



## Geomembranes as a Liner For Manure Storage Structures

### WHY GEOMEMBRANES ALONE SHOULD NOT BE USED AS A LINER FOR MANURE STORAGE STRUCTURES

Due to damage that can occur during installation and operation, Geomembranes (a.k.a. flexible membrane liners, PVC liners) should not be used alone as liners for manure storage structures. The following data will illustrate the performance that can be expected to be achieved by using a Geomembrane liner as compared to other types of liners. Keep in mind that experts agree that the "Great Liner" category is unrealistic and will not be reached in most construction projects. In addition to this, the performance of Geomembrane liners in a system involving agitation and pumping has not been well researched. These factors have influenced the MPCA feedlot program's position on Geomembrane liners. The MPCA feedlot program requires that storage structures are designed to have a maximum seepage rate of 500 gallons/acre/day.

#### Poor Liner

Soil liner Alone:

seepage rate = 1,200 gal/acre/day  
( $K_s = 1 \times 10^{-6}$  cm/s)

where  $K_s$  = the coefficient of hydraulic conductivity.

Geomembrane liner Alone:

seepage rate = 10,000 gal/acre/day  
(30 holes/acre,  $a=0.1\text{cm}^2$ )

Composite liner (soil + Geomembrane):

seepage rate = 100 gal/acre/day  
( $K_s = 1 \times 10^{-6}$  cm/s,  
30 holes/acre,  $a=0.1\text{cm}^2$ )

#### Good Liner

Soil Liner Alone

seepage rate = 120 gal/acre/day  
( $k_s=1 \times 10^{-7}$  cm/s)

Geomembrane Liner Alone:

seepage rate = 3,300 gal/acre/day  
(1 hole/acre,  $a=1.0\text{cm}^2$ )

Composite Liner (soil + Geomembrane):

seepage rate = 0.8 gal/acre/day  
( $k_s = 1 \times 10^{-7}$  cm/s, 1 hole/acre,  $a = 1.0\text{cm}^2$ )

#### Great Liner

Soil Liner Alone

seepage rate = 12 gal/acre/day  
( $K_s = 1 \times 10^{-8}$  cm/s)

Geomembrane Liner Alone

seepage rate = 330 gal/acre/day  
(1 hole/acre,  $a=0.1\text{cm}^2$ )

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Composite Liner (soil + Geomembrane):

seepage rate = 0.1 gal/acre/day  
( $k_s = 1 \times 10^{-8}$  cm/s, 1 hole/acre,  $a=0.1\text{cm}^2$ )

- I. Calculations for Flow Rate
- II. Calculation for Flow Rate Through Through Geomembrane Alone
- III. Soil Liner Alone

$q$  = flow rate (m<sup>3</sup>/s)  
 $CB=0.6$  (flow coefficient)  
 $a$  = area of hole(m<sup>2</sup>)  
 $g$  = acceleration due to gravity (m/s<sup>2</sup>)  
 $h$  = head (m)

Example:

$q=CBa$ embed Equation.2

$h= 1\text{ft} = 0.305 \text{ m}$

$a= 1\text{cm}^2 = 1 \times 10^{-4} \text{ m}^2$

For one hole in an acre:

$q= Cba$

$q= (0.6)(1 \times 10^{-4}\text{m}^2)$

$= 3,346 \text{ gal/acre/day}$

$q$  = flow rate (m<sup>3</sup>/s)  
 $K_s$  = hydraulic conductivity of soil (m/s)  
 $A$  = area (m<sup>2</sup>)  
 $i$ = hydraulic gradient

Example:

$h=1 \text{ ft}; D=3\text{ft};$

$k = 1 \times 10^{-7}\text{cm/s} = 1 \times 10^{-9}\text{m/s}$

$i= (1+3)/3 = 4/3 = 1.33$

$A= 1 \text{ acre} = 43,460 \text{ ft}^2=4047\text{m}^2$

$q = k_iA$

$q = (1 \times 10^{-9}\text{m}^3/\text{s})(1.33)(4047\text{m}^2)$

$= 123 \text{ gal/acre/day}$

### **References:**

Giroud, J.P., and R. Bonaparte(1989), "Leakage through Liners Constructed with Geomembranes-partI. Geomembranes Liners," Geotextiles and Geomembranes, Vol. 8, pp.27-67.

Giroud, J.P., and R. Bonaparte(1989), "Leakage through Liners Constructed with Geomembranes - Part II. Composite Liners," Geotextiles and Geomembranes, Vol. 9 pp.71-111.

Giroud, J.P. Khatomi, A.,and K.Badu-Tweneboah (1989),"Evaluation of the Rate of Leakage through Composite Liners," Geotextiles and Geomembranes, Vol.8,pp. 337-340.

### **For More Information:**

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