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Evaluation of a Dynamic Leaching Technique and Factorial Desing to Optimize the Recovery of Leached Uranium Ore Waste from Lagoa Real - BA

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1. Introduction

Leaching is a hydrometallurgical process that represents a fundamental step in the ore processing route, where the solubilization of the metals present in the ore or residue occurs by selective dissolution of a mineral or minerals. In order to obtain better results from the leaching process, kinetic and system thermodynamics analysis are recommended to determine favorable parameters according to experimental conditions [1].

The exploration of uranium in Brazil is carried out exclusively by Industrias Nucleares do Brasil S.A. – INB. The Uraniferous Province of Lagoa Real is the only active deposit in the country. The ore used in this work comes from Mina da Cachoeira (anomaly 13), which is currently out of operation, but has several tons of waste produced in the heap leaching process with sulfuric acid [2, 3]. This is a static process in which the ore is crushed, placed in heaps and irrigated with a sulfuric acid solution to leach the uranium. This technique has a relatively low implantation cost compared to dynamic leaching, but, on the other hand, the extraction yield of the contained uranium is lower than other techniques [4].

The recovery of uranium after the leaching process is around 75%, leaving uranium contents in the leached residue of up to 700 μg/g U_3O_8 for ores with an initial content of around 2,700 μg/g [5]. To recover the uranium present in the waste, dynamic leaching tests were carried out at the Nuclear Technology Development Center – CDTN, based on a factorial design to optimize the experiments and analyze the most significant variables for a more efficient leaching.

2. Methodology

The characterization using fission delayed neutrons in a 40g sample of leached ore residue from Lagoa Real showed the presence of 0.06% uranium oxide in the sample.

To organize the experiments, a 2^3 factorial design was carried out to analyze the significance of the variables temperature, particle size and time, and their interactions. The experiments were performed in duplicate with four central points as shown in table 1.

Table I: Factorial design table 2^3.

Test	Temperature (ºC)	Particle size (µm)	Time (h)
1	30	105	1
2	80	105	1
3	30	590	1
4	80	590	1
5	30	105	5
6	80	105	5
7	30	590	5
8	80	590	5
9	30	105	1
10	80	105	1
11	30	590	1
12	80	590	1
13	30	105	5
14	80	105	5
15	30	590	5
16	80	590	5
17	55	210	3
18	55	210	3
19	55	210	3
20	55	210	3

All leaching experiments were carried out in tall 250 ml beakers under mechanical agitation at 450 rpm and temperature controlled by a water bath. The separation of the solid and liquid phases was done by vacuum filtration using Büchner funnel and Kitasato flask. The ore was weighted and added to the beaker with water to form a pulp, and then the sulfuric acid (H_2SO_4) and the oxidant agent (sodium chlorate - $NaClO_3$) were added. During de process, the electromotive force of oxidation was controlled. After leaching, the pulp was filtered and the residue was dried, weighed and sent for analysis. The uranium recovery was obtained by analysis the leaching residue by the delayed neutrons technique. The results of this work were statistically treated using the Minitab software, version 17, for a 95% statistical confidence interval.

3. Results and Discussion

All analyzed variables showed a significant influence in the uranium leaching process, with particle size and temperature and thei interactions being the most relevant. A smaller particle size and higher temperature contributes to the leaching process happening faster and achieving higher results. Their interactions between temperature/time and among temperature/particle size/time were not significant. Figure 1 shows the results for analysis of variables of uranium recovery through a pareto chart.

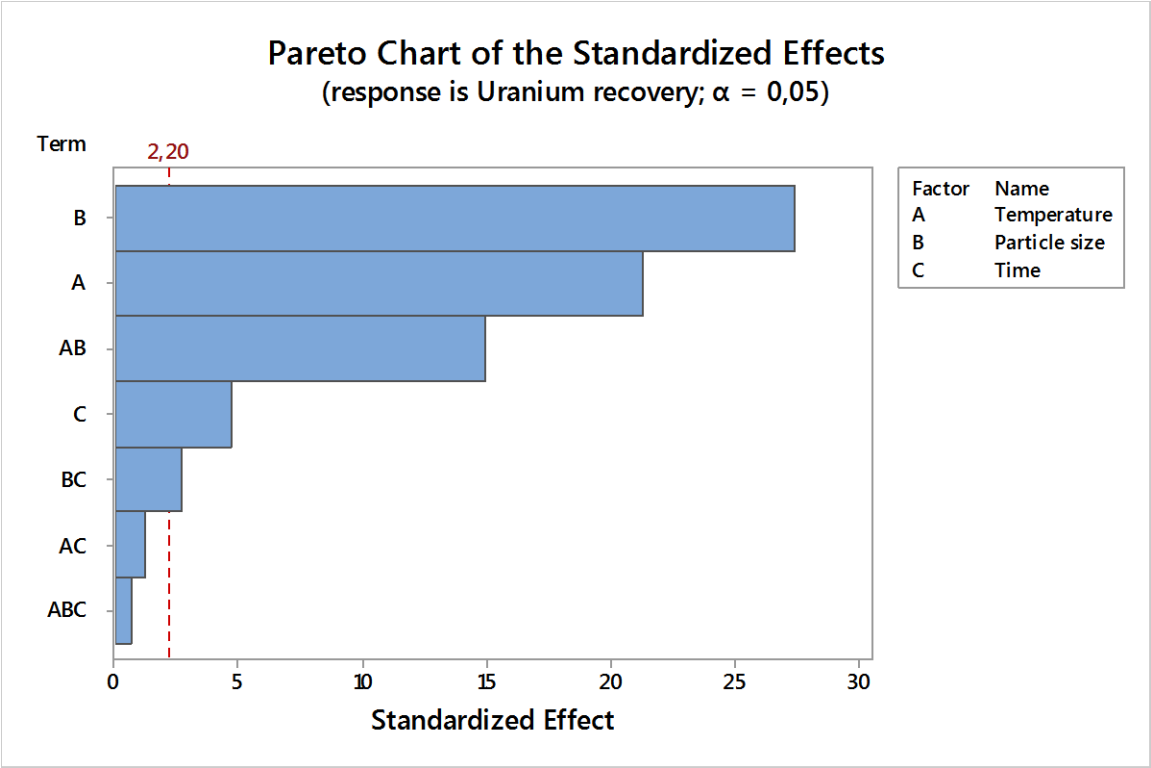

Figure 1: Pareto chart for analyze variables most important by uranium leaching

4. Conclusions

The recovery of leached uranium ore waste from Lagoa Real is economically and environmentally viable, the dynamic leaching studies carried out in this work showed a recovery of uranium around 90%. The best results for a shorter reaction time were obtained with a smaller particle size and higher temperature.

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