



**Pharos University in Alexandria**

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**Faculty of Engineering**

**Department of Petrochemical Engineering**

**Using Eco-Friendly Nano-Polymers in Industrial Water Treatment**

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**In**

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*Submitted by*

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## Summary

The major target of this research is to synthesize an eco-friendly coagulant, based on a biomaterial (potato starch) that contribute in industrial water treatment. From this work an eco-friendly nano-polymer was produced from potato starch. Successfully not only the potatoes were used, but also the potato peel, which has an economic impact on reducing the amount of water wasted in planting such an important crop as the potatoes all over the world. Because of increasing the need for food production and changing the dietary pattern, the development of potato industry has become the first among all food crops in most of the countries. As a result potato starch became the most popular type among the polysaccharides. To achieve this, the experimental work started by extracting the starch from the potato and potato waste (peels). In order to enhance the potato starch characteristics, the synthesis of starch nano-particles (StNPs) was conducted by gelatinization using a mixture of sodium hydroxide along with glycerol in aqueous medium throughout the reaction process, while settling down the StNPs which was done by homogenization at ambient temperature. Characterization was done on both native potato starch and starch nano-particles using Scanning Electron Microscope (SEM), Fourier Transform Infrared Spectroscopy (FTIR), X-Ray Diffraction (XRD) and Energy Dispersive X-ray Spectroscopy (EDX). The process of adsorption is a common procedure, applied to disconnect and clarify flowing liquid currents. Several adsorbents (Industrial starch- Prepared Native Starch – Poly DADMAC and Nano-Starch) that have different characteristics and expenses, were investigated through the experiments to evaluate the disposal ability of them targeting the suspended solids through raw water (Synthetic and Real). Thus, the classification of adsorbent, size and amount of suspended solids and overall the experimental conditions, it all affects the cost of adsorption, which is counting instantly on the adsorption contact time and the cost of the adsorbent resources. Thus, it is important to lower the quantity of adsorbent and the contact time required. This research attempts to review several experiments to reduce these two variables, theoretical adsorption kinetics and isotherms can be employed. The theoretical approaches and the associated calculation methods are employed during the optimization of adsorbent quantity and contact duration. To support these theoretical calculations, a comprehensive review of the commonly used theoretical adsorption isotherms, which model experimental equilibrium data, can aid in optimizing the adsorbent mass effectively. The second part of the experimental work is to test the eco-friendly starch nano-particles (starch-based coagulants) in industrial water treatment, and to evaluate its effectiveness as a coagulant-aid

against the most commonly used synthetic polymer (PolyDADMAC) playing the same roll in industry and whether it can really replace it or not. A comprehensive cost analysis was conducted to compare the performance and economic feasibility of the eco-friendly starch nanoparticles (StNPs) against the conventional synthetic coagulant aid, PolyDADMAC, in industrial water treatment. The analysis considered multiple parameters including raw material cost, dosage required, contact time, and overall treatment efficiency. Results revealed that starch nanoparticles, synthesized from both potatoes and agricultural waste (peels), significantly reduce treatment costs due to their lower required dosage and shorter adsorption contact time, while maintaining or surpassing the coagulation performance of PolyDADMAC. Furthermore, PolyDADMAC, a petroleum-derived polymer, poses environmental risks due to its non-biodegradability and potential toxicity, leading to long-term ecological accumulation. In contrast, starch nanoparticles are biodegradable, renewable, and non-toxic, providing a sustainable and safer alternative. This replacement supports several United Nations Sustainable Development Goals (SDGs)—particularly SDG 6 (Clean Water and Sanitation) by promoting access to safer water treatment methods, SDG 9 (Industry, Innovation and Infrastructure) through the development of green technologies, and SDG 12 (Responsible Consumption and Production) by transforming food industry waste into valuable materials. Therefore, adopting starch nanoparticles as a coagulant aid not only enhances cost-effectiveness but also drives progress toward a more sustainable and circular water treatment process.