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Biological reduction of biologically formed elemental sulfur to hydrogen sulfide for industrial applications

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Biological reduction of elemental sulfur (S^0) has potential for high-rate production of hydrogen sulfide (H_2S) for application in industrial processes. Producing H_2S from S^0 instead of sulfate has various advantages: it requires 4x less e-donor, it is possible at acidophilic conditions and S^0 is a side product from fuel desulfurization, making for a circular and economic business case. Therefore, it is of interest to study and optimize parameters which influence H_2S production rate. Especially biologically formed S^0 ($bioS^0$) produced during biological desulfurization of gas is expected to be a suitable S^0 source due to the recently shown controllable small particle size (Figure 1 A, C and D) and hydrophilicity in comparison to chemically formed S^0 (Figure 1B). In the current project, batch bottle experiments were used to study the effect of inoculum source and concentration, $bioS^0$ particle size and shape, salinity, and pH on the H_2S production rate. The temperature was 30°C and hydrogen (H_2) was used as an e-donor. $BioS^0$ from three different reactors (one lab scale and two industrial reactors) with volumetric median particle sizes of 4.5, 10 and 14.6 µm was used. The inoculum originated from two industrial anaerobic digestors: one methanogenic reactor and one sulfate reducing reactor. Throughout the experiments H_2S concentration was measured both in the liquid and gas phase. Moreover, headspace composition and pressure were measured frequently to ensure sufficient H_2 and CO_2 as well as to monitor formation of side products. Preliminary results show that the smallest $bioS^0$ particle size led to the highest H_2S production rate, methanogenesis was prevented by using inoculum from the sulfate reducing reactor, and that a high pH was positively correlated with high H_2S production rate due to the expected effect of formed polysulfide as electron acceptor.

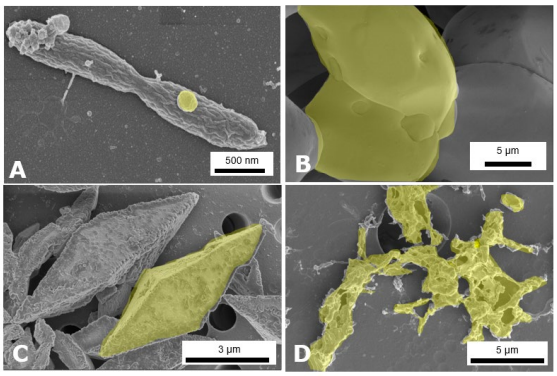

Figure 1. A. Sulfide oxidizing bacterium from biological desulfurization reactor with sulfur globule on cell surface. **B.** Hydrophobic chemically formed sulfur with low specific surface area. **C.** Biosulfur bipyramids **D.** Biosulfur agglomerates. Both **C** and **D** are formed from the globules in A in the bioreactor but under different operations conditions.