In Situ Permeability Testing of Animal Waste Storage Ponds and Lagoons

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Background

Problem

The E.P.A. has proposed new regulations concerning specific discharge from animal waste holding ponds and lagoons. It is expected that the new regulation will follow the current NRCS allowable rate of 0.028 $ft^3/ft^2/day$. New facilities shall be constructed to meet this regulation, and existing facilities must be evaluated.

The current method for evaluating an existing facility with a clay liner is to empty the facility, then measure the coefficient of permeability from Shelby tube samples (ASTM D2937) or a Boutwell test (ASTM D6391-99). This method is time consuming, expensive, and destructive to the clay liner.

Clay Liner Design & Construction

- Soil Sample sent to USDA-NRCS laboratory in Fort Worth, TX
  - Optimum water content/maximum density (Proctor test ASTM D2167).
  - Coefficient of permeability
  - % of Proctor required to meet permeability
  - Liner thickness

$$d = \frac{K \times \Delta H}{q - K}$$

- K - Coefficient of permeability ($L\ T^{-1}$)
- q - Flux discharge ($L\ T^{-1}$)
- H - Hydraulic head (L)
- d - Clay liner thickness (L)

Design

Design Criteria

Measurement : ± 10% precision

Non-technical user installation

1. Installation by two people in < 1 hr.
2. Simple data collection by 1 person in < 1 hr.
3. Transportable in an 8-ft. truck bed

Minimal intrusiveness

- Implementation does not change flux values

Robust system - Able to withstand elements

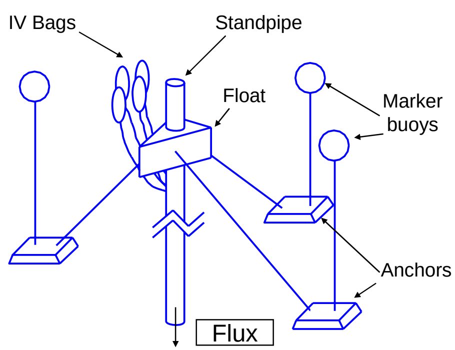
Cost - Cost < current method

Proposed Technique

•Standpipe confines a known area of liner

•Effluent mass passing through the liner measured over a specific time

$$Flux = \frac{Mass_{liq}}{density \times time \times area_{tube}}$$



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Testing

Lab Testing

Purpose

•Verify standpipe method

Method

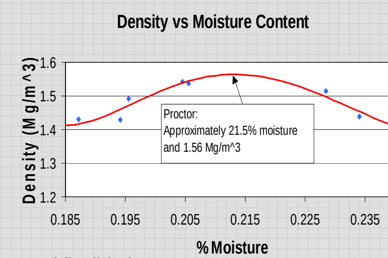
•Construct simulated liner

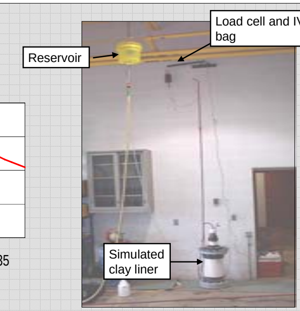
•Proctor density of soil

•Coefficient of permeability

•Provide constant head

•Load cell measures mass changes of flexible bag





Field Testing

Goals

•To meet rational design criteria

•Compare measurements with accepted method

Results

•Performed structurally

•Time consuming

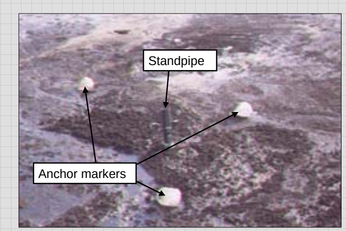
•Safety concerns

What we did not account for

•Biogas production

•Bags increased in weight

•Useless data



Next Step:

Solving the Biogas problem

Method 1 - Prevention

•Possible to kill all microbes?

•Bring them to a tolerable level

•How to kill microbes

Method 2 - Venting

•Vent the system to prevent gas buildup

•Volume vs. mass relationship?

Safety

•Penetrating the standpipe into the liner was precarious

•Viscosity of slurry is such that one cannot swim

•Lung infection if inhaled

Conclusions

•Individual components operated as planned

•System failed due to biogas production

•Safety issue

•Time constraints

Current Work

•Solutions to biogas problem