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Combined H_2S and CO_2 Removal Process For Upgrading Biogas

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Background and Research Aim

- Development of energy efficient, scalable processes for hydrogen sulphide (H_2S) removal in biogas using Sulphur Oxidising Bacteria (SOB).
- To test the Bioreactor (Bio trickling filter) for optimized bacterial activity.
- Development of energy efficient, scalable processes for carbon di oxide removal in biogas using Bottom ash.
- Combination, optimization and interaction of the combined process.

Step 1 - Hydrogen Sulphide Removal

The main reaction principle involved:

$$H_2S + ½\ O_2 \longrightarrow S^0 + H_2O$$

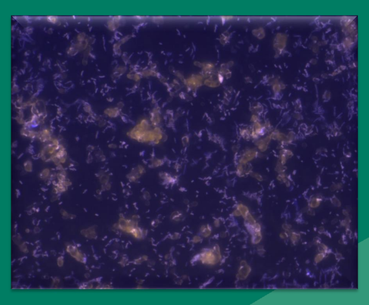

Figure 1: FISH picture showing SOB bacteria

Methodology

- SOB Bacteria are capable of degrading H_2S into elemental sulphur or Sulphate in acclimatized Bio trickling Filter (BTF)
- Operation of BTF is normally characterised by Loading Rate (LR) and Empty Bed Retention Time (EBRT)

$$LR = [(Q_{biogas} + Q_{air\ in}) * C_{in}] / V$$

$$EBRT = V / (Q_{biogas} + Q_{air\ in})$$

- Reactor performance described by Removal Efficiency (RE) and Elimination capacity (EC) are studied

$$RE = [(C_{in} - C_{out}) / C_{in}] * 100$$

$$EC = [(Q_{biogas} + Q_{air\ in}) * (C_{in} - C_{out})] / V$$

Step 3 - Combined process for Upgrading Biogas

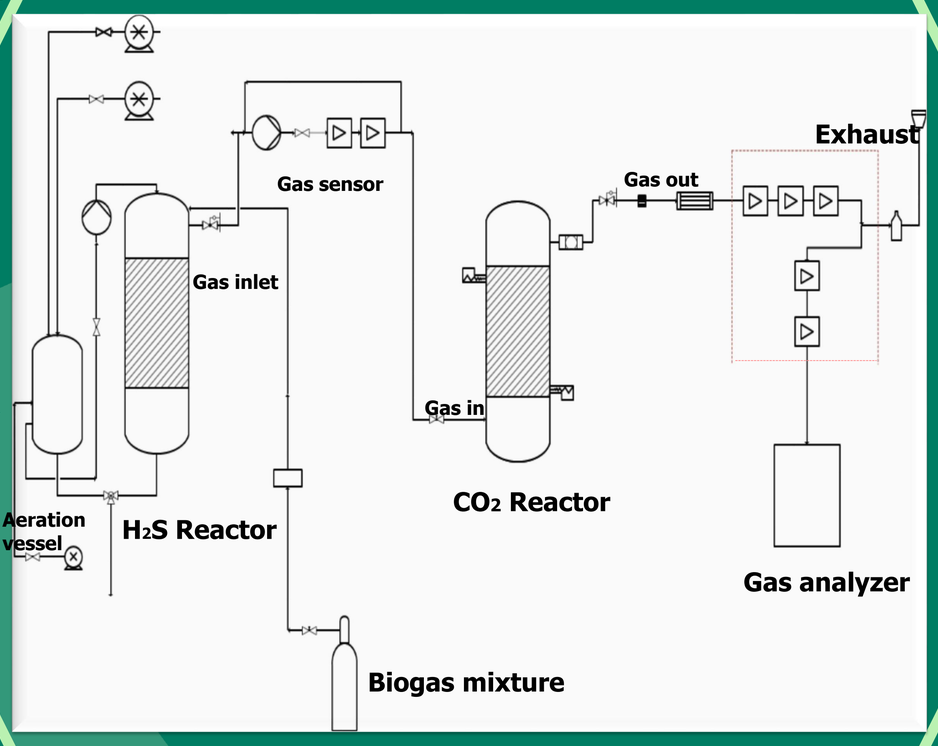

Figure 3: Process layout for Combined H_2S and CO_2 removal system

Step 2 - Carbon di oxide Removal

The main reaction principle involved:

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

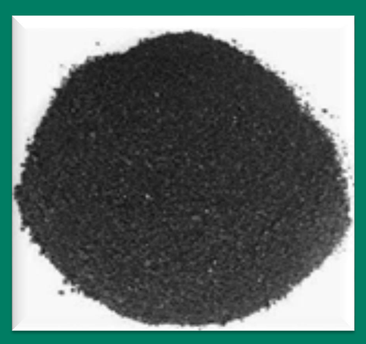

Figure 2: Carbonated Bottom ash sample

Methodology

- Different size fractions and moisture content of Bottom ash samples were tested in lab
- Further experiments are performed to study the breakthrough capacity of bottom ash for removing CO_2
- The sorption capacity (kg of CO_2/ton of Bottom ash) will also be calculated to know the carbonation performance

Past Results

- Good start up phase results on Bio trickling filter performance
- Initial results matches with real scale plant performance for Biological H_2S removal
- Preliminary results on CO_2 Removal process showed that Lowest size fraction of Bottom ash samples with 15% moisture content showed better CO_2 sorption

Future Work

- Combination of both the process will be optimized and operated in parallel to study upgrading efficiency.