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The importance of Chemistry in Hydrometallurgical processes Youtube channel "Hidrometalurgia UAM-Iztapalapa" – Overview (https://www.youtube.com/@HidrometalurgiaUAM-Iztapalapa)

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Abstract. This overview showcases a series of conferences on Youtube that highlights some of the most important contributions by the Hydrometallurgy group for using thermodynamic information and material balances to propose innovative hydrometallurgical processing routes, as well as to improve existing ones.
Keywords: YouTube; hydrometallurgy videos; thermodynamic equilibrium diagrams; UAM-Iztapalapa.

Resumen. Esta descripción general presenta una serie de conferencias in Youtube que resalta algunos de las más importantes contribuciones realizadas por el grupo de Hidrometalurgia, utilizando información termodinámica y balances de materia para proponer rutas innovativas de procesamiento hidrometalúrgico, así como para mejorar los procesos existentes.
Palabras clave: YouTube; videos sobre hidrometalurgia; diagramas de equilibrio termodinámico; UAM-Iztapalapa.

The Hydrometallurgy field studies the extraction, purification, and recovery of metal compounds into and from aqueous solutions. The origin of these metallic species, or starting materials, may vary from mineral ores to electronic waste. Although Hydrometallurgy has existed since the age of the Alchemists, modern industrialized processes only date back to the end of the 19th century, with the implementation of cyanidation for the extraction of precious metals and of the Bayer process to recover aluminum from bauxite. Since then, many hydrometallurgical processes have been crucial for the advancement of our modern-day society.

The principals involved in Hydrometallurgy are deeply rooted in Chemistry, because the metal species must first dissolve into an aqueous solution, to separate them from the unwanted constituents in the starting material; an operation called leaching or lixiviation. For this to happen, the desired metal ion must be soluble in the aqueous medium, which in most cases, requires the introduction of chemical additives, such as oxidants and reducing, as well as chelating agents. This is achieved by cyanide and oxygen in gold and silver cyanidation. Once dissolved, the solution is usually subjected to a series of purification steps to remove impurities, and the desired metal or metallic entity is recovered by chemical or electrochemical means. This is standard industrial practice.

However, despite the apparent simplicity of these processing routes, the diversity of minerals and other starting materials, has become increasingly broad; decreasing metal content and/or the presence of competing entities for the additives, increase costs and cause downstream purification difficulties. Furthermore, many

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mineral phases are extremely stable compounds, which are not easily transformed to their soluble form; some materials, such as the printed circuit board in our cellphones, contain so many different metals that separation is problematic. Additionally, the vital necessity to conserve natural resources, especially water, and the demand for increasingly ecofriendly processes, are constant challenges for the Hydrometallurgy community.

For this reason, the Hydrometallurgy group of the Universidad Autónoma Metropolitana, Iztapalapa campus, initiated a Youtube channel (https://www.youtube.com/@HidrometalurgiaUAM-Iztapalapa) to demonstrate how aqueous solution chemistry can used to propose creative solutions to process these complex materials. One example of these novel processes is an ambient temperature, closed-circuit hydrometallurgical alternative to recover metallic lead from spent lead-acid batteries, using citrate solutions [1]. This design substitutes the current high-temperature smelting procedure, which is prohibited in many countries. The strategy we employ to determine the appropriate chemical system and locate the conditions of highest solubility is illustrated in Fig. 1.

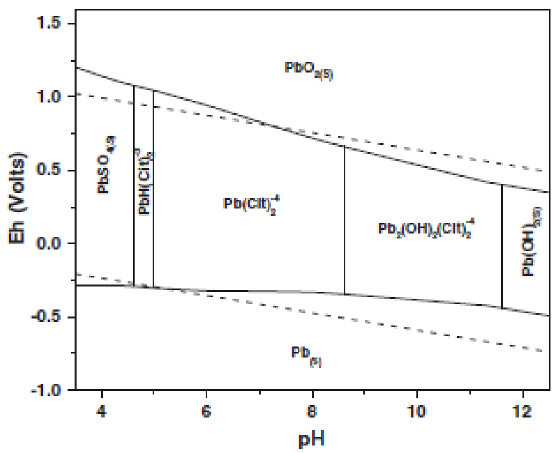

Fig. 1. Diagram of the appropriate chemical system to locate the conditions of greatest solubility.

This type of thermodynamic diagrams, as well as others indicating the solubilities of the desired metal and accompanying impurities under specific conditions, constitute the perfect starting point for the determination of the most advantageous chemical system and solution parameters to begin experimentation for each stage of the process. Once those are confirmed in the laboratory, process design can begin, initiating with global material balances for each component involved, to evaluate the preliminary viability of the proposed processing route.

At this moment, the channel contains the following seven videos, each including many examples of applications:

- "Hidrometalurgia mejorada mediante cálculos termodinámicos" in Spanish
  ("Improved Hydrometallurgy through Thermodynamic Calculations") [1-8].
- "MEDUSA equilibrium diagrams – instrucciones generales" in Spanish
  ("MEDUSA equilibrium diagrams – general instructions").
- "Lixiviación selectiva" in Spanish
  ("Selective Leaching") [7].
- "Minería sustentable – Reciclaje" in Spanish
  ("Sostenible Mining – Recycling") [7, 9-12].
- "Mi cellular dejó de funcionar….¿Y ahora qué?" in Spanish
  ("My cellphone died…Now what?") [7, 9].
- "Minimizing the Hydro in Hydrometallurgy" in English
  ("Minimizando el hidro en hidrometalurgia") [8,11,13-17].
- "Modelado matemático de procesos hidrometalúrgicos: ¿cómo podría impactar en la industria?" in Spanish
  ("Mathematical Modelling of Hydrometallurgical Processes: How can it impact in the industry?"). [18-21]

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These videos present an overview of the methodology employed for several different starting materials and chemical systems and are not limited to any specific case study. References to the collective work of the Hydrometallurgy group may be found in the following journals, under the authorship of G.T. Lapidus: Chemical Engineering Science, Hydrometallurgy, Minerals Engineering, Waste Management, Journal of Applied Electrochemistry, Journal of the Electrochemical Society, Canadian Metallurgical Quarterly, Sustainable Environment Research, Electrochimica Acta, ACS Omega. Revista Mexicana de Ingeniería Química.

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