REMOVAL OF ZINC IONS FROM AQUEOUS SOLUTIONS BY SORPTIVE-FLOTATION USING LIMESTONE AS A LOWCOST SORBENT AND OLEIC ACID AS A SURFACTANT

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***Abstract*— Environmental pollution, mainly in the aquatic systems, due to developments in industry, is one of the most significant problems of this century. Many industrial wastewater streams (ca. the metal working, semiconductor, and copper industries, mine water, etc.) contain heavy metals, which are of great environmental concern and must be removed prior to water discharge or water recycling. The present study aims to develop a simple, rapid and economic procedure for Zn^{2+} ions removal under the optimum conditions. It is based on the sorption of Zn^{2+} ions from aqueous solutions onto limestone fines (LS), which is an inexpensive and widespread over the globe, followed by flotation with oleic acid (HOL) surfactant. The different parameters (namely: solution pH, sorbent, surfactant and zinc concentrations, shaking times, ionic strength, temperature and the presence of foreign ions) influencing the sorptive-flotation process were examined. About 100 % of Zn^{2+} ions were removed from aqueous solutions at pH 7 after shaking for 5 min and at room temperature (~25ºC). The procedure was successfully applied to recover almost Zn^{2+} ions spiked to some natural water samples. A mechanism for sorption -flotation is suggested.**

***Keywords*— zinc, sorptive-flotation, limestone, low-cost sorbent, oleic acid**

I. INTRODUCTION

Mobilization of heavy metals in the environment due to industrial activities is of serious concern due to their toxicity for humans and other life organisms. Removal of toxic heavy metals from industrial waste waters is essential to control environmental pollution (Puranike and Pakniker, 1999; Guangy and Thiruvenkatachari, 2003). At least 20 metals are classified as toxic and half of these are emitted into the environment in a quantity that poses risks to human health (Nasir *et al.,* 2007). The ability of water body to support aquatic life as well as its suitability for other uses, however, depends on trace elements.

Zn is used principally for galvanizing iron and more than 50% of metallic zinc goes into galvanizing steel, but is also important in the preparation of certain alloys. It is used for the negative plates in some electric batteries and for roofing and gutters in building constructions. Zinc is the primary metal used in making American pennies and is used in die casting in the automobile industry. Its oxide is used as a white pigment in water colors or paints, and as an activator in the rubber industry. Zinc metal is included in most single tablet and it is believed to possess anti-oxidant properties, which protect against premature aging of the skin and muscles of the body.

Trace concentration of zinc are important for the physiological functions of living tissues and regulate many other biochemical processes. However, just like other heavy metals, when Zn is discharged into natural waters at increased concentration in sewage, industrial waste water or from mining operations it can have severe toxicological effects on humans and aquatic ecosystem (Kortonekamp *et al.,* 1966).

The free zinc ion is a powerful Lewis acid up to the point of being corrosive. Stomach acid contains hydrochloric acid, in which metallic zinc dissolves readily to give corrosive zinc chloride. Hence, it is essential to remove Zn from industrial waste waters before transport and cycling into the natural environment.

Many technologies that could eliminate and/or reduce the presence of heavy metals in industrial effluents have been developed. These include precipitation and co-agulation, cementation, membrane separation, solvent extraction, ion-exchange, adsorption and biosorption (Palterson, 1989; Ghazy *et al.,* 2005). Flotation as a solid/liquid or liquid/liquid (or both) separation process has recently received a considerable interest owing to: simplicity, rapidity, economic, good separation yields (R > 95%) for small impurity concentrations (10^{-6}-10^{-2} mol/L), a large possibility of application for species having different nature and structure, flexibility and friability of equipment and processing for recovery purpose (Stoica *et al.,* 1998; Ghazy *et al.,* 2003). It is believed that this process will be soon incorporated as a clean technology to treat water and wastewater (Rubio *et al.,* 2002). For the aforementioned reasons a combination of adsorption and flotation into unified operation termed sportive-flotation could be considered as a vital process.

In recent years there has been a considerable interest in the development of new products which are abundant in nature, low in cost and have minimal environmental impact for restoration or remediation of natural resources (Gomez