



# 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

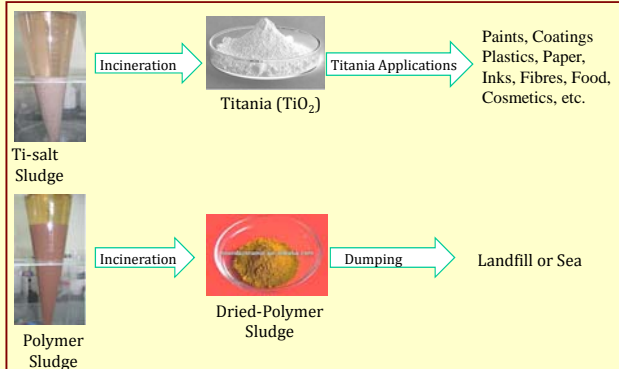
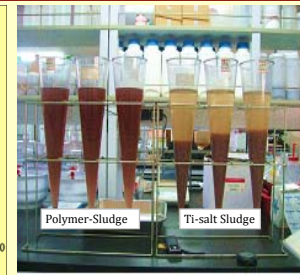
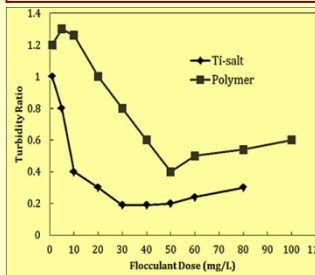
The collected sludge from Ti-salt flocculation was dewatered using filter papers to reduce water content and then oven-dried. The dried sludge was grinded and placed in a furnace at 600°C for 12 h. Titania produced from sludge was washed with diluted acid, centrifuged and finally oven-dried to have Titania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