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Short Communication

Cobalt Removal from Petrochemical Wastewater with Metal Oxide Nanoparticles Coupled with Electrocoagulation

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DESCRIPTION

The lack of water has forced researchers to apply wastewater for use in industry, agriculture, and green space irrigation [1-5]. Due to the expansion of the petrochemical industry, the discharge of heavy metals such as cobalt and manganese through petrochemical effluents into the waters has been observed abundantly [6].

Cobalt is one of the heavy metals that can enter the environment *via* refinery wastewater and endangers human health. Side effects caused by cobalt for humans include diarrhea, abdominal pain, severe vomiting, broken bones, sterility and infertility, damage to the central nervous system, damage to the immune system, mental abnormalities, and possible DNA damage or cancer [7,8]. The inefficiency of conventional wastewater treatment methods and the superiority of electrocoagulation compared to conventional chemical coagulation led us to a combined process of using nanoparticles and coupled with the electrocoagulation process. Electrocoagulation has particular advantages, such as a lower amount of coagulant ions required, a higher degree of removal of pollutants, no need to add chemicals, as a result, no secondary pollution, and a reduction in the amount of sludge produced, short-term. The reaction time and the small size of the reactor are environmentally friendly and economical [9].

In this process, aluminum and iron electrodes lead to the production of electric ions that neutralize and condense the colloidal particles in the wastewater produced by multiple collisions with different ions. And finally, they settle down. In this method, coagulant materials are produced on-site and no chemical coagulant is needed.

METHODOLOGY

In this work by designing a glass container in the shape of a rectangular cube with a volume of one liter and dimensions of 17 × 15 × 15 cm^2 and also using four aluminum metal plates with dimensions of 13 × 15 × 1.2 cm^3 and an effective surface of 175 cm^2 considering the distance between the electrodes in all experiments were 3 cm long. It should be noted that a direct current source (MICRO-Iran) was used to generate direct current.

Next, 3 metal oxide nanoparticles of copper, iron and zinc were synthesized and their Scanning Electron Microscope (SEM) analysis was done [10]. Then, three metal oxide nanoparticles of copper, iron and zinc were synthesized, and their SEM analysis was done.

RESULTS

With Minitab 17.2.0 software, 32 experiments were evaluated to perform the process with each of the nanoparticles. The effect of each parameter including pH, initial concentration of cobalt, nanoparticle concentration and time was examined. The optimal conditions were obtained according to the Table 1.

Removal percentage	Removal percentage model	Potential difference	pH	Time	Concentration	Dose of nanoparticles
52 ± 2.6	50.8 ± 2.5	30.5 ± 1.52	7.5 ± 0.3	60 ± 3	10.1 ± 0.5	0.02 ± 0.001 ppm

Table1: Optimum conditions in terms of cobalt removal.

CONCLUSION

The experiments conducted to test the efficiency of separating cobalt from refinery effluent showed that a potential difference of 30 minutes and a time of 60 minutes yielded the best efficiency, which was 52%. As a result, further tests were conducted under similar conditions. Copper, iron oxide, and zinc nanoparticles were used in subsequent experiments, and it

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was realized that each of these particles was capable of reducing the amount of cobalt by 73%, 87%, and 61%, respectively. Iron oxide nanoparticles proved to be the most effective at removing cobalt from wastewater. Therefore, adding nanoparticles to the sample increases the efficiency of the electrochemical reaction, making it a cost-effective alternative to other methods of treatment.

INTERPRETATION

This method requires no coagulant materials, takes minimal time, and can reduce the financial burden by up to 60%. On a large scale, it can be compared favorably to other treatment methods for petrochemical wastewater.

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