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Review Article

A Review on Studies and Research on Various Aspects of Leaching

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ABSTRACT

Leaching is one of the major unit operations used in mining sector. Leaching is extraction of the component from solids by using a solvent. The solvent preferably removes certain component. Leaching finds application in recovery of various valuable metals. Microbial leaching is gaining importance for recovery of metals from waste. It also plays important role in agriculture. It is always desirable to avoid the leaching of valuable components of soil through run offs. Various investigators have carried out research on various aspects of leaching. This review paper summarizes studies and research on various aspects of leaching.

Key words: mining, bioleaching, recovery, metals, temperature, concentration.

INTRODUCTION

Leaching is the process of extracting minerals or solute from a solid by dissolving them in a liquid or solvent, either in nature or through an industrial process. Dissolution, desorption or complexation can be the reason for the removal of solute. The leaching process can be carried out in single stage or number of stages. Multistage leaching can be carried out cross currently or counter currently. In cross current leaching the residual solid left after preceding stage is feed for next stage and is fed with fresh solvent. In countercurrent operations the feed and solvent flows are in opposite direction.

The equailibrium stage is one in which the leached solute and solute with leached solids are in equilibrium. Leaching finds major application in mining. Also in food and biological industries, many products are separated from their original natural structure by liquid-solid leaching. The present review provides summery of research carried out on leaching with respect to its effects, application, methodology and modifications.

RESEARCH ON LEACHING

Potter et. al. carried out studies to examine the importance of factors potentially determining net canopy element fluxes, and to quantify canopy exchange and dry deposition rates in a regenerating southern Appalachian forest. [1] They found that net through fall fluxes (through fall minus precipitation transfers) showed consistent canopy effects on rainfall chemistry. They also observed that stem flow fluxes increased canopy exchange rates by more than 20 percent. Mishra and Rhee studied microbiological leaching for metal

recovery from industrial wastes. [2] According to them, microbiological leaching has played a greater role to recover valuable metals from various sulfide minerals or low grade ores. In the era of depleting ores and stricter environmental laws, microbiological leaching process has been shifted for its application to recover valuable metals from the different industrial wastes. They highlighted the advantages of microbial leaching such as low demand for energy, material and less generation of waste by product. The microorganisms from acidophilic group play important role in the leaching for recovery of metals. Ighwela et.al carried out studies on the effects of different levels of maltose on feed pellet water stability and nutrient leaching. [3] According to their studies, the presence of maltose in the diets significantly improved pellet water stability ($p<0.05$). They also observed that increase in maltose increases the stability of pellet. Their results confirmed that there was a great potentials in maltose, which got from barley in fish feed methods for dietary fiber, neutral detergent stability and nutrients retention.

Knudsen et.al. carried out studies in order to estimate leaching losses for organic and conventional farming in Denmark. [4] Their study indicated that N loss was less in organic farms than conventional farm.They also observed that leaching was highest on sandy soils with a high level of soil organic matter. They stressed the importance of using representative data from organic and conventional farming practices in comparative studies of N leaching loss. Strzałkowska et.al. carried out studies on Pb(II) leaching from waste CRT funnel glass in nitric acid solutions. [5] Their paper presented experimental results of Pb (II) leaching from waste CRT funnel glass using solution of nitric acid (V). Bassioni et.al. carried out risk assesment for aluminum foil in food preparation. [6] Their studies indicated that amount of leaching was high in acidic solutions, and even higher with the addition of spices. The obtained values of concentration were not acceptable according to world health organization standards. They warned against used of aluminum foils for cooking specially with acidic food. Matkovic et.al. carried out an investigation aimed at determining optimal parameters of the leaching process for the high-temperature sulphuric acid pressure leaching of nickel silicate ore from the deposit "Rudinci". [7] With respect to nickel leaching and selectivity, they obtained satisfactory results. They observed that addition of $KMnO_4$ during the leaching results in decrease of iron content in the leach solution. It makes further processing of the solution easier.

Lajibola et. al. carried out investigation on recovery of lead and zinc from complex sulphide ore deposit by agitation leaching. [8] They carried out work as prelude to a more systematic study on the considerable body of knowledge in processing this type of ore. They roasted ore with air and leached in three acids HF, HCl and H_2SO_4 using agitation leaching method with variation in leaching time and molar concentration of acids. They observed that both metals have higher values of recovery at lower concentration. Laird et.al. carried out investigation aimed at biochar impact on nutrient leaching from a midwestern agricultural soil. [9] According to these studies application of biochar increases soil quality and decreases leaching of nutrients. They quantified the impact of biochar on leaching of plant nutrients following application of swine manure to a typical midwestern agricultural soil. They suggested that soil–biochar additions could be an effective management option for reducing nutrient leaching in production agriculture. Chezom et.al. compared different leaching procedures. [10] They presented a study on

leaching procedures namely toxicity characteristic leaching procedure, synthetic precipitation leaching procedure, Extraction procedure toxicity test. Also they discussed factors controlling leaching under field conditions such as climate conditions, design of the fill site, vegetation, hydrogeological conditions, ph, redox conditions, solid to liquid ratio for extraction, solubility, solid phase compound, solubility, partitioning, presence of organic carbon, solid to liquid ratio for extraction, non-aqueous phase liquid.

The preliminary research on acid pressure leaching of pyritic copper ore was carried out by Akcil. [11] According to him, the combination of roasting and pressure leaching was an alternative process for copper extraction. He examined copper and iron sulphide minerals in chalcopyrite ($CuFeS_2$) and pyrite (FeS_2).He obtained best result by pre-treatment by roasting followed by acid pressure leaching in an autoclave system. Kalembkiewicz et.al studied the leachability of heavy metals (Cu, Pb and Zn) from the coal fly ash samples. [12] They studied effect of various parameters like the diameter of ash grains, the kind of leaching solutions, and pH of leaching solutions, the volume ratio of leaching solutions to the mass of ash samples, and the leaching time on leachability. They observed that the contents of soluble forms of metals like Cu, Pb and Zn exceeded the standards for waste entering into waters or into the ground. They also found that the presence of organic compounds with a potential complexion of metals has a significant impact on the concentration of Cu, Pb and Zn in soluble forms. Tietema et.al. carried out investigation on Nitrate leaching in coniferous forest ecosystem. [13] They evaluated the effect of ecosystem disturbance on nitrate leaching in coniferous forest ecosystem by using results of two projects (NITREX (nitrogen saturation experiments) and EXMAN (experimental manipulation of forest Ecosystems)). They concluded that the effect of disturbance on nitrate leaching depends on the N status of the ecosystem.

Fan et. al. Investigated the factors affecting the leaching of Nickel and Cobalt from waste superalloys with sulhuric acid. [14] In their work they proposed "atomized spray-sulfuric acid leaching nickel and cobalt" technology. They investigated the effect of various parameters like sulfuric acid concentration, temperature, leaching time, stirring speed and size of superalloys on leaching. The optimum parameters were 4 hrs time, 85 percent sulphuric acid concentration, 85^{o}C temperature. Baba et.al investigated microbial leaching of Iron ore in Sulphuric acid. [15] They carried out research on effect of various parameters such as acid concentration, temperature, particle size and stirring speed on the chemical dissolution of the ore. The temperature and acid concentration were two important factors affecting leaching. They observed that there was increase in the amount of iron-ore dissolved at a particular time with increase in the concentration of H_2SO_4. The average diameter of the particles had inverse relation with rate of leaching. Aylmore and Kookana carried out studies in order to predict and describe the pesticide leaching. [16] According to them, the significance of sorption time-dependency and long-term reversibility of sorption on the mobility of pesticides and the effects of soil environment on the rates of degradation under natural leaching conditions in the field is not completely understood. There is need to define the extent complexity and characterization considering their applicabilty and use in studies and processes. Zhang et.al. investigated ultrasonic enhanced ammonia leaching of tailings. [17] They studied the effect of ultrasonic waves on copper

dissolution. They observed that show that tailings with ultrasonic treatment can leach up to 89.5% of Cu, which is 13.5% more than those without the treatment.

Dew et.al. carried out comparative studies on bioleaching of base metal sulphide concentrates at different temperatures. [18] They observed that thermophiles achieved efficient bioleaching of primary copper sulphide and nickel sulphide concentrates. Higher recovery was obtained compared to mesophile or moderate thermophile culture.

CONCLUSION

Leaching is very important operation in mining industry. Extraction of metals from ore is carried out by using different solvents. Leaching can be sometimes adversely affect the fertility of land as many important minerals may be leached away with water. Contact time, concentration, temperature and particle size are important parameters in leaching. Leaching finds application in biological and food industries for seperation of various products. Lithum and cobalt from spent batteries can be recovered by using organic acids. It can be concluded that leaching is very efficient and simple method to recover valuable componemt from solid waste. It is very important to use appropriate solvent and maintain optimum operating condition for efficient and cost effective recovery of metals or solute.

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