195a Biological Sulfide Oxidation under Alkaliphilic Conditions

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Gaseous hydrogen sulfide, $H_2S_{(g)}$ from biogas and malodorous emissions from waste treatment plants, need to be controlled to reduce the impact on the neighboring population. The amount of $H_2S_{(g)}$ transferable to an aqueous solution increases exponentially at higher pH as it is converted to much more soluble species, such as HS^- and $S^=$. To biologically transform $H_2S_{(g)}$ under alkaline conditions (pH>9), extremophile organisms such as the alkaliphilic sulfoxidizing bacteria need to used instead of the more ubiquitous thiobacilli that thrive under mild or extreme acidic conditions. An alkaline sulfooxidant bacterial consortium (ASBC) was obtained from alkaline soils and soda lakes in Mexico. The ASBC used sulfide, polysulfide, thiosulfate, elemental sulfur and tetrathionate as energy sources with oxygen as electron acceptor, and uses carbon dioxide as carbon source. The optimal conditions were pH 10, T= 30°C and sodium content of 0.6 M.

The ASBC was characterized at optimal conditions with sulfide as energy source under continuous chemostat operation with suspended cells. The biokinetic parameters obtained were: maximum specific growth rate around of 0.07 h^{-1}, yield coefficient of 6.02 g_{Prot} (mol HS^-)$^{-1}$, maintenance coefficient of 0.00108 mol HS (g_{Prot})$^{-1}$ h^{-1}, and maximum specific substrate consumption rate of around 17 mmol HS^- g_{Prot}^{-1}. h^{-1}. Through respirometric techniques, the affinity and inhibition constants resulted in 0.074 mM and 1.19 mM respectively. These values are lower than those obtained with the acidophilic thiobacilli.

The aerobic biodegradation of sulfide at alkaline conditions involved significant chemical sulfide oxidation, which was confirmed by the higher sulfide conversion rates, producing intermediaries such as pentasulfide which is itself further transformed to thiosulfate and sulfite. Chemical oxidation resulted in decreased sulfide inhibition for the ASBC and increased oxidation rates. The stoichiometry and kinetics expressions for sulfide oxidation and intermediaries formation were obtained ($-r_{HS^-} = 5\, r_{S_5^{2-}} = 1.294[HS^-]$, $r_{S_2O_3^{2-}} = 0.196\,[S_5^{2-}]$, $r_{SO_3^{2-}} = 0.220\,[S_5^{2-}]$, in mmol L^{-1} h^{-1}), these showed that the pentasulfide formation had a characteristic formation time in the order of minutes, whereas the characteristic biological process time was in the order of hours. In that way, the inclusion of the chemical sulfide oxidation with its intermediaries formation has a beneficial impact, improving the sulfide elimination capacity by reducing the inhibitory effect. This was confirmed with the operation, at optimal conditions, of a laboratory scale continuous reactor which consisted in a vessel with immobilized bacteria and medium recycling that allowed to separate the chemical and the biological oxidations and improve biomass retention time. This system can transform 2.4 g HS^- L^{-1} d^{-1} with 100% of elimination efficiency, feeding 150mM of sulfide at hydraulic retention time of 2 days.