

Geosynthetic Clay Liners in Mining Applications: Impact of Acid Solutions on GCLs Hydraulic Conductivity

1. INTRODUCTION

Geosynthetic clay liners (GCLs) are widely used as leachate barriers in engineering constructions. However, the hydraulic performance of GCLs could be considerably impaired when permeated with low pH solutions.

In mining projects, GCLs have a high probability to coming into contact with acids, such as in heap leach containment systems and the acidic leachate caused by the oxidation of impound tailings.

2. BACKGROUND

Hydraulic conductivity is the key index to evaluate the effectiveness of GCLs as leachate barriers. The hydraulic conductivity test is conducted based on Darcy's Law, and among all laboratory testing methods, we have adopted the constant head method in our research.

Constant head method requires the system to maintain constant hydraulic pressure, pressure should be measured and supervised during the test. The apparatus usually used in constant head test is shown in Figure 1.

In order to facilitate gas removal and saturation of the hydraulic system, four drainage lines are connected to the specimen, two to the base and two the top cap with valve controls.

The specimen is mounted into the permeameter cell as shown in Figure 2. One sheet of filter paper should be placed between the top and bottom porous stones and the specimen to prevent intrusion of the material into the porous stones.

Flexible membrane is used to encase the specimen against the leakage. Rubber O-rings should be used to provide adequate seal at the base and cap.

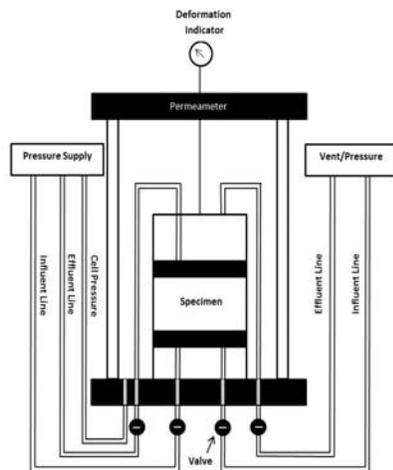


Figure 1. Constant Head System

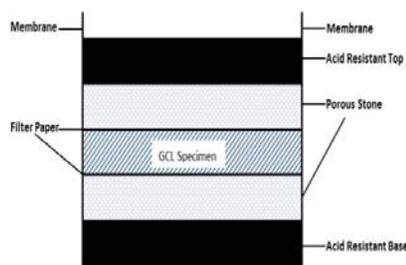


Figure 2. Specimen Cell

The hydraulic conductivity is calculated as follows:

$$k = \frac{Q \times L}{A \times t \times h}$$

Where:

- k = hydraulic conductivity, m/s
- Q = quantity of flow for given time t, taken as the average of inflow and outflow, m³
- L = length of specimen along path of flow, m
- A = cross-sectional area of specimen, m²
- t = interval of time, S
- h = difference in hydraulic head across the specimen, m of water

3. RESEARCH AT MONASH UNIVERSITY

A fully automated hydraulic conductivity system was developed to allow a continuous monitoring of contaminant flow until chemical equilibrium was achieved. Tests were only terminated once chemical equilibrium based on the ratios of outflow to inflow electrical conductivity (EC) and pH, or EC_{out}/EC_{in} and pH_{out}/pH_{in} , respectively, were within 1.00 ± 0.15

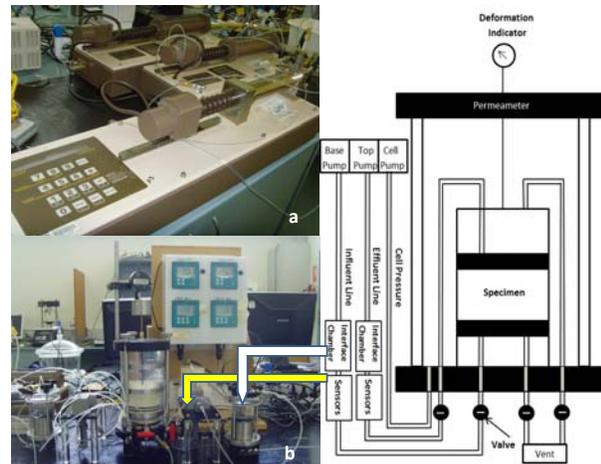


Figure 3. Modified Constant Head System

Interface chambers (white arrow in Fig. 3b) are placed between the flow pumps and the flexi-wall permeameter cell to allow use of leachates of extreme chemistry. pH, EC sensors are installed in both inflow and outflow lines to have real time monitoring of pH and EC values changes (yellow arrow in Fig. 3b) during the tests to insure that chemical equilibrium has been achieved before the test could be stopped. Typical hydraulic conductivity tests results for a needle punched GCL permeated with an acid solution (pH=0.6) are shown in Fig. 4.

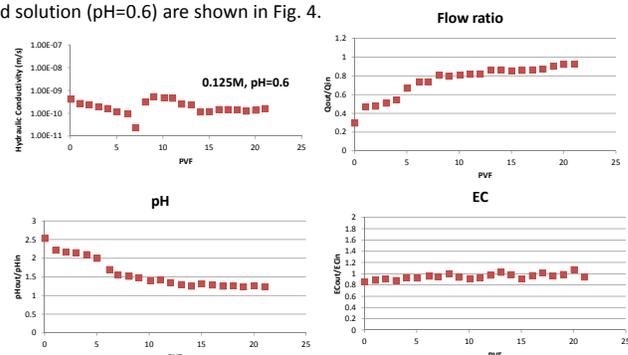


Figure 4. Results of hydraulic conductivity tests with 0.125 M H₂SO₄

4. CONCLUSIONS

A fully automated hydraulic conductivity system was developed to allow a continuous monitoring of contaminant flow until chemical equilibrium is achieved. Thus making termination time much easier to identify and hydraulic conductivity values more accurate when GCLs are in contact with mining liquors or other types of leachate.

Hydraulic conductivity tests currently conducted include:

- GCL specimens at different concentrations of H₂SO₄, 0.015M, 0.125M and 0.5M;
- GCL specimens at different effective stresses, 35kPa and 200kPa;
- Different types of GCLs