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MONTHLY PROGRESS REPORT FOR JULY: CONTROL TECHNOLOGY FOR IN-SITU OIL SHALE RETORTS

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Publication Date
1980-08-01

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LAWRENCE BERKELEY LABORATORY
Room: 128 Bldg.:70 Ext.: 6271

August 12, 1980

TO: Charles Grua, Brian Harney, and Art Hartstein

FROM: Peter Persoff, Joe Ratigan, Bill Hall, Mohsen Mehran, and Phyllis Fox

RE: Monthly Progress Report for July
Control Technology for In-Situ Oil Shale Retorts
LBID-263

TASK 3. BARRIER OPTIONS

Development of cementitious properties in spent shale

Lurgi spent shale, with no added material, was heated at temperatures ranging from 800 to 950°C under flowing N_2, evolved CO_2, or flowing steam. The products of these treatments were analyzed by X-ray diffraction (XRD) and cementing properties were judged by a qualitative time-of-set test. For this test, a paste was made using enough water to flow and molded in half-inch cubes. The molded pastes were cured in moist air at 73 ± 2°F and tested by penetration with a needle. Only specimens heated in evolved CO_2 or flowing N_2 at 850°C or lower reached initial set in one to five days. This setting appears to be due not to the presence of hydratable calcium silicates (which would cause a more rapid set) but to hydratable MgO which forms $Mg(OH)_2$. XRD analysis confirmed this, and showed that at higher temperatures, or under steam, the MgO is converted to akermanite. This catalytic effect of steam has been previously noted by others, including recent work done at Livermore.

Lurgi spent shale was also heated at 700°C in flowing steam. The product of this treatment did not set; XRD analysis showed that the major product was akermanite.

Testing of grouted core samples

The data from triaxial tests of grouted core samples have been reduced using the testing machine load-deflection curves to generate stress-strain curves. An assumed Poisson's ratio of 0.5 was used to compensate for increase in specimen cross-sectional area during testing. The reduced data are being interpreted to determine what degree of structural support may result from use of these low-cost grouts (for grout recipes see the February monthly report, LBID-177). In our modeling of subsidence, a four parameter model described the stress-strain behavior of grouted retorts, as shown in Figure 1. Values of these four parameters have been taken from the stress-strain curves for each test. Scatter of the data requires that more testing be done before final conclusions can be drawn; a tentative conclusion is that none of the grouts tested can provide enough structural support to permit pillars to be retorted in a second pass.

Samples of the cured grouts, with no coarse aggregate, have been saturating in de-aired water under vacuum for 10 days. During this time, electrical conductivity decreased, but not as dramatically as it did for oven-dry sandstone. We will continue to monitor conductivity changes to determine the length of time needed for saturation of grout samples prior to permeability measurement.

TASK 5. LEACHING OPTIONS

Activity during the month was concentrated on deriving mass transfer coefficients for the movement of dissolved organic carbon (DOC) between the solid and liquid phases in the leaching columns. We are trying to establish a method for determining the rate limiting process in the mass transfer of DOC from the shale to the leachate. Three kinetic models are being employed. One model represents the movement of solute within the solid particle and another depicts the transfer of a solute from the surface of the shale through the phase interface into the liquid. These two models are being used to determine, from batch studies, internal diffusion rates of DOC within the shale and interface transport rates, respectively. The third model applies to the transfer of DOC within a fixed bed and is being used to derive mass transfer coefficients from the experimental column studies previously performed. Coefficients obtained from the three models will be compared so that the rate limiting process can be defined.

A new Beckman Model 915-B Carbon Analyzer has been placed in operation. Some time was spent standardizing analytical procedures to be used in determining the DOC content in leachates from batch and column studies.

TASK 6. GEOHYDROLOGIC MODIFICATION

Development of groundwater flow model

Verification of the program TRUST with approximate analytic solution by Kroszynski and Dagan (1975) for the case of transient axisymmetric flow in an unconfined aquifer is continuing.

Computations of dewatering by internal drainage for Tract C-a is underway while the results already obtained for Tract C-b are being analyzed. The results of mine drainage of the two tracts for the case of an expanding retort will be presented in a single report by October 1980.

An abstract "Importance of Unsaturated Flow Properties in Dewatering an Expanding Underground Oil Shale Retort" has been submitted to the Seventh National Conference on Energy and the Environment to be held Nov. 30 - Dec. 3, 1980. A copy of the abstract is attached.

REFERENCE

U. I. Kroszynski and G. Dagan, "Well pumping in unconfined aquifers: the influence of the unsaturated zone", Water Resources Research, Vol. 11, No. 2, page 479 (1975).

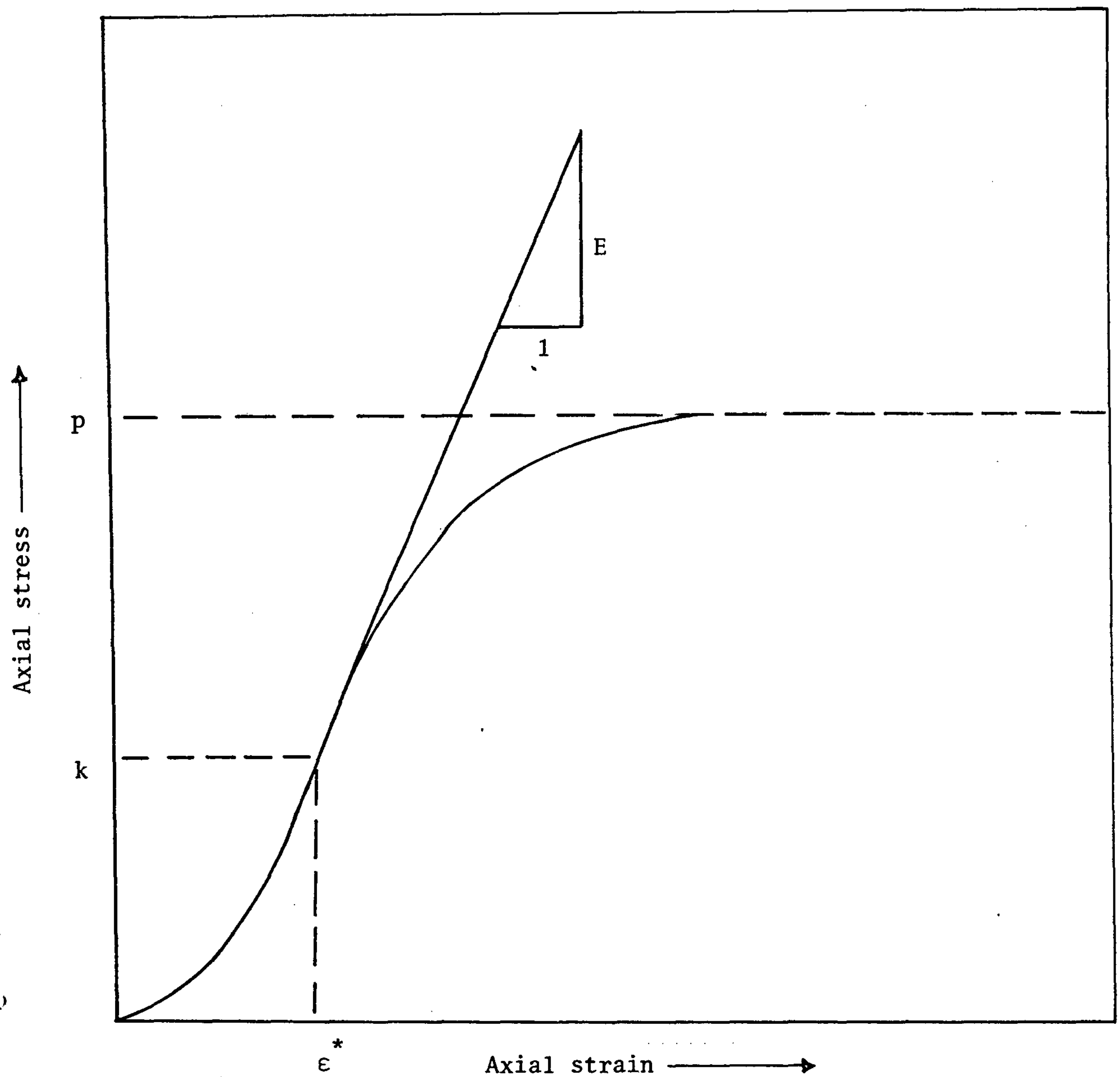

Figure 1. Four-parameter model of stress-strain behavior of grouted retorts.

Importance of Unsaturated Flow Properties in Dewatering an Expanding Underground Oil Shale Retort

By

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In in-situ shale oil recovery, dewatering is an important step for facilitating the mining operations and increasing the efficiency of combustion. So far, the study of dewatering by the use of groundwater models has ignored certain physical phenomena such as unsaturated flow. Since under many circumstances, water physically drains out of the spore space, contribution of unsaturated flow could play an important role.

In this study, the saturated-unsaturated groundwater flow equation for an expanding underground retort is solved numerically using an integrated finite difference scheme. The strong dependency of hydraulic conductivity and degree of saturation on pressure head is studied extensively. It is demonstrated that ignoring the important physical phenomena such as desaturation could lead to unrealistic results which in turn may give rise to erroneous conclusions with regard to economic analysis of dewatering as well as prediction of contaminant transport.

This report was done with support from the Department of Energy. Any conclusions or opinions expressed in this report represent solely those of the author(s) and not necessarily those of The Regents of the University of California, the Lawrence Berkeley Laboratory or the Department of Energy.

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