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Use of AI for the Evaluation of the Effects of Steel Corrosion in Mining Environments

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Abstract : Steel is one of the most widely used materials in polymetallic sulfide mining installations. One of the main problems suffered by these facilities is the economic losses due to the corrosion of this material, which is accelerated and aggravated by the contact with acid waters generated in these mines when sulfides come into contact with oxygen and water. This generation of acidic water, in turn, is accelerated by the presence of acidophilic bacteria. In order to gain a more detailed understanding of this corrosion process and the interaction between steel and acidic water, a laboratory experiment was carried out in which carbon steel plates were introduced into four different solutions for 27 days: distilled water (BK), which tried to assimilate the effect produced by rain on this material, an acid solution from a mine with a high Fe_2+/Fe_3+ (PO) content, another acid solution of water from another mine with a high Fe_3+/Fe_2+ (PH) content and, finally, one that reproduced the acid mine water with a high Fe_2+/Fe_3+ content but in which there were no bacteria (ST). Every 24 hours, physicochemical parameters were measured, and water samples were taken to carry out an analysis of the dissolved elements. The results of these measurements were processed using an explainable AI model based on fuzzy logic. It could be seen that, in all cases, there was an increase in pH, as well as in the concentrations of Fe and, in particular, Fe(II), as a consequence of the oxidation of the steel plates. Proportionally, the increase in Fe concentration was higher in PO and ST than in PH because Fe precipitates were produced in the latter. The rise of Fe(II) was proportionally much higher in PH, especially in the first hours of exposure, because it started from a lower initial concentration of this ion. Although to a lesser extent than in PH, the greater increase in Fe(II) also occurred faster in PO than in ST, a consequence of the action of the catalytic bacteria. On the other hand, Cu concentrations decreased throughout the experiment (with the exception of distilled water, which initially had no Cu, as a result of an electrochemical process that generates a precipitation of Cu together with Fe hydroxides. This decrease is lower in PH because the high total acidity keeps it in solution for a longer time. With the application of an artificial intelligence tool, it has been possible to evaluate the effects of steel corrosion in mining environments, corroborating and extending what was obtained by means of classical statistics.

Keywords : carbon steel, corrosion, acid mine drainage, artificial intelligence, fuzzy logic
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