Biological Production of Sulfuric Acid and Fixation of CO_2 with Sewage

Comparing the Biological Production of Sulfuric Acid in Pure and Mixed Cultures

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Introduction

The synthetic production of sulfuric acid requires burning at high temperatures meaning it has a high environmental impact [1]. Alternatively, biological routes for production exist from different sulfur substrates, with one bacterium, *Acidithiobacillus thiooxidans,* possessing the unique ability to utilise elemental sulfur [1]. This bacterium is also present in the sludge of wastewater treatment plants (WWTP), an industry which relies on sulfuric acid. WWTP produce biogas containing undesired hydrogen sulfide gas, which can be converted to elemental sulfur via catalytic oxidation. This solid sulfur could be used to produce sulfuric acid used in the same WWTP as a circular process. While previous studies focused on pure cultures, this study set out to study the feasibility of a sequential batch system using mixed cultures from sludge.

Methods

Fermentations were carried out on a shaking incubator in shake flasks containing 200 mL of DSMZ-71 medium containing solid sulfur granules. When fermentation was complete a sequential batch system was executed.

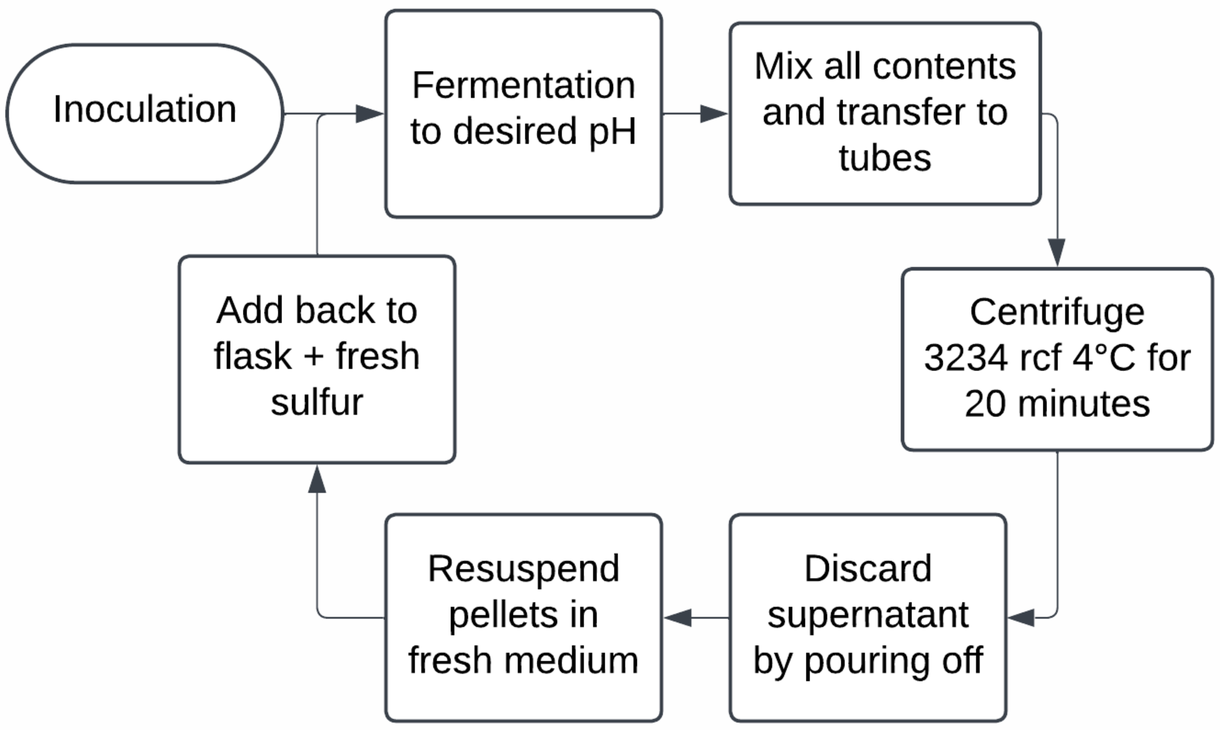

Figure 1. Flow chart: Schematics of the sequential batch system. Fermentation is carried out until stable pH, then sulfur and bacteria are separated from old medium and resuspended in fresh medium with fresh sulfur.

Discussion & Conclusion

As can be seen in the graph, acid concentrations in samples containing only sludge reached similar or higher levels than in samples containing pure cultures, indicating that sulfur oxidation was successful in these samples. The gradual increase of the slope of the secant lines in the graph for subsequent runs shows that the sequential batch method works to increase the efficiency of the system as a whole. With an exception of run 4, where no sulfur was available to be added to the shake flasks causing only the fermentation of the residual sulfur. Large error margins towards the end of the fermentations and large spread of points can be explained by improper calibration of the pH meter for the extremely low pH levels measured.

References

1. Young et al., “Method for the microbiological production of sulfuric acid”. United States of America Patent US 6,610,268 B1, 26 August 2003.

Results

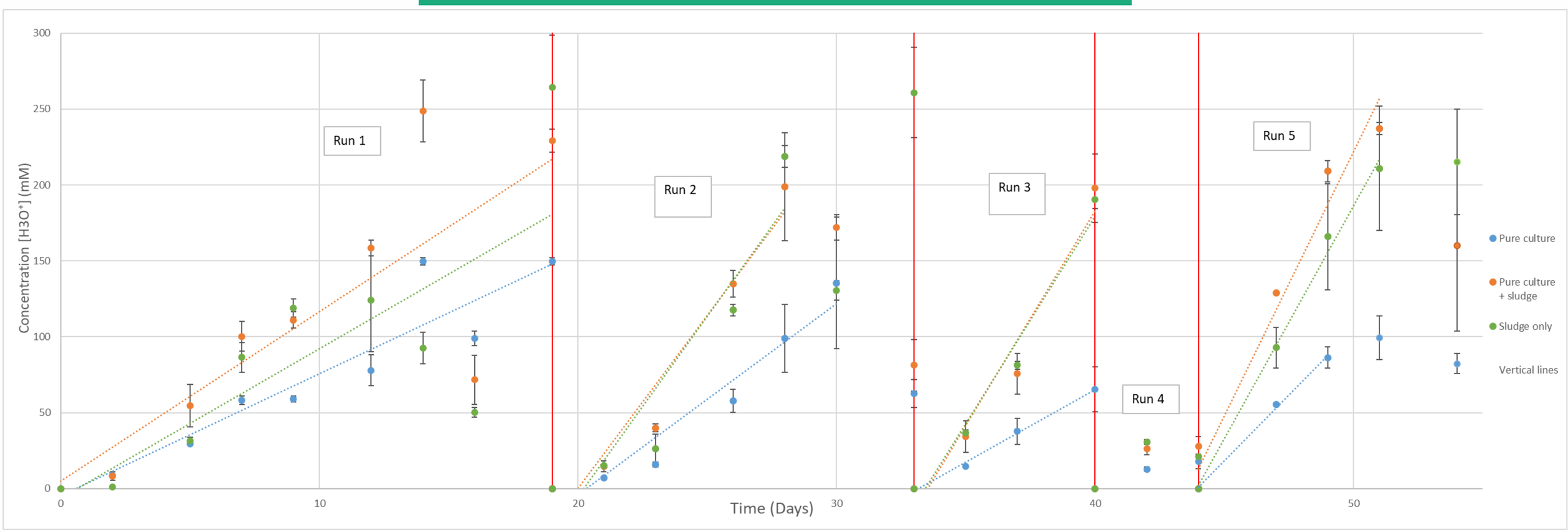

Figure 2. Acid production over time: In the above graph, the concentration acid (mM hydronium) is plotted against time in days for the mean values of pure cultures (blue), pure cultures with sludge (orange) and just sludge (green) for runs 1 through 5. Different runs are separated by vertical red lines. For the part of the graph where active fermentation was occurring, the secant line is shown. Notice the steady increase in the slope on subsequent runs (ex. run 4).