BENTOMAT® COMPATIBILITY TESTING WITH DILUTE SODIUM CYANIDE

In the mining industry, the process of heap leaching utilizes dilute sodium cyanide solutions to extract metals from ore. The heap leach liner system is designed to capture the ore-laden leachate and to meet regulatory requirements for groundwater protection. For any liner to perform as designed it must be chemically compatible with the contact solution.

Compatibility testing was performed with Bentomat geosynthetic clay liner (GCL) in a dilute (0.06%) sodium cyanide solution. A flexible-wall permeameter test was performed with several Bentomat samples. The industry standard for permeability testing with a leachate is to run a minimum of 2 pore volumes through the sample. The two specimens which ran over two pore volumes had hydraulic conductivities of less than $1x10^{-9}$ at confining pressures of 30 and 50 psi. This is comparable to CETCO's GCL specification of $5x10^{-9}$ at 5 psi confining pressure.

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July 15, 1991

AMERICAN COLLOID COMPANY
1500 W. Shure Drive
Arlington Heights, IL 60004-1434

Attention Mr. Jim Olsta

Gentleman:

Final Report
Permeability Testing of Bentomat
Seepage Control Liner
For American Colloid Company

INTRODUCTION

This report presents final results obtained from the permeability tests that have been conducted on the Bentomat Seepage Control Liner by Dames & Moore. The tests were conducted using the method described in Daniel, D.E., Trautwein, S.J., Boynton, S.S., and Foreman, D.E., "Permeability Testing with Flexible-Wall Permeameters", Geotechnical Testing Journal, GTJODS, Vol. 7, No. 3, September 1984. Preliminary test results were presented in our report dated November 30, 1990.

RESULTS

The results for Sample 1 show a permeability of about 2.0×10^{-9} cm/sec. This number is an average of the last five readings where the permeability appears to have stabilized. These five readings are at flows representing approximately 0.21 to 0.25 pore volumes.

Sample Number 2 was composed of 12 disks of bentomat. Permeability testing for this sample was conducted over an 8 month period using a hydraulic gradient of 217.2. A cumulative flow of 1.109 pore volumes of fluid was able to pass through the sample during this time period resulting in a measured coefficient of permeability of 6.82×10^{-10} cm/sec at the conclusion of the test.

Sample number 3 was composed of a stacked 3 disk composite and was tested continuously between November 4, 1991 and Jan. 27 1991 during which time a total of 2.159 pore volumes of 600 ppm sodium cyanide solution was allowed to permeate and flow through the sample. At the conclusion of the testing an average permeability of 4.97×10^{-10} cm/sec was calculated for the 6 final readings.

Sample number 4 was also composed of a stacked 3 disk composite and was tested continuously between November 15, 1990 and January 15, 1991. A total of 2.142 pore volumes of permeating fluid were measured to have passed through the sample during this time period. The average permeability calculated for the final 6 flow measurements was 9.96×10^{-10} cm/sec.

Measured material properties for the four samples tested are summarized in the following Table.

Sample Number	No. of Disks	Moisture Content-%	Dry Unit Weight-pcf	Pore Volumes	σ_3 -psi-	Coefficient of Permeability-cm/sec
1	8	71.4	52.1	0.238	20	2.05×10^{-9}
2	12	56.6	58.4	1.109	35	6.82×10^{-10}
3	3	86.6	47.9	2.159	50	4.97×10^{-10}
4	3	79.3	47.1	2.142	30	9.96×10^{-10}

DISCUSSION OF RESULTS

The graph attached and lab data show permeability plotted against pore volume expelled for Sample 1. The first portion of the curve shows a significant fluctuation of the permeability as tap water was used and the bentonite in the sample continued to undergo hydration and swelling. The highest permeability value, 8.6×10^{-8} cm/sec, was recorded during this period. It should be realized that this value is not an instantaneous maximum permeability but is an average permeability over a 25 minute time increment. The major fluctuations appear to have ended by approximately 0.09 pore volumes. The 600 PPM leachate solution was introduced at 0.094 pore volumes after which there was little fluctuation. By 0.18 pore volumes the permeability is essentially constant. Similar procedures were followed for tests 2, 3 and 4 with similar behavioral responses being observed during the tests.

CONCLUSION

Long term hydraulic conductivity data developed in our laboratory using a 600 ppm sodium cyanide solution as the permeate indicate an average long term permeability value of less than 1×10^{-9} for the American Colloid Bentomat product tested.

It has been a pleasure serving American Colloid on this project. Should you have any questions concerning the test results presented herein please call at your earliest opportunity.

Sincerely,
DAMES & MOORE

John F. Wallace, P.E.
Manager, Engineering and Design Services

Attachments: Sample 1 Test Results
Appendix : Laboratory Test Data