations typical of municipal waste water. Different dosage of sludge (1 g/L to 5g/L) was used for the batch adsorption test.

- They study that the dosing regime has affected the adsorption behaviour. More P is immobilized when 5g of Sludge is used per litre of suspension compared to 1 g.
- The maximum P adsorption capacities were determined using the linear from of the Langmuir isotherm. The adsorption capacity for orthophosphate was 10.2 mg PO43-/ g sludge, polyphosphate was 7.4 mgPO43-/ g sludge and organic phosphate was 4.8 mg PO43-/ g sludge, all at pH 4.0 Orthophosphate has the highest adsorption capacities for all pH values tested while organic phosphate removal was the lowest.
- Greater P removal was observed when the pH of the suspension was within the acidic range while less adsorption occurred within the basic region for all P types analyses. P is adsorbed most when the pH of the suspension is 4.0.

**2. Reuse of alum sludge for phosphate removal from municipal waste water BY NidaMaqbool, Zahiruddin Khan, Aisha Asghar**

In this study, alum sludge (A and B) from two local treatment plants were collected and used for removing phosphorous from synthetic and Municipal Wastewater (MWW). Ortho phosphorous (OP) and condensed phosphorus (CP) were used as model pollutants.

- The experimental results showed that 79% removal for OP and 86% removal for CP was achieved at 12 g/L of sludge A after four hours of mixing.
- Sludge B also exhibited good removal i.e. 92% of OP and 89% of CP at 30 g/L after four hours of mixing.

The optimum time for Sludge A and Sludge B was 90 min and 80 min respectively. Real wastewater samples were collected from NUST main drainage and analyzed for OP and CP. It contained 24.5 mg / L of OP, 13.3 mg/L of CP and 5.2 mg/L of OP. optimized dose and contact time for sludge A and B were employed on real wastewater samples.

- Sludge A was obtained maximum removal of 85% of OP, 69% of CP, and 50% of OP at 12 g/L of Sludge.

- Sludge B was obtained maximum removal of 88% of OP, 80% of CP and 60% of OP was achieved using 30 g/L of sludge.

**3. Dewatered alum sludge; A potential adsorbent for phosphate removal. Y. Yang, D, Tomlinson, S. Kennedy and Y. Q. Zhao.**

The purpose of this study is to test the adsorption behaviour of dewatered Irish alum sludge for phosphorus removal in an artificial solution. The phosphorus solution was prepared artificially by dissolving the pre-weighed potassium dihydrogen phosphate in distilled water. Adsorption experiments were conducted in 250 ml flasks which were placed on an orbital shaker at 200 RPM for a certain adsorption period.

- The appropriate dosage of the alum sludge was determined to be 5 gm of Al/L.
- This study identified the adsorption capacity decrease from 3.5 to 0.7 mg-P / g- Sludge when the pH of the phosphate suspension increases from 4.3 to 9.0.
- The results have shown that pH plays a key role in the adsorption process. Alum sludge has a higher phosphate adsorption capacity in acid pH region that in the alkaline pH region.

**4. Extending the use of dewatered alum sludge as a P-trapping material in effluent purification: Study on two separate water treatment sludges. Y. Q. ZHAO1 and Y. YANG1,**

This study examined the maximum phosphorus-adsorption capacity of two dewatered alum sludge sampled from the two largest water treatment works (Ballymore WTW and Leixlip WTW) in Dublin, Ireland. Both the waterworks use aluminium sulphate as a coagulant. The objective lies in clarifying the change of alum sludge characteristics and its P-adsorption capacity over the location of the alum sludge produced and the raw water being treated.

Series of batch adsorption experiments were conducted to examine the possible variability of the P- adsorption ability. The mixed samples were prepared by Different weight of prepared alum sludge's and 100 mL of prepared P solution. Then placed on a Stuart Orbital Shaker and agitatedat200rpm for 48 hours for equilibrium to be achieved.

- Experiments have demonstrated that the two alum sludges have a similar P adsorption capacity 14.3mg P/g sludge for Ballymore Eustace sludge and 13.1 mg P/g sludge for Leixlip sludge at pH 7.0). There is no significant difference in maximum P-adsorption capacity for the two alum sludge's.

- The highest P adsorption capacity tested is 22.4 mg P/g sludge (at pH=4.3) for Ballymore-Eustace sludge and 20.1 mg P/g sludge (at pH=4.3) for Leixlip sludge, respectively. It shows that the dewatered alum sludge possesses excellent P-adsorption capability with P-adsorption favoured at lower pH. The study supports that alum sludge beneficial reuse as a low-cost adsorbent for P immobilization should study its P adsorption capacity.

**S. Adsorptive Removal of Phosphorous from Wastewater Using Drinking Water Treatment- Alum Sludge (DWT-AS) as Low Cost Adsorbent. N. Nawar1, *, M. E. Ahmad2, W. M. El Said2, M. N. Moalla**

The overall goal of this study is to discuss and evaluate the effectiveness of low cost adsorbent materials for removing phosphate from wastewater. Batch adsorption experiments were performed by shaking the predetermined amount of alum sludge adsorbent with 50 ml of phosphate solution.

The effect of pH on phosphorus adsorption was examined by using a series of experiments by varying pH between 2 and 11. pH of the solution was adjusted by adding 0.1 M HCL and 0.1 NaOH solution as per required pH value.

- The experimental result shows that the amount of phosphorus adsorbed onto alum sludge as a function of the pH. Removal of P varied from 94 to 95 % when pH was varied from 2 to 5. Phosphorus adsorbed slightly increases with increasing the pH value reaching the maximum removal at pH 5 and then decreases with increasing pH values.

**5. Influence of aging on the structure and phosphate adsorption capacity of dewatered alum sludge Y. Yang, Y.Q. Zhao, P. Kearney**

This paper reports n in depth investigation of the effects of ageing time (0 day to up to 18 months) on the structure and the phosphate adsorption capacity of dewatered alum sludge obtain from a local drinking water treatment plant in Ireland.

- The adsorption capacity of the sludge varied from 21.4 to 23.9mgP g−1 sludge at pH 4.3, 14.3 to 14.9mgP g−1 sludge at pH 7.0, and 0.9 to 1.1 mgPg−1 sludge at pH 9.0 during the ageing period from 0 day to up to 18 months.
- The result shows that the ageing time has an insignificant effect on the structure and properties of the dewatered alum sludge. Ageing seems not to considerably affect the P-adsorption capacity of the alum sludge since the change <5% in maximum adsorption capacity during the ageing process.

**6. Two strategies for phosphorus removal from reject water of municipal waste water treatment plant using alum sludge. Y. Yang, Y. Q. Zhao, A. O. Babatunde and P. Kearney**

This paper outlines strategies for P removal from reject water using alum sludge, which is produced as a by-product in drinking water treatment plant when aluminum sulphate is used for flocculating raw waters.

The strategy involves the use of the dewatered alum sludge cakes in a fixed bed for P immobilization from the reject water that refers to the mixture of the supernatant of the sludge thickening process and the supernatant of the anaerobically digested sludge. The experimental setup consists of a Perspex column (1.0m long and 94mm in-diameter) packed with 3.3kg of prepared dewatered alum sludge.

- Experimental trials have demonstrated that the alum sludge can efficiently reduce P level in reject water. The results of the continuous flow filtration trial showed that the average P concentration in the reject water was reduced from 113mg-P/L to 0.008mg-P/L.

**CONCLUSIONS:**

From the study, it is concluded that the Dewatered alum sludge has the adsorption ability for PO4- P removal from Sewage wastewater. Alum sludge which was considered as waste. So, the alum sludge produced from water treatment plants can be used for the treatment of wastewater which further helps in the management of alum sludge.

- Alum sludge has the potential to be used for Phosphorus removal in P-enriched wastewater.
- P adsorption favors acidic Condition rather than alkaline condition. Removal of P varied from 90 to 85 % when pH was varied from 2.0 to 6.0.

**REFERENCES:**

[1] Effectiveness of a drinking-water treatment sludge in removing different phosphorus species from aqueous solution by M. Razali, Y.Q. Zhao∗ , M. Bruen
[2] Reuse of alum sludge for phosphorus removal from municipal wastewater by Nida Maqbool, Zahiruddin Khan & Aisha Asghar;
[3] Dewatered alum sludge; A potential adsorbent for phosphate removal. By Y. Yang, D, Tomlinson, S. Kennedy and Y. Q. Zhao.
[4] Extending the use of dewatered alum sludge as a P-trapping material in effluent purification: Study on two separate water treatment sludges by Y. Q. ZHAO1 and Y. YANG1;
[5] Adsorptive Removal of Phosphorous from Wastewater Using Drinking Water Treatment-Alum Sludge
[6] (DWT-AS) as Low Cost Adsorbent by N. Nawar1, *, M. E. Ahmad2, W. M. El Said2, S. M. N. Moalla;
[7] Influence of aging on the structure and phosphate adsorption capacity of dewatered alum sludge by Y. Yang,
[8] Y.Q. Zhao, P. Kearney
[9] Two strategies for phosphorus removal from reject water of municipal waste water treatment plant using alum sludge by Y. Yang, Y. Q. Zhao, A. O. Babatunde and P. Kearney;
[10] Phosphorus adsorption and oven dried alum residual solids in fixed bed column experiments by M.M. Mortula and G.A. Gagnon;
[11] Phosphorus Removal from Wastewater Using Oven-Dried Alum Sludge by Wadood T.Mohammed and Sarmad A. Rashid;
[12] Characterization of Alum Sludge for Reuse and Disposal by Hanim Awab1, P.T. Thanalechumi Paramalinggam1 and Abdull Rahim Mohd Yusoff;
[13] Phosphorus adsorption characteristics of alum sludge: Adsorption capacity and the forms of phosphorus retained in alum sludge by Qingjie Hou, Panpan Meng, Haiyan Pei, Wenrong Hu, Yang Chen;
[14] Equilibrium and kinetic analysis of phosphorus adsorption from aqueous solution using waste alum sludge by A.O. Babatunde, Y.Q. Zhao;
[15] Nitrate and Phosphate contamination in water and possible remedial measures by Asha Lata Singh;
[16] Phosphates from detergents and eutrophication of surface water ecosystem in India by S. Kundu, M. Vassanda Coumar, S. Rajendiran, Ajay and A. Subba Rao;
[17] A review on alum sludge reuse with special reference to agricultural applications and future challenges by
[18] K.B. Dassanayake, G.Y. Jayasinghe, A. Surapaneni, C. Hetherington.
[19] Characterization of Water Treatment Plant's Sludge and its Safe Disposal Options by T. Ahmad*, K. Ahmad, M. Alam.
[20] Constructive Approaches Toward Water Treatment Works Sludge Management: An International Review of Beneficial Reuses by A. O. Babatunde & Y. Q. Zhao.
[21] Soluble Phosphorus Removal Through Adsorption on Spent Alum Sludge by D. A. Georgantas , V. M. Matsis & H. P. Grigoropoulou.
[22] Comparison of different phosphate species adsorption by ferric and alum water treatment residuals by Sijia Gao, Changhui Wang, Yuansheng Pei.
[23] Re-use of water treatment works sludge to enhance particulate pollutant removal from sewage by Xiao-Hong Guan, Guang-Hao Chen , Chii Shang.

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