SOLAR UV RADIATION ASSISTED As(V) REMOVAL (SORAS) FROM GROUND WATERS BY MEANS OF A SEMI-CIRCULAR SECTION TUBULAR PHOTO-REACTORS – $Fe(OH)_3$ FLOCCULES GROWTH KINETICS

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ABSTRACT

Four semi-circular section tubular photo-reactors have been constructed, characterized and applied to the treatment of ground waters contaminated with As(V) by means of solar oxidation and removal of arsenic (SORAS) technique, using a ferrous salt and sodium citrate as basic chemicals. The solar concentrators were built with recyclable waste materials, such as Ne lamp glass tubes and 6" PVC tubes and commercial steel thin plates covered by aluminum foil. The photo-reactors concentrate solar radiation from 2.5 to 10 times its natural intensity.

Simultaneous batch experiments without agitation, carried out in the photo-reactors, showed that the time periods for the growth of $Fe(OH)_3$ floccules up to a size larger than 0.45 □m were 2-3 min, 3-4 min, 4-5 min and 6-8 min for the solar concentrators of 71, 48, 32 y 15 cm in diameter, respectively, under a range of 57-60 Wm^{-2} UVA integral (290-390 nm) incident radiation intensities, showing that removal rate was higher in the case of the large size photo-reactor. In all cases, arsenic removal efficiencies above 80% were accomplished within those time periods.

Batch irradiation experiments followed by controlled agitation (shear rate = 18 -22 s^{-1}; 10 min agitation period) showed that the larger size photo-reactor accelerates the formation of settle-able floccules (particle size, 0.5 – 1.0 mm; Willcomb index, 6-8). Elapsed irradiation times necessary for said formation were: 15, 7.5, 5 and 3 min for photo-reactors having effective UVA radiation intensities of 141, 274, 409 and 569 Wm^{-2}, respectively.

A linear relationship (r = 0.990) between floccule growth rates up to 0.5 mm and effective UVA radiation intensities was found, within the experimental range of conditions. This means that the generation of free radicals, due to the quantity of UVA range photons, is the limiting step for the global $Fe(OH)_3$ floccule formation process.

Comparison of calculated treatment capacities among the photo-reactors, under continuous flow regime (considering hydraulic retention times equal to irradiation times), showed that 71 cm diameter concentrator has the largest capacity, 190 Lm^{-2} for a 5-h operation period under UVA irradiation intensities of 57-60 Wm^{-2}. From the economic point of view, this photo-reactor is more practical than the smaller size reactors, due the smaller quantities of materials and fittings involved.

Keywords: Tubular photo-Reactor, Solar Radiation Assisted Removal of Arsenic (SORAS), Groundwater, Flocculation Kinetics.