GCLs Hydraulic Conductivity to Coal Seam Gas Waters

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 aggressive solutions.

In coal seam gas (CSG) projects, GCLs have a high probability to coming into contact with brine solutions which are characterised by high salinity and elevated temperatures.

2. Background

Hydraulic conductivity is the key index to evaluate the effectiveness of GCLs as liquid 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.

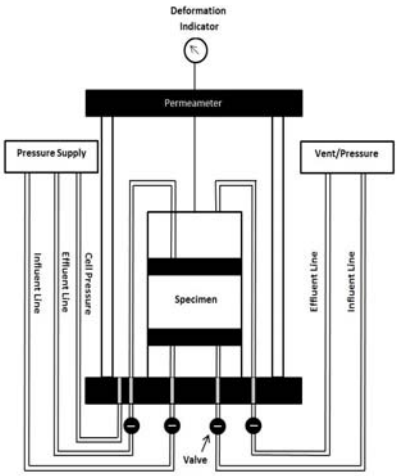

Figure 1. Constant Head System

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.

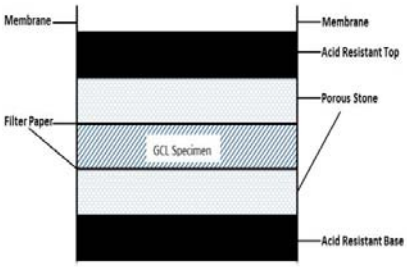

Figure 2. Specimen Cell

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

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, m^2
- 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 with temperature control

Interface chambers with heat sleeves are placed between the flow pumps and the flexi-wall permeameter cell, also thermally controlled, to allow use of leachates of extreme chemistry at any given temperature. pH, EC sensors are installed in both inflow and outflow lines to have real time monitoring of pH and EC values changes during the tests to insure that chemical equilibrium has been achieved before the test could be stopped. Typical hydraulic conductivity tests results for a GCL permeated with a brine solution at 70°C are shown in Fig. 4.

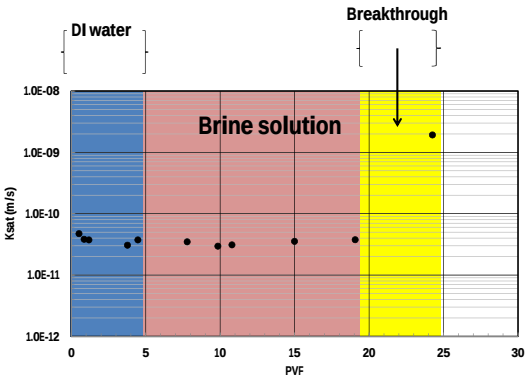

Figure 4. Results of hydraulic conductivity tests with a brine solution

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. Furthermore, the set up is capable of conducting hydraulic conductivity at temperatures up to 80°C

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