Analysis and assessment of H_2S sorption capacity of the selected biofiltration materials

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PUF, CLC waste, biochar, and PPF packing materials used in biofilter in a row showed higher RE of H2S from biogas at specified conditions:

1. SOB: biofilters implemented aerobic SOB to desulfurize H2S from biogas
2. Temperature: biofilters operating within the optimal temperature range of 28°C to 30°C showed better RE compared to those at the room temperatures (23°C to 28°C).
3. Humidity: biofilters with the humidity close to 60% demonstrated better RE. Conversely, lower humidity (below 50%) led to slightly lower RE.
4. ILR: biofilters with the ILR above 1,000 ppm often resulted in higher RE.
5. EBRT: biofilters with the EBRT controlled between 60s-180s.
6. pH: biofilters which pH is close to natural (7).

Introduction

Hydrogen sulfide known as one of the highly toxic chemical compounds existed in the raw biogas and needs to be eliminated before implementation. Biological filtration by a biofilter is a method to used to desulfurize it and known as the green technology. Packing material is the main component inside a laboratory-scale biofilter to undertake the desulfurization process of H_2S. This study is dedicated to compare cellular concrete (CLC) waste, polyurethane foam (PUF), and polypropylene foam (PPF), biofilter packing material's impact on hydrogen sulfide purification from biogas, known as biofilters "removal efficiency (RE)". Variable environmental and equipment conditions are identified such as type of Sulfur Oxidizing Bacteria (SOBs), pH, temperature, empty bed retention time (EBRT), and humidity/moisture content in the packing material, chosen to be approximately the same.

Methods and Methodology

This review article focuses on evaluating various methods used in the biological desulfurization of biogas through laboratory-scale biofilters. It specifically examines fifteen recent scientific publications that employed biochar, CLC waste, PUF, PPF as packing materials. The assessment is conducted under controlled environmental and equipment conditions, considering six key parameters: The use of aerobic SOB. The pH remained close to natural levels (around 7). The temperature controlled within the range of 23°C to 30°C. Inlet loading rate of biogas kept below 10,000 ppm. EBRT set between 60 to 180 seconds. Moisture content of the packing material maintained between 40% to 60%.

Results and Discussion

Packing materials	RE	Packing materials	RE	Packing materials	RE
[1]Biochar	98	[6]PUF	99	[11]PPF	70
[2]Biochar	95	[7]PUF	>93	[12]PPF	80
[3]CLC waste	>93	[8]PUF	98	[13]PPF	>88
[4]CLC waste	>92	[9]PUF	>98	[14]PPF	>85
[5]PUF	97	[10]PUF	95	[15]PPF	66

1. Biochar achieved RE 90%-94% when packed with aerobic bacteria, with ILR set to 105-120 ppm. The EBRT was controlled at 80s, close-to-natural pH condition, with a moisture content of 49%-55% and a temperature of 30°C.

2. CLC waste demonstrated RE 92%-93%, when packed with aerobic SOB, with ILR controlled to 50-100 ppm. The EBRT ranged from 56s-63s, with a moisture content of 40%-45% and a temperature of 28°C-30°C. Both acidic (pH 6.2) and natural (pH 7.1-7.3) pH conditions were effective.

3. PUF achieved RE 93%-99%, when packed with aerobic SOB, with ILR ranging from low to high concentrations. The EBRT varied from 60s-180s, with a moisture content of 50%-60% and a temperature of 25°C to 30°C. Both alkaline and natural pH conditions were effective.

4. PPF demonstrated RE 66%-88%, when packed with aerobic SOB, with an ILR mostly under 2000 ppm. The empty bed retention time ranged from 84s-180s, with a moisture content of approximately 60% and a temperature of 23°C-27°C. Both alkaline and natural pH conditions (7-8.2) were effective.