



Production of Titania Nano-particles from Waste-Sludge

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Abstract

Disposal of a large amount of waste-sludge is considered as the most costly and environmentally challenge in Water Treatment Plants. In the Kingdom of Saudi Arabia (KSA), huge amounts of waste-sludge are produced. The production in Riyadh City in 2013 was estimated as 200 dry Tons/day (1, 2). All Water Treatment Plants used conventional flocculants or synthetic polymers and disposed the waste-sludge by landfilling which is environmentally dangerous. To resolve this problem, this research aims to use a novel technique of Titanium (Ti)-salt flocculation instead of the used polymer in Majmaah City Water Treatment Plant to reduce the volume of the produced waste-sludge through producing Titania (TiO_2). Results indicated that Ti-salt flocculation was performed better than the polymer and the production of TiO_2 reduced waste-sludge volume up to 75%.

Introduction

Flocculation is the main process applied in Water Treatment Plants to minimise the water pollutants and suspended particles. However, the production of a large amount of waste-sludge is considered as one of the most costly and environmentally problematic challenges which needs urgent solution using conventional coagulants of Al-, Fe- salts or polymers (3). Recently, Ti-salts as alternative coagulants were used in Water Treatment Plants. While, the flocculated sludge of metal-salts of Al, Fe and polymers is dumped or landfilled, the sludge obtained after Ti-salt flocculation is utilized to produce a useful by-product (4). Therefore, this research not only would solve the problem of waste-sludge, but also would produce a useful by-product that has numerous environmental and industrial applications in Majmaah City and also in the KSA.

Objectives

The main objective of this research is to solve the accumulated waste-sludge problem from Water Treatment Plants by:

- Applying Ti-salt coagulation in Majmaah Water Treatment Plant instead of the already used synthetic polymer.
- Utilizing from the waste-sludge produced by preparing a valuable by-product of Titania nanoparticles
- Later on, try to use of Titania from sludge in environmental and industrial applications, as Titania production would be expected to be generated in large amounts.

Methods and Materials

Wastewater Flocculation

The groundwater samples were collected from Majmaah Water Treatment Plant. The flocculation of groundwater was carried out using Conventional Jar Tester with known amount of Ti-salt and groundwater.

Sludge-Waste Recovery to Titania

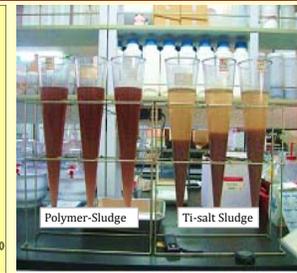
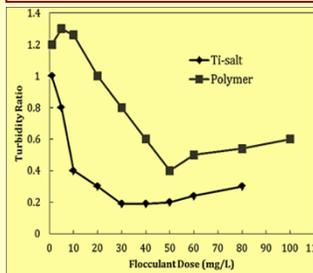
The collected sludge from Ti-salt flocculation was dewatered using filter papers to reduce water content and then oven-dried. The dried sludge was grinded and placed in a furnace at 600°C for 12 h. Titania produced from sludge was washed with diluted acid, centrifuged and finally oven-dried to have Titania nanoparticles.

Enhancement the Properties of Treated Groundwater

The properties of raw and treated groundwater using synthetic polymer flocculation and Ti-salt flocculation were measured and compared in terms of pH, turbidity, color, salts concentrations, iron, phosphorous and alkalinity.

Results

- Ti-salt flocculation was very effective in removing turbidity and alkalinity compared with the synthetic polymer in Majmaah Water Treatment Plant.
- Turbidity matter removal and alkalinity reached up to 85% compared with the synthetic polymer.
- Ti-salt achieved high iron and orthophosphate removal reached up to 90% compared with the synthetic polymer.
- Titania nanopowders were produced from incineration of waste-sludge of Ti-salt flocculation.
- The waste-sludge of Ti-salt flocculation was incinerated and Titania nanoparticles were obtained, while waste-sludge from polymer flocculation was disposed by landfilling.
- The reduction in waste-sludge volume and mass was reduced up to 75% using Ti-salt flocculation.
- The settling of Ti-sludge was faster than polymer-sludge, therefore, the flocculation time was less for Ti-salt flocculation.



Conclusions

- Ti-salt flocculant exhibited more reduction in turbidity and color of groundwater compared with the synthetic polymer flocculation.
- Groundwater properties were improved and more suspended and dissolved particles were removed using Ti-salt flocculant instead of the synthetic polymer.
- Therefore, the use of Ti-salt reduced the labor-work, filter-workability and labor-time before sand filtration and microfiltration processes.
- The use of Ti-salt instead of all other flocculants and polymers has an advantage of sludge-reuse to Titania nanoparticles.

References

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