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University of Bahrain
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AI VS STATISTICAL MODELING AND OPTIMIZATION FOR NICKEL RECOVERY FROM WASTE ORTHODONTIC (DENTAL) BRACKETS USING GENETIC ALGORITHM

Abstract

The increased use of nickel in industrial applications and batteries has increased both nickel demand and supply. In this project, the optimization of Ni leaching from orthodontic implants with a binary solution of nitric acid (HNO3) using response surface methodology (RSM), artificial neural network (ANN) using genetic algorithm (GA)

Objective and Motivation

Orthodontic brackets contain 18–20 % metallic Ni, which is higher than natural resources, and is therefore a potential waste material for recycling and recovering nickel. These wastes could harm the environment and human health if they contaminate soil, water, and air. In this regard, optimization using RSM and ANN-GA has shown to be a successful alternative with broad applicability in simulating natural issues. Thus, we believe our project will contribute to a durable and sustainable economy and society.

Design and Implementation

Two statical approaches were employed to increase the nickel recovery rate from waste orthodontic brackets. The first is a Design Of Experiment (DOE) using surface response methodology (RSM) based on Central Composite Design (CCD) and the second is a modeling feedforward artificial neural network (FANN) constructing from one input layer, one hidden layer and output layer with genetic algorithm to evaluate and optimize the effect of temperature, time, rotational speed, and S-L ratio on total Nickel (Ni) recovery from waste orthodontic brackets.

Results

A total of 31 experiments were prepared and carried out in order to optimize Ni recovery utilizing surface response methodology (RSM) and a feedforward artificial neural network (FANN). Temperature and S-L ratio have the largest influence on improving the Nickel recover rate, since increasing these parameter increases the Nickel recover rate. The optimal values for best Ni recovery using RSM were found to be 90 (℃), 180 (min), 40 (rpm), and 51.21 ($g\ L^{-1}$) while using FANN the optimal values were 89.99 (℃), 26.25 (min), 44.38 (rpm), and 70 ($g\ L^{-1}$)

Conclusion

Feedforward artificial neural network (FANN) employing genetic algorithm outperforms response methodology (RSM) in terms of nickel recovery rate, reaching 96.4 % using FANN and 94.1 % using RSM.

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