Novel Geotextile Mat Tailored to Reduce Odor Emission (H_2S) from Landfills

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TAG MEETING: 1

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Background: H_2S In Landfills

- Landfills are essential as a waste management tool world-wide
- H_2S levels range from
  - 0.03 to 10 PPM at the landfill surface
  - Up to 5,000 PPM with in the waste mass
- Large areas to treat (larger than one acre)
  - Natural soils applied to landfills have limited effectiveness
  - Quicklime has shown effectiveness but not feasible
- Cost effective solutions that can be easily applied are required

Solution:

GeoTreat Mat

Conceptualizations of the proposed product at the commercial scale.

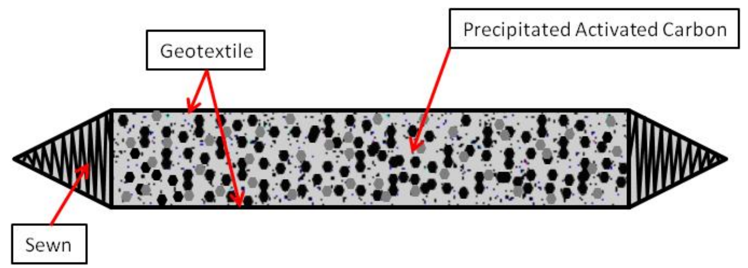
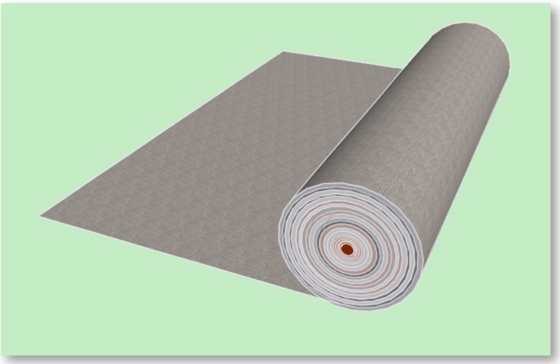


Figure 1. Conceptual cross-section of geotextile integrated with precipitated AC.



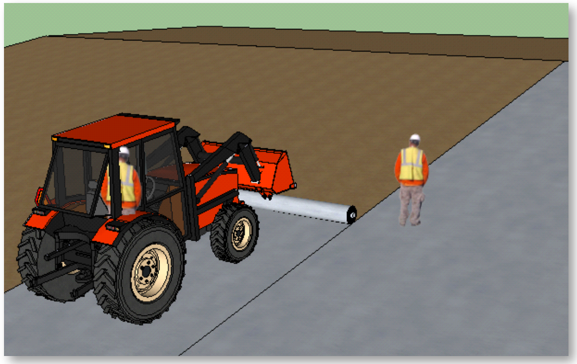


Figure 2. The GeoTreat Mats would be manufactured in rolls approximately 15 ft. wide and 100 ft. long and deployed at landfills using heavy equipment or rolled out by hand.

Iron Oxide Sorbents For H_2S

- Activated carbon and iron oxides should yield a high capacity sorbent.
- H_2S reacts with iron oxide in the presence of humidity to form sulfur iron species at ambient temperatures.
- High capacity will be required because of competitive adsorption.
- Two impregnation methods
  - Chemical Precipitation on Activated Carbon
  - Steam Quenching of Activated Carbon

GeoTreat Mat

Significance of proposed innovation:

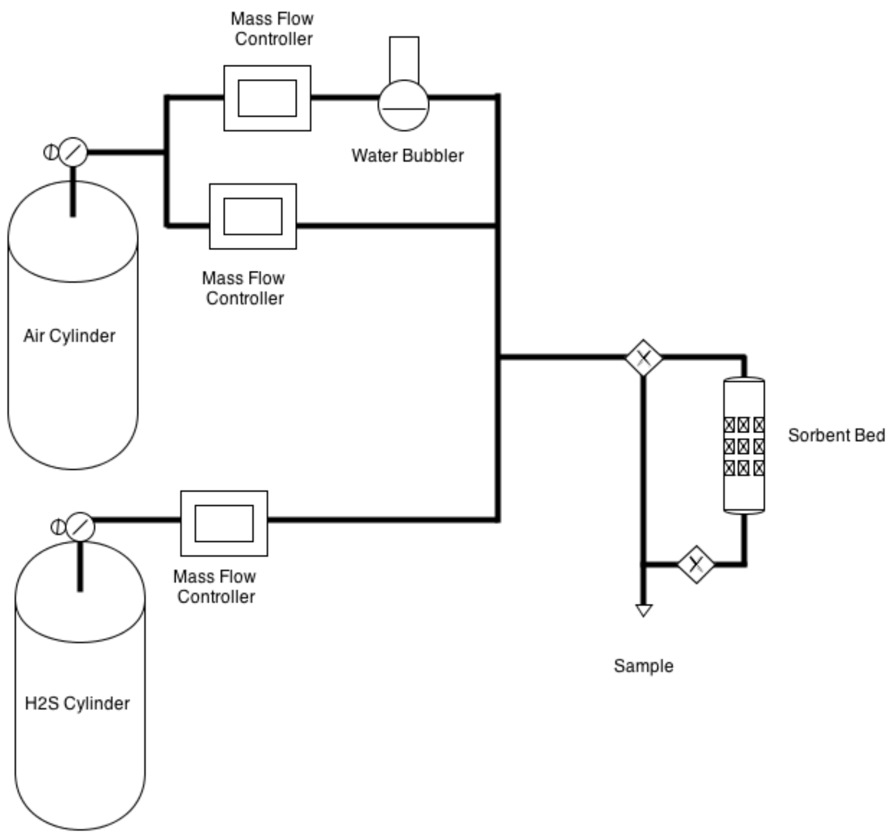
- It includes a reactive medium tailored to remove H_2S and potentially other odor-causing gas-phase constituents.
- It will test an innovative production technique to further reduce cost and increase sustainability of the medium production.
- The medium is delivered in a geotextile mat that can cover large areas of a landfill's surface and can be deployed using standard landfill equipment.
- The mat can be moved and repeatedly used.
- The overall product cost is projected to be less than comparable market solutions like natural soils.
    - < $2.50/ft^2 (20% savings)

Research Objectives

1. Verify that impregnated AC, as produced via traditional chemical precipitation, is well suited for mitigating landfill odor emissions (e.g., H_2S) and define the desirable material properties.
2. Produce impregnated AC using an innovative cost and resource saving production method and confirm that the desired material properties and removal capabilities were achieved.
3. Confirm the efficacy of the impregnated AC contained between two geotextiles, to create a “small” GeoTreat Mat, at the lab scale for H_2S removal.

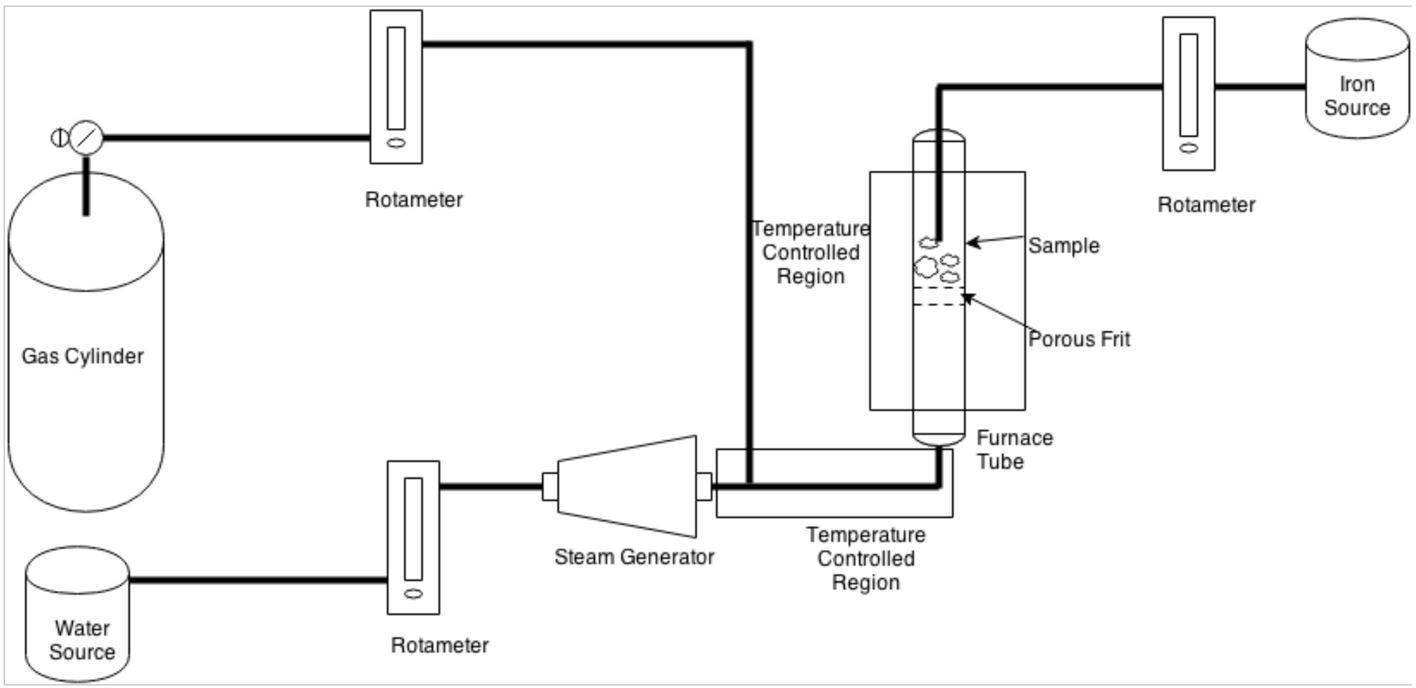
Task 1: Production and Validation of Precipitation Production Method

1. Lab scale precipitation of iron oxides on the AC surface.
   - $2Fe^{3+} + Fe^{2+} + 4OH^{-} \rightarrow Fe_3O_4 + 2H_2O$
2. Four ACs will be produced with low to high levels of iron as measured by the mass ratio of carbon to iron
   - 50:1, 20:1, 10:1, and 5:1
3. Gas phase sorption of H_2S by the iron oxide-impregnated AC will be measured and the adsorption capacity will be calculated.
4. AC performance will be compared and the optimal carbon to iron ratio for H_2S removal will be defined.



Task 2: Production and Validation of Steam Quench Production Method

Four ACs will be produced with low to high levels of iron as measured by the mass ratio of carbon to iron (50:1, 20:1, 10:1, and 5:1) using steam quenching application.



Task 3: Proof of Concept

1. AC material identified in Task 2 will be produced in sufficient quantities to be used in a test mat.
2. The test mat will be constructed by filling two geotextiles of about 0.023 m^2 (6” by 6” square) with the produced AC.
   - Two mats will be made, one with an AC loading of 0.5 kg/m^2 and the other with 1.0 kg/m^2
3. Mats will be tested under 100 ppm of H_2S to reflect aggressive H_2S landfill surface emission conditions.

Project timeline

Task Month	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**
Project Management												
Sample Production												
Sample Characterization												
H_2S Testing												
Mechanism Analysis												
Project Reporting and TAG Meetings												

Physical Properties- FeACs

Structural parameters of FeACs

Sample	C:Fe Mass Ratios	S_{BET} (m^2/g)	Pore width (Å)	V_{Total} (cm^3/g)	V_{BJH} (cm^3/g)	Total microporosity
AC_{Virgin}	-	407	19.6	0.198	0.030	85%
FeAC-1	50:1	338	20.6	0.171	0.031	75%
FeAC-2	20:1	357	20.2	0.181	0.032	82%
FeAC-3	10:1	350	20.6	0.181	0.036	80%
FeAC-4	5:1	285	20.2	0.164	0.035	79%

Energy—dispersive X-ray Spectroscopy

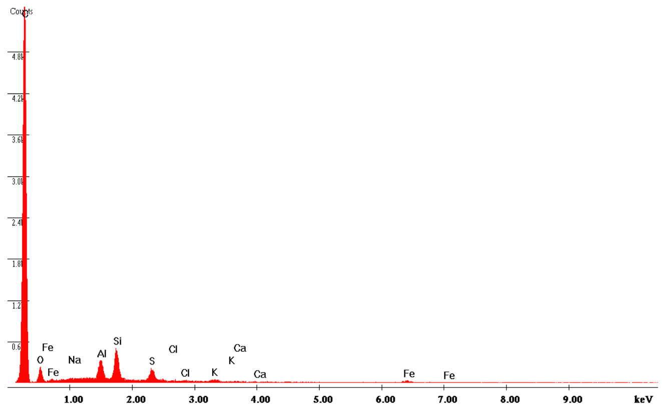


Figure 11. Element composition obtained by EDS microanalysis of AC_{Virgin} sample.

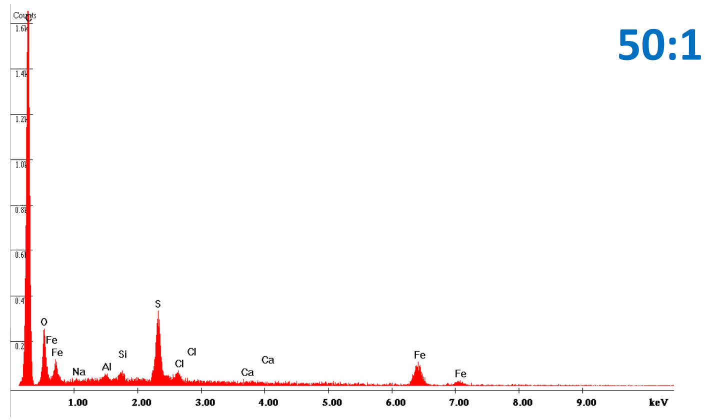


Figure 12. Element composition obtained by EDS microanalysis of FeAC-1 sample.

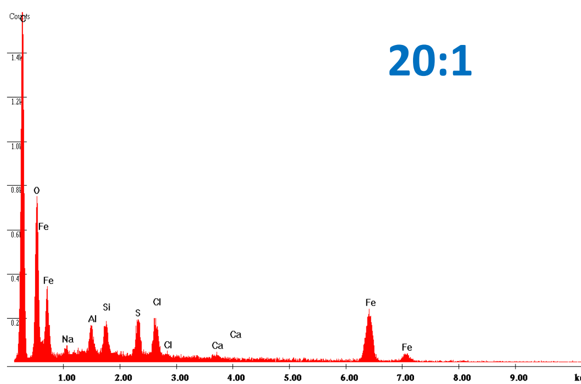


Figure 13. Element composition obtained by EDS microanalysis of FeAC-2 sample.

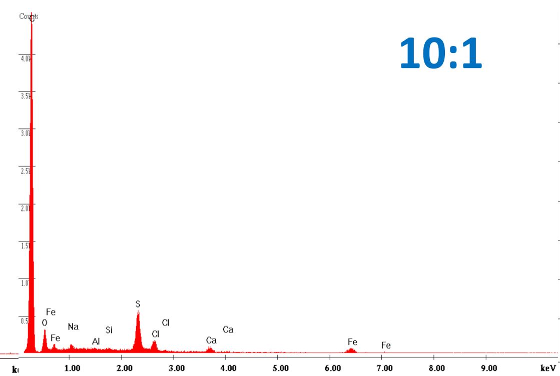


Figure 14. Element composition obtained by EDS microanalysis of FeAC-3 sample.

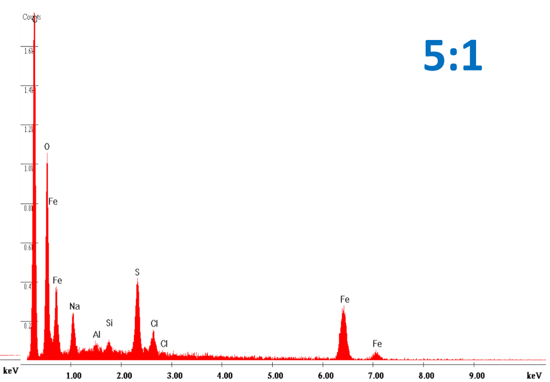


Figure 15. Element composition obtained by EDS microanalysis of FeAC-4 sample.

Breakthrough Behaviors of 100 PPM

H_2S breakthrough time and sorption capacity at 100 PPM

Sample	C:Fe Mass Ratio	Breakthrough Time (min)	Sorption Capacity (µg H_2S/g AC)
AC_{Virgin}	-	781	2297
FeAC-1	50:1	133	382
FeAC-2	20:1	119	342
FeAC-3	10:1	348	1021
FeAC-4	5:1	372	1088

Next Steps

1. Increase processing temperature to better convert iron into iron oxides
2. Compare performance for H_2S removal
3. Prepare proposal to NSF for continued funding
4. Hold second TAG meeting early August

Thank you for your time!

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