FOUR AQUEOUS FOAM SANITARY LANDFILL APPLICATIONS

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Waste Management Technology Forum
August 10, 2004
Houston, TX
Introduction & Background
FOAM TOPICS

Daily Cover
Membrane Barriers
Gas Recovery
Controlled Foam Injection
(Foam Blasting)
Daily Cover

Existing Technology
Daily Cover Choices

Soil
Tarps
Foam
Special Wastes
Others
Daily Cover Issues

Air Space
Odor/Emissions Control
Safety
Cost
Soil Consumes Airspace

Tarps & Foam Don’t
Emission Control
For Daily Cover Materials
(% Control)

<table>
<thead>
<tr>
<th></th>
<th>IMMEDIATELY, POST APPLICATION</th>
<th>NEXT DAY, 14 HOURS LATER</th>
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<tbody>
<tr>
<td></td>
<td>ODOR</td>
<td>METHANE</td>
</tr>
<tr>
<td>FOAM</td>
<td>98</td>
<td>100</td>
</tr>
<tr>
<td>SOIL</td>
<td>99</td>
<td>0</td>
</tr>
<tr>
<td>TARPS - FILM</td>
<td>100</td>
<td>100</td>
</tr>
<tr>
<td>WOVEN</td>
<td>82</td>
<td>100</td>
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References:
Head Space

Tarps = Finite
Foam = Zero
Safety

Flammability

Working Face Manpower

Reference:
Rusmar Incorporated
AC-667-SE

Ferrous Ion Stabilized Keratin Protein Foam

Permitted as Soil Equivalent Foam

Reference:
General Application
12’ to 14’ Passes, Up & Down

Aquafoam Inc.
Completed Application
No Change Overnight
Pneumatic Foam Unit 2500/60

Aquafoam Inc.
Foam Discharge Manifolds

Aquafoam Inc.
Bidirectional Discharge

Reference:
Kittle, P.A. and Manlowe, D., “Foam Distribution Apparatus,”
Front & Back Discharge

Aquafoam Inc.
Foam vs. Soil
Rain Effect
Completed Application

No Weather = No Change Overnight

Aquafoam Inc.
Applied Friday, 5:00 PM

Saturday, Noon
Five Hours Overnight Rain
0.6” to 0.7” Overall

Aquafoam Inc.
Saturday, 3:00 PM
Thunderstorms for 2 Hours
Additional 1+” Rain
Economics

All Inclusive -
Application Equipment
Chemical Storage Equipment
Foam Concentrate
Freight
Service

$0.06/SF
(equivalent)
Mature Technology
(Not an experiment)

22,000,000# AC-667 Concentrate
165,000,000# Foamed Solution
Average Application Rate ~ 0.8#/SF

Therefore -
200,000,000+ SF Covered
Also consider –

Daily cover foam could be modified to include “additives” for gas production, not to mention the benefit of ferrous and/or ferric ion for hydrogen sulfide control.
Proposal -

Which landfill will be first?
- Least airspace?
- No expansion opportunities?
- Odor problems?
- Available equipment?
Questions?
Foam Daily Cover
Membrane Barriers
Existing Technology
Some Development
Task –

How do you apply a continuous coating over a porous substrate?
Liquid = No!
Foam = Yes!
Alternatives -

(1) Apply the foam, then the coating
(2) Combine the chemistry
(3) Foam the coating
Technology –

(1) Support the coating on the foam
(2) Film forming is faster
(3) Foam decay is slower
Technology exists –

(1) Emulsion polymer, low $T_g$
(2) Viscosity modifiers
(3) Surfactant
(4) Apply by foaming

Reference:
TNMHC Control > 95%

Reference:
Foster Wheeler - Hazmat
Foster Wheeler - Hazmat
Foster Wheeler - Hazmat
Foster Wheeler - Hazmat
Current Technology

Low SBR latex concentrations
Durability = Months
No vehicle traffic
Not covered with soil

Main use is VOC & Odor Control
Waste Management’s Requirements:

- Longevity
- Physical Strength
- Barrier Quality
- Cost Effective
Proposal –

(1) Define the performance properties
(2) Define a working arrangement
(3) Develop the application technology
   (a) Chemical & Equipment
   (b) Field Trials
   (c) Permitting
Questions?
Membrane Barriers
Gas Recovery
Development Required
Build a Model
Water

In order to make methane the system needs water.
Water & Substrate

Wet - Not Submerged
Water

Injected vertically, flows to leachate

Injected horizontally, better distribution

Reference:
Aqueous Foam

Vertical or Horizontal Injection Can Provide Proper Distribution

Reference:
Aqueous Foam

Thixotropic Flow Properties
Controlled Drain Times
Aqueous Foam

Maintains Water Content
Can Use Leachate
Minimal Excess Water
No Void Volume Filling
Allows Gas Transport
Oxidizing or Reducing Medium
Waste Management Sequential System

All Liquid
then
All Air
Continuous System

Liquid then Air = Sequential
Liquid + Air = Foam
or
Foam = Continuous
Aerobic –
Expansion Gas is Air

Anaerobic –
Expansion Gas is N\textsubscript{2} or CO\textsubscript{2}

Mixtures -
Now –

Continuous Feed Process
Horizontal or Vertical Feed
Aerobic or Anaerobic
Chemical Access
Chemical Access
Foam Injection

Nutrients
Bacteria
Other Chemical Agents
Other Chemical Agents

Odor Control – H₂S
Hydrogen Sulfide

Fe\(^{++}\) & Fe\(^{+++}\) Control
Protein Foam - Fe\(^{++}\)

Control at the Source
Prevent Fugitive H\(_2\)S
Special Cases
Iron Accumulation
Now –

Continuous Feed Process
Horizontal or Vertical Feed
Aerobic or Anaerobic
H₂S Control
Iron Dispersion

Reference:
Filed, January, 2004, pending.
Proposal –

(1) We believe this technology can complement your current approach.
(2) We seek your cooperation in this development.
Questions?
Gas Recovery
Controlled Foam Injection
“Foam Blasting”
Semi-Commercial
Out-of-the-Box

but

Actual & Real
Conventional Blasting

Fast Combustion Process
Fast Gas Generation
Shock Impulse
Substrate Failure
Conventional Blasting

10 – 100X More Energy Used Than Required for Substrate Failure
Controlled Foam Injection
(Foam Blasting)

Drill Blast Hole
Inject High Pressure Foam
Substrate Fails

No Substrate Shock/Vibration
No Debris or Dust
No Combustion Gases/Emissions
No Noise
Film Clip < 1 minute

- Sound Level – Voices
- Debris Distribution
- Foam on Broken Rock
- No Dust
- No Excessive Noise

See film clip - click here
Komatsu

Aquafoam Inc.
Caterpillar

Aquafoam Inc.
Some Details –

(1) Any Substrate – Granite, Marble, Concrete
(2) 50% Less Drilling
(3) Conventional Drilling
(4) Common Rod for Foam Injection
(5) Fracture Time <<<< Drill Time
(6) No Interference
(7) No Evacuation
May, 2004 –

Technology introduced to Waste Management
Matt Sarge – Pad Construction Manager
Alliance Landfill
Scranton, PA
Applied Geodynamics, Inc.

Chapman Young, President

PO Box 2129
Steamboat Springs, CO 80477

Phone: 970-879-3032
E-mail: cfi@capprex.com
Technology is Patented:


Others Pending.
CFI Technology:

- Operating in Colorado
- Available Commercially
- Specific Application Designs

✓ Describe your needs
✓ We can respond
Questions?
Controlled Foam Injection
Conclusions
Daily Cover

Saves Airspace
Good Odor Control
Mature Commercial Technology
Immediately Available
Conclusions
Membrane Barriers

Known Patented Technology
EPA Approved Barrier
Specific Development Required
Permitting Necessary
Performance Objectives Achievable
Conclusions
Gas Recovery

Patent Pending Technology
Significant Development Required
Complements Existing Programs
Unique \( \text{H}_2\text{S} \) Control
Conclusions

Controlled Foam Injection

Unique Patented Technology
L/F Construction = Ideal Application
No Nuisances
Faster, Cheaper, Safer, Better

Aquafom Inc.
THANK YOU