Mixed-flow bio-reactor for atmospheric CO_2 sequestration

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A mixed-flow steady-state bio-reactor was designed to biomineralize CO_2 with active *Synechococcus* sp.. Dissolved CO_2, was the only source of inorganic carbon. Cyanobacteria maintained alkaline pH conditions. Ca^{2+} activities of 0.16 ± 0.02, 1.71 ± 0.07 and 3.07 ± 0.09 mM, corresponding to ionic strengths of 0.08 ± 0.02, 0.09 ± 0.01 and 0.11 ± 0.01 M, remained constant. Similarly the *Synechococcus* sp. biomass, averaging 204 ± 12, 198 ± 13 and 197 ± 8 mg/L. Stable pH values of 10.75 ± 0.10 and 10.66 ± 0.11 for Ca^{2+} activities of 0.16 ± 0.02 and 1.71 ± 0.07 mM, were stable. For the highest Ca^{2+}, the pH dropped from 10.32 ± 0.17 to 9.54 ± 0.14. The saturation index for the lowest Ca^{2+} activity ranged from 1.13 to 1.92 where no calcite formed. This supports the lack of spontaneous nucleation of calcite. This suggests that active cyanobacteria do not act as calcite nucleation sites. At the highest Ca^{2+}, the saturation index reached a maximum value of 5.03, decreasing to 3.92. Carbonate activities of $1.15 \times 10^{-7} \pm 1.28 \times 10^{-8}$ to $6.37 \times 10^{-8} \pm 2.91 \times 10^{-9}$ moles/cm^3 at the end of the runs. Precipitation rates were calculated from the evolution of $\{CO_3^{2-}\}$, with reaction orders of 2.91 ± 0.17 and 2.79 ± 0.14. This indicates the efficiency of the mixed-flow reactor set-up for CO_2 sequestration.