Combined H_2S and CO_2 Removal Processes For Upgrading Biogas

Keren Jenifer Rajavelu[1,2]; Martin Denecke[1]
[1]Department of Urban Waste and Water Management, University of Duisburg Essen, Germany
[2]QUESTOR Centre, Queen's University Belfast, United Kingdom

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Abstract

Biogas produced from anaerobic digestion is a renewable energy resource. Typical biogas composition is 50-60 % methane (CH_4), 30-45 % Carbon dioxide (CO_2), moisture and traces of hydrogen sulphide (H_2S). However, presence of CO_2 and H_2S greatly affects CH_4 content and purity of biogas. In this work, a method using bottom ash for removal of CO_2 and biological Desulphurization of H_2S using sulphur Oxidizing bacteria (SOB) will be studied. The technical feasibility of employing combined removal process will be investigated.

Background and Research Aims

- Development of energy efficient, scalable processes for hydrogen sulphide (H_2S) removal in biogas using naturally occurring bacteria.
- Test the Bioreactor (Bio trickling filter) for optimized bacterial activity.
- Development of energy efficient, scalable processes for carbon dioxide removal in biogas using bottom ash.
- Combination and optimization and interaction of combined process.

Experimental Process and Results

Hydrogen Sulphide removal (Biological oxidation)

The main reaction principle involved:

$$H_2S + ½\ O_2 \longrightarrow S^o + H_2O$$

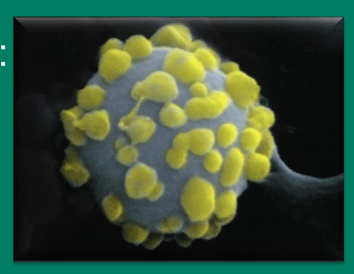

Fig:1 Elemental Sulphur deposition on a *Thiobacilli* bacterial cell

- Various microbiological studies were performed before the start up of the reactor.
- Two different activated sludge SOB 1 and SOB 2 (as shown in graph) were initially inoculated into the thiosulphate and basal medium (for enriching sulphur oxidising bacteria).
- SOB bacteria showing higher efficiency has been selected for further processes for H_2S removal in bio trickling filter.

Carbon dioxide Removal (Carbonation reaction)

The main principle involved:

$$1)\ CO_2 + H_2O \longrightarrow H_2CO_3$$
$$2)\ H_2CO_3 + Ca(OH)_2 \longrightarrow CaCO_3 + 2H_2O$$

- Operating parameters such as CO_2 pressure, ash humidity, temperature L/S ratio will be studied.
- Lab scale reactor will be designed and developed based on resulting carbonation efficiency.

Fig:2 Bottom ash from MSW plant

Process layout

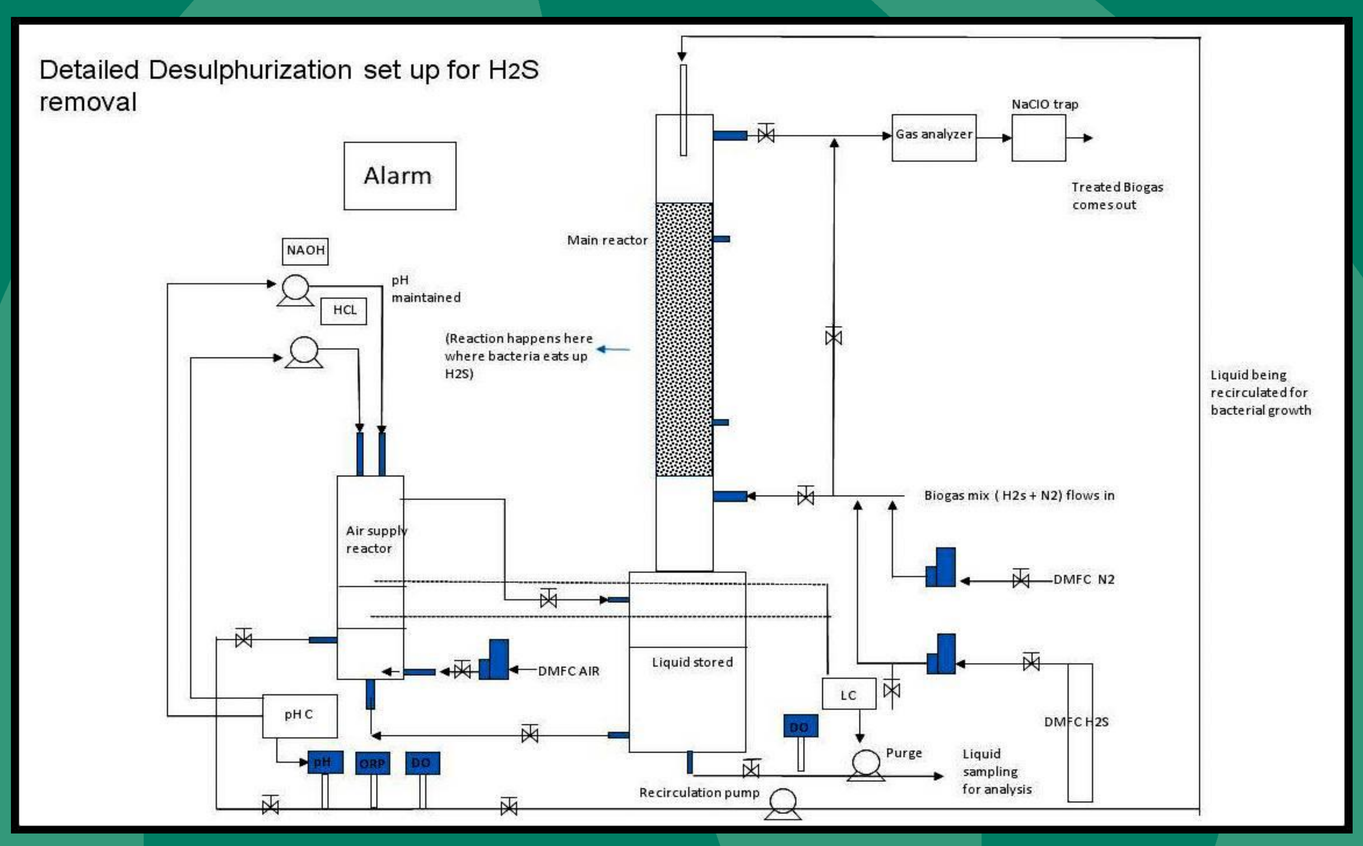

Fig:3 Biotrickling filter set up with a aeration unit for desulphurization of Biogas (to be integrated and coupled with CO_2 removal using bottom ash)

- Figure 4 shows the comparative sulphate ion production at 144 hrs (6 days) at 30 ^{0}C.
- SOB2 has high sulphate production though SOB1 produced significantly higher sulphate even after 40 hrs.
- The selected sludge sample has been acclimatized to the reactor for H_2S removal.

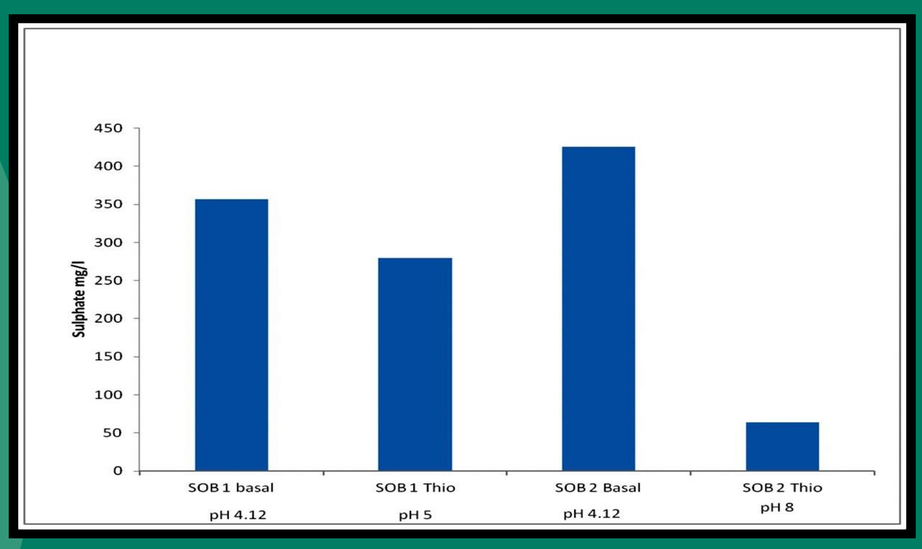

Fig:4 Comparative Sulphate ion production (mg/l) of different Sulphur oxidizing bacteria in different medium at various pH

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