International Symposium on
Setting their Table: Women and the Periodic Table of Elements
Feb. 11-12, 2019 - Murcia (Spain)

United Nations Educational, Scientific and Cultural Organization
2019 IYPT International Year of the Periodic Table of Chemical Elements

Nickel effect on the microbial activity of a WWTP´s biological reactor

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Topic: The elements and the Periodic Table for sustainable chemistry

Abstract:

Nickel is present in several industrial effluents which can arrive to wastewater treatment plants, usually causing negative effects to the efficiency of the biological process.

The objective of this study is to evaluate the nickel effect on the activity of heterotrophic and autotrophic bacteria present in the activated sludge of a wastewater treatment plant (WWTP) using respirometric techniques[1,2].

The experiments were performed in a laboratory respirometer, BMT model from SURCIS, S.L. Operation is based on a closed batch circuit in which the oxygen measurements of activated sludge and combined samples are continuously monitored in a unique, optimally designed reactor vessel. Before testing in the respirometer, the sludge was aerated during 24 hours until endogenous conditions were reached. Volatile suspended solids (VSS) concentration of activated sludge was 4 $g \cdot L^{-1}$

From tests performed in static mode, total and endogenous OUR (oxygen uptake rate) were measured for different concentrations of nickel. The effect on the heterotrophic bacteria activity was determined by comparison with a reference level that corresponds to the oxygen uptake rate obtained with a solution of sodium acetate. A series of tests were carried out, by adding samples with the same concentration of sodium acetate and different concentrations of nickel (from 0.5 $mg \cdot L^{-1}$ to 120 $mg \cdot L^{-1}$). In the assays performed to determine the effect of nickel on the activity of autotrophic bacteria, ammonium chloride was used instead of sodium acetate.

The results shown that, when nickel was added, an inhibitory effect was observed. The inhibition percentage increased with nickel concentration. For the highest concentration studied (120 $mg \cdot L^{-1}$), 55.3% and 54.56% inhibition was achieved for heterotrophic and autotrophic bacteria respectively.

Toxicity of nickel was evaluated by progressive increase in the metal concentration in a test carried out in dynamic mode. Acetate solution was added to activated sludge in order to create a maximum respiration rate and set the reference level. Once this level was reached, doses of nickel were added in order to progressively increase nickel concentration in the reactor. In case of toxicity the respiration rates decrease progressively. 100 % inhibition was reached when nickel concentration was 170 $mg \cdot L^{-1}$. This test supplies information about the maximum quantity of heavy metal that activated sludge can bear. Nickel concentration found to cause 100 % activated sludge inhibition was much higher than that established by municipal legislation about industrial discharge to sewage system.

References

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