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LEACHING TESTS APPLIED TO INDUSTRIAL WASTES

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Introduction

Leaching of pollutants from contaminated industrial soils is a critical environmental issue worldwide, with significant negative impacts on the economy, society, and daily life. Waste is defined as material produced during a technological or domestic process that can no longer be directly used in the production of the original product.
Leaching tests are chemical extraction methods used to assess the concentration of metals in solid waste, aiming to identify and quantify potentially toxic elements that may be released into the environment due to improper waste storage. Analysis of the resulting leachate helps determine whether metal concentrations exceed the thresholds set by current regulations. If regulatory limits are exceeded, additional waste management measures must be implemented.
The results of the leaching tests enabled the classification of the analyzed waste into three distinct categories—inert, non-hazardous, and hazardous—based on the concentrations of specific metals. This classification is critical for implementing an appropriate waste management strategy.
This experimental study focused on a comprehensive analysis of various waste matrices—including soil mixed with coal, coke, petroleum coke, ash, and contaminated industrial soil—as well as sludge, to evaluate the leaching behavior of specific toxic metals. The objective was to compare the measured leaching values against relevant legislative standards. Additionally, the study aimed to generate a well-documented assessment of how metal leaching varies with different liquid-to-solid (L/S) volume-to-mass ratios.

Materials and methods

Leaching tests were conducted on each type of waste using two different reports: 1:2 (g/L) and 1:10 (g/L) based on mass-to-volume proportions. Prior to testing, the waste samples were sieved using a 4 mm mesh to remove larger particles. A measured amount of the sieved solid material was then mixed with ultrapure water to achieve the specified ratio. The mixtures were agitated on a shaker at 100 rpm for 24 hours to ensure proper interaction. After agitation, the solutions were filtered and analysed using an ICP-EOS AVIO 500 Spectrometer in order to determine the concentrations of leached metals (As, Ba, Cd, Co, Cr, Cu, Mo, Ni, Pb, Se, Sb and Zn).

Results and conclusions

For ash, soil mixed with coal, and industrial soil wastes, metal concentrations measured in the 1:10 (g/L) leaching tests were higher than those obtained in the 1:2

(g/L) tests. In contrast, for coke-type wastes, concentrations of Mo and Zn were lower in the 1:10 tests compared to the 1:2 tests, whereas Cu and Ba showed higher concentrations in the 1:10 leaching tests. For petroleum coke waste, Cu, Zn, and Ba concentrations were greater in the 1:10 tests, while Mo concentrations were higher in the 1:2 tests.

These variations between the 1:10 and 1:2 leaching results can be attributed to several factors, including the leaching ratio itself, differences in the metal sorption capacity of the waste, and chemical reactions occurring during leaching. Generally, a lower ratio (1:2) provides less water for dilution, often resulting in higher metal concentrations in the solution. On the contrary, a higher ratio (1:10) potentially could produce lower concentrations in some cases. However, when results are expressed as mg/kg of solid, the lower volume used in the 1:2 tests can lead to lower calculated values compared to the 1:10 tests, despite higher metal concentrations in the leachate.

Effective waste management plays a vital role in safeguarding both environmental and public health. Accurate identification of waste categories through leaching test data provides essential guidance for authorities and waste operators in adopting suitable measures for environmental protection.

Leachate analysis is a crucial tool in waste characterization, enabling the evaluation of environmental risks associated with metals and metalloids, and supporting efforts to mitigate the harmful impacts of toxic waste on the environment.

A comparative analysis of the leaching behavior across different waste types highlights the need for responsible and regulation-compliant waste management. Understanding the mobility and behavior of metals within various waste matrices is fundamental to mitigating environmental risks and promoting a healthier living environment for surrounding communities.