In field arsenic removal from natural water by zero-valent iron assisted by solar radiation

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An in situ arsenic removal method applicable to highly contaminated waters by using zero-valent iron, citrate and solar radiation was developed.

1. Introduction

Throughout history, the quality of water used for human consumption has been a quality of life indicator and a determining factor of human welfare. The presence of arsenic in humanly consumed water has affected more than 100 million persons in the world (Wegelin et al., 2001; Tyrovola et al., 2007; Lin and Liao, 2008). Chronic hydro-arsenicism is an illness that has principally been reported for Asian and Latin American populations (Smedley and Kinniburgh, 2002; Mandal and Suzuki, 2002; Hanjani et al., 2007; Pedrero et al., 2007). Permanent arsenic intake provokes chronic intoxication due to its accumulation in the human organism, and prolonged arsenic exposure damages the central nervous system, liver, skin and results in the appearance of diverse types of cancer, such as hyperkeratosis, lung and skin cancer (Chiu et al., 1995; ATSDR, 1999; NRC, 1999; Hall, 2002; Lee et al., 2007; Valenzuela et al., 2007).

The towns of Camarones, Esquiña and Illapata are located in the Atacama Desert in northern Chile. These populations principally use natural water from the Camarones River for both human consumption and agricultural activities. Camarones River water presents natural arsenic contamination with total arsenic concentrations above 1000 µg L⁻¹ that exists mainly in the form of As (V) (Mansilla et al., 2003; Yáñez et al., 2005). This contamination has chronically affected the rural populations living near the river, generating a variety of health problems. High arsenic concentrations have also been reported in the soil, plants, and animals of the area (Mansilla et al., 2003).

In Chile, arsenic removal from waters used for human consumption principally occurs by large water treatment plants located in larger cities (Smedley and Kinniburgh, 2002; García et al., 2004; Mohan and Pittman, 2007), and arsenic removal technologies are not readily available in rural areas.

Recent studies have developed diverse methodologies to remove arsenic from natural waters (Meng et al., 2002; Ng et al., 2004; Daus et al., 2004; Mondal et al., 2006; Zhang et al., 2007; Guo et al., 2007; Nguyen et al., 2007; Biterna et al., 2007). One is Solar Oxidation Removal of Arsenic (SORAS), a method that has been applied with relative success in natural waters of Bangladesh, where the concentrations range between 100 and 150 µg L⁻¹, removing As (III) in percentages between 50 and 70% (Hug et al., 2001a,b). The SORAS methodology uses Fe (III), naturally present in the treated water, with additions of citrate in presence of solar light to remove arsenic by adsorption with iron oxides. Recently, As (V) has been successfully removed from natural water of the Camarones River (1250 µg L⁻¹)