Understanding and improving the haloalkaline biodesulfurization process

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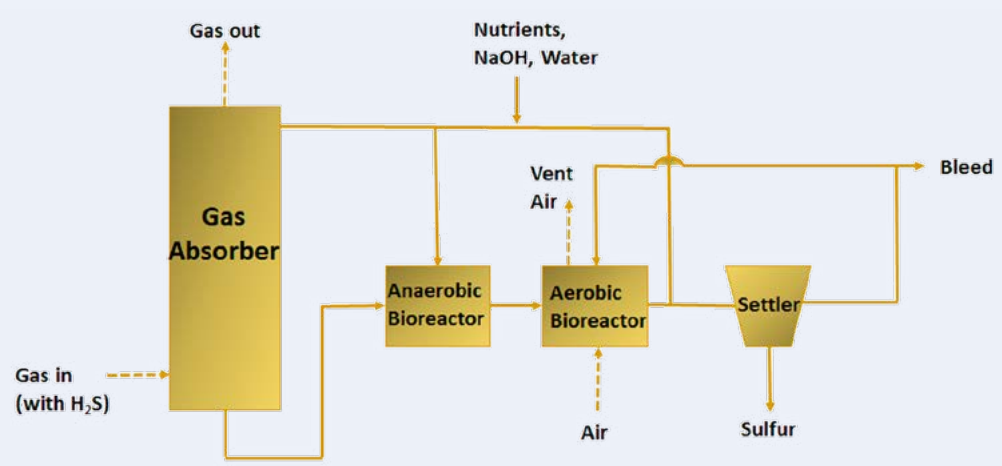
Motivation

Dihydrogen sulfide (H_2S) is a malodorous and highly toxic compound, which can cause asphyxiation. It is a component which is present amongst others in natural gas and biogas streams. Upon combustion of these untreated gas streams in the environment, H_2S is oxidized to sulfur oxides which then become environmental pollutants. One of the economical and ecofriendly methods to remove H_2S from gas streams is the biodesulfurization process. This process make use of haloalkaliphilic sulfur oxidizing bacteria to convert dissolved sulfide to biologically formed elemental sulfur. However, the bio-production of elemental sulfur is often accompanied by the production of undesired acidifying sulfur compounds, such as sulfate (SO_4^{2-}) and thiosulfate ($S_2O_3^{2-}$) [1].

Technological challenge

A recent study has shown formation of 98% sulfur from removed H_2S by addition of an anaerobic reactor in the existing line-up of the biodesulfurization process (Fig 1.) compared to around 90% [1] formation using the traditional process. The microbiological mechanisms behind the enhanced sulfur production are still unknown. Also, little is known about the microbial community involved in the biological H_2S conversions and about their stability after perturbations. Finally, it is needed to obtain insights into the biochemistry of the sulfur oxidation process of these bacteria to know the associated metabolic mechanisms, biochemical pathways and enzyme complexes involved. Hence, an integrated approach combining novel concepts from bioprocess technology with state-of-the-art 'omic' techniques will be used to study the microbial communities. The information obtained will be applied to improve the robustness and reliability of the new line-up in the long run.

Fig 1. New line up for biodesulfurization process



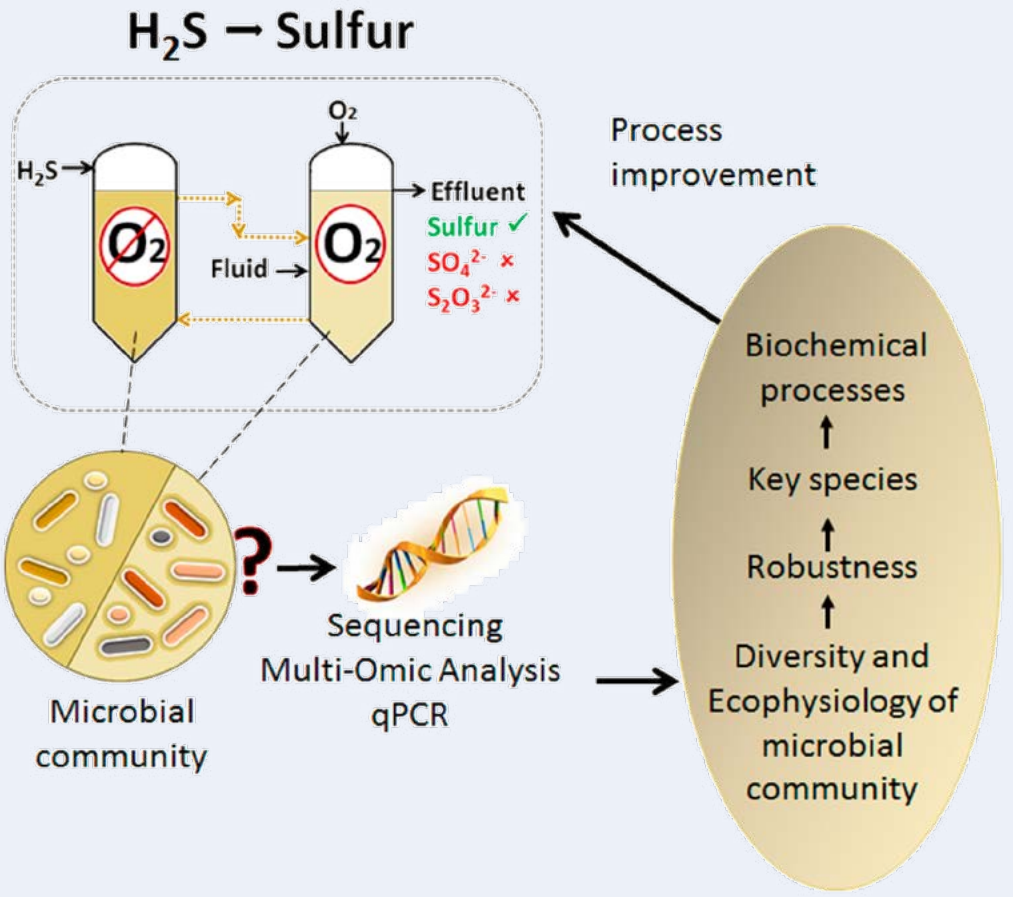


Fig 2. Graphical abstract of the project

Research goals

The main goal of the research is to obtain a comprehensive understanding of the diversity and ecophysiology of haloalkaliphilic sulfur bacteria with the final aim to obtain a robust and reliable biological desulfurization process.

In order to achieve this goal, the study is divided into four interacting tasks:

(i) Acclimation of microbial communities towards optimal sulfide oxidation
(ii) Study of diversity and ecophysiology of the sulfur bacteria
(iii) Study of robustness of the biodesulfurization process
(iv) Physiology and biochemistry of sulfur oxidizers

[1] J.B.M. Klok *et al.*, Pathways of Sulfide Oxidation by Haloalkaliphilic Bacteria in Limited-Oxygen Gas Lift Bioreactors. Environment Science and Technology, 46(14),2012, pp 7581–7586.

This project has received funding from the European Union's Horizon 2020 research and innovation programme under the Marie Skłodowska-Curie grant agreement No 665874