# Microbial Pb(II) precipitation: The role of biosorption as a Pb(II) removal mechanism

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This study investigated the role of biosorption in the precipitation of Pb(II) as PbS and Pb(0) out of solution by an industrially obtained consortium. Previous investigations with this consortium have demonstrated Pb(II) removal from solution taking place in a two-phase (rapid and slow) system. This study focused on confirming whether the initial, rapid phase of removal is caused by the abiotic mechanism of biosorption before precipitation occurs.

The experiments compared the Pb(II) removal rates of dead and living bacteria. Cultures were prepared under anaerobic conditions for 24 hours in batch reactors starting with 20 g/L tryptone, 10 g/L yeast extract, 1.0 g/L NaCl and 0.43 g/L $NaNO_3$. Bacteria purposed for studying abiotic Pb(II) removal through biosorption were suspended in 50 mM of sodium azide ($NaN_3$) solution for 3 hours to successfully inhibit the microbial respiratory chain, thereby preventing bacteria growth and activity. Fourier-transform infrared spectroscopy (FTIR) was used to inspect whether $NaN_3$ deformed the structure of bacteria cell walls and changed material characteristics.

Reactors containing 100 mL of 80 mg/L Pb(II), 20 g/L tryptone, 10 g/L yeast extract, and 1.0 g/L NaCl were spiked with 1 mL of bacteria culture and sampled over a 7 day period. Bulk Pb(II) concentration and metabolic activity were measured.

Results showed similar initial Pb(II) removal rates for both living and dead bacteria, where equilibrium was reached at 50 % removal for dead bacteria after 30 minutes. After for the initial 6 hours, percentage removal from living bacteria gradually increased until equilibrium was reached at 91 % removal following 168 hours. Reactors with living bacteria turned black after 24 hours, indicating the precipitation of PbS and Pb(0), while reactors with dead bacteria did not indicate any signs of precipitate formation. Metabolic activity measurement confirmed that the dead bacteria did not reanimate while FTIR readings showed negligible influence of $NaN_3$ on bacteria surface structure.

These observations confirm that the rapid Pb(II) removal phase is caused by abiotic biosorption. Additionally, these results suggest that biological precipitation becomes the rate limiting step in Pb(II) removal once bacteria cell walls have become saturated with lead ions. This consortium shows promise not only as a means for Pb(II) recovery in the form of precipitate but also as an attractive material to remove Pb(II) ions from wastewater through biosorption.