21
300
R

Investigators: HC (Hannah Castellaw)
RDM (Randall D Manteufel)

The Boorum & Pease® Quality Guarantee

The materials and craftsmanship that went into this product are of the finest quality. The pages are thread sewn, meaning they're bound to stay bound. The inks are moisture resistant and will not smear. And the uniform quality of the paper assures consistent rulings, excellent writing surface and erasability. If, at any time during normal use, this product does not perform to your expectations, we will replace it free of charge. Simply write to us:
Boorum & Pease Company
71 Clinton Road, Garden City, NY 11530
Attn: Marketing Services
Any correspondence should include the code number printed at the bottom of this page as well as the book title stamped at the bottom of the spine.

CNWRA
CONTROLLED
COPY 092

One Good Book Deserves Many Others.

Look for the complete line of Boorum & Pease® Columnar, Journal, and Record books. Custom-designed books also available by special order. For more information about our Customized Book Program, contact your office products dealer. See back cover for other books in this series.
Made in U.S.A.
RM201092

Contents | Page

Contents		Page
Initial Entries -	Title	1
	Investigators	1
	Introduction and Objectives	1
	Experimental Setup	2
	Equipment & Materials	4
	Sandbox	5
	Porous Media	7
	Sieve Analyses	~~4~~ 7 (21Dec93 HC)
	Permeability Tests	17
	Flowmeters	27
	ADM 1000	27
	Termination	31

JC 12/16/93

Title: Preferential Flow Paths in Nearly Homogeneous Porous Media: Effects on Thermally-Driven Liquid Redistribution

Investigators: Hannah Castellaw under direction of Randy Manteufel

Introduction and Objectives:

Studies involving the pumping-removal of hydrocarbons from a porous medium have shown that a nonuniform distribution of residual hydrocarbons remain in the medium even after careful preparation of "homogeneous" column packs. It has been postulated that this nonuniform distribution is due to the development of preferential flow paths. Preferential flow channeling is accentuated by increased heterogeneities in the media, yet it appears to be present in all porous media due to pore-level heterogeneities. . Flow channeling causes the flow to be isolated to a relatively small percentage of the porous medium leaving large portions of the medium stagnant (no flow). Flow in the preferential paths is due to advection. Fluids may move from "stagnant" regions to the channels by diffusion which is a less effective transport mechanism. Therefore, fluids may remain in the stagnant regions for extended periods of time. Classical mathematical models do not take into account this phenomenon.

At the proposed high-level waste repository, it is anticipated that in situ water will vaporize due to the emplacement of heat-generating high-level waste. The vapor is expected to flow away from the heat-generating waste packages and condense in cooler regions of the geologic media. The flow can be advection driven due to either vapor-pressure gradients (i.e., temperature > boiling temperature, hence boiling) or large-scale buoyant forces. It is anticipated that preferential gas flow paths will develop, thereby leading to relatively wet and dry regions of rock. It is anticipated that current models of vapor transport overpredict the extent of rock dryout. A correct prediction of rock dryout and condensate formation are important in predicting the performance of a repository, especially the spatial and temporal distributions of liquid water and water vapor.

The objectives of these experiments are to: 1) study the development of preferential flow paths under conditions which diminish and accentuate preferential flow and the effects of heat on preferential flow, 2) identify or develop simple mathematical models which account for the effects of preferential flow paths on fluid redistribution, 3) assess the importance of preferential flow paths to the anticipated dryout and vapor flow near heat-generating high-level waste at the proposed repository at Yucca Mountain.

JC 12/16/93

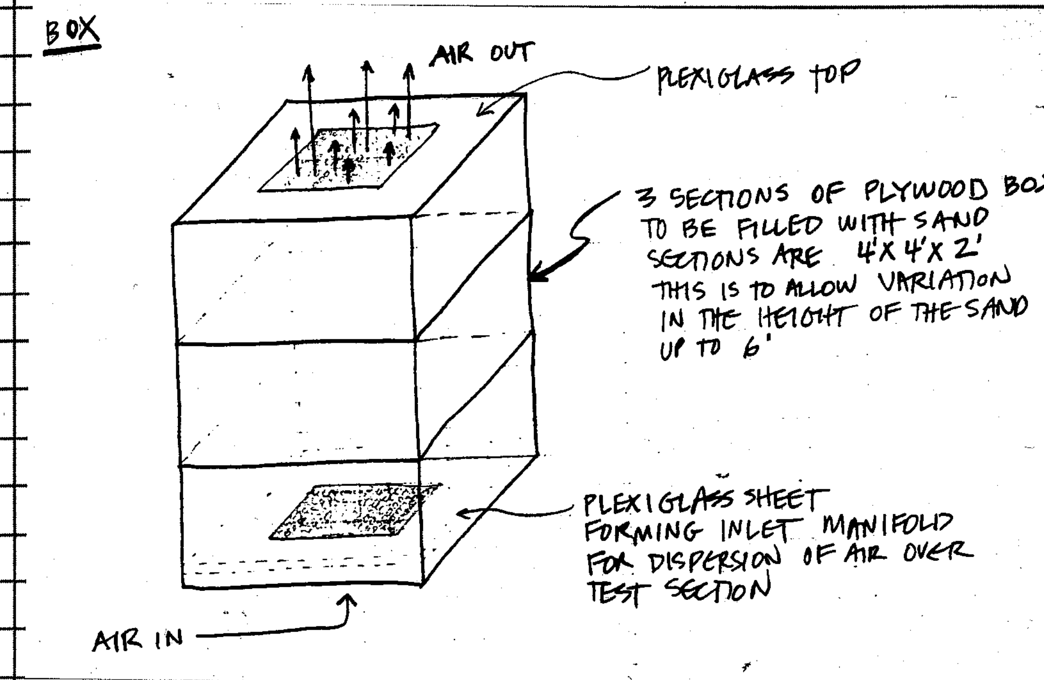
Experimental Setup:

The development of preferential flow paths will be studied by creating vertical air flow through a nearly homogeneous porous media. A large box, as illustrated in the sketch on the following page, will be filled with sand. The bottom of the box will be equipped with an air inlet manifold. The manifold will distribute incoming compressed air over a test area in the center of the box. The centered test section is an attempt to reduce potential for streaming along the boundaries. The top of the box will be equipped with air outlet tubes in the center test area. The rate of outflow of air will be measured with a gas flow meter. The spatial distribution of outflow will be observed and quantified. The box will be sectioned to allow variation in the height of the sand. Initial experiments will test the experimental method and establish baseline cases with both minimum and maximum preferential flow paths.

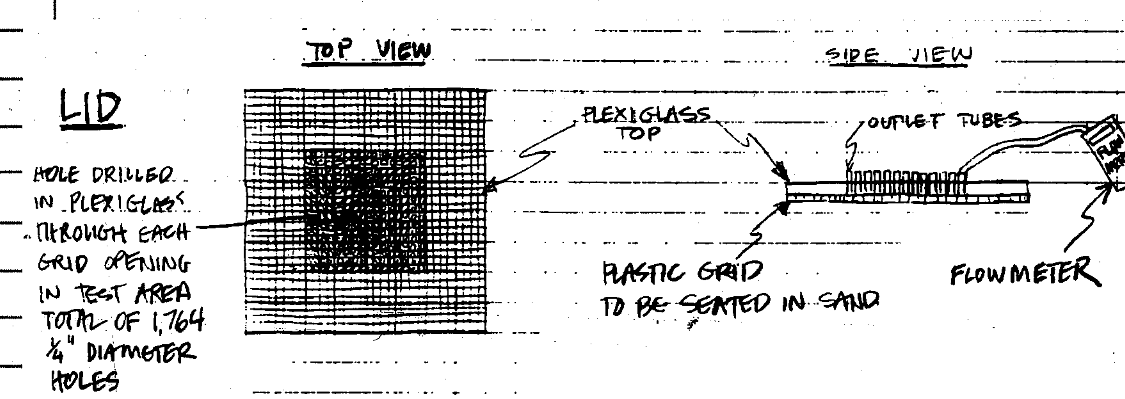
The first phase of the experiment will be conducted under isothermal conditions. The distribution and rate of outflow of air through nearly homogeneous sand will be observed and measured. Heterogeneities will then be introduced. The outflow of air will be observed and measured.

The second phase of the experiment will be conducted under non-isothermal conditions. A source of heat will be introduced at the onset. The same procedures will be followed as in phase one, observing and measuring outflow under homogeneous, then heterogeneous conditions.

JC 12/16/93



JC 12/16/93

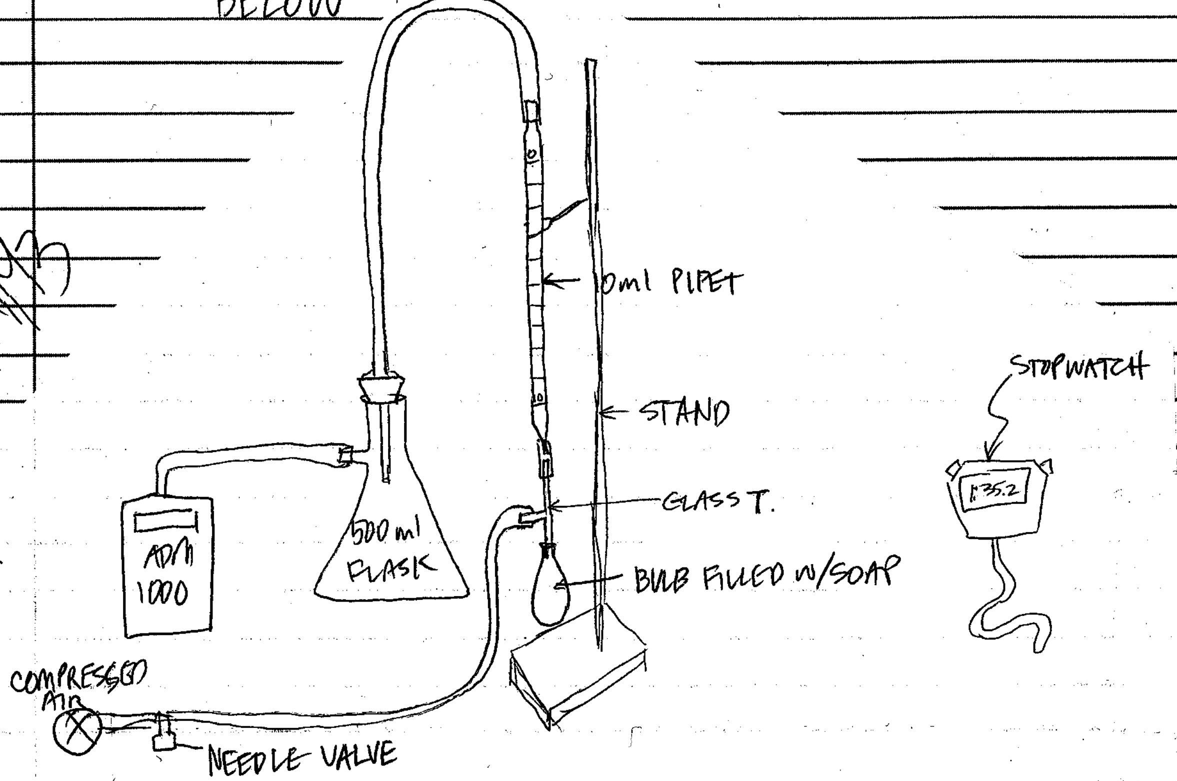


JC 12/16/93

Pages 4 Through 26 Are Intentionally
Left Blank

JC 12/21/93 ADM 1000 - CALIBRATION

SETUP - A BUBBLE FLOWMETER WAS USED TO CALIBRATE THE J&W SCIENTIFIC ADM1000 INTELLIGENT FLOWMETER AS SHOWN BELOW



12/21/93 JC

PROCEDURE - WITH AIR FLOWING A BUBBLE IS STARTED IN THE PIPET AND TIMED AS IT MOVES FROM THE 10ml MARK TO THE 0ml MARK. THE TIME IS RECORDED. THE AVERAGE READING ON THE ADM 1000 AS THE BUBBLE MOVES THROUGH THE PIPET IS ALSO RECORDED. THE BUBBLE METER FLOW RATE IS CONVERTED TO ML/MIN. THE ADM1000 READINGS ARE PLOTTED VS. THE ACTUAL FLOW RATE INDICATED BY THE BUBBLE METER. FLOW IS GRADUALLY INCREASED. AT 100 ml/min (ADM1000 READING) 10ml PIPET IS EXCHANGED FOR A 25ml BURET. AT ~ 240 ml/min (ADM reading) 25ml buret exchanged FOR 1000cc BURET.

HC 12/21/93 ADM 1000 FLOWMETER - CALIBRATION

FLOW RATE (ml/min) ADM 1000	FLOW RATE (sec/10ml) BUBBLE FLOW METER	= ml/min
1.30	158.45	3.78
2.88	84.69	7.08
5.1	54.32	11.04
8.03	37.53	15.99
11.5	28.84	20.80
16.1	21.71	27.63
21.6	17.36	34.56
31.1	12.97	46.26
41.4	10.14	59.17
52.5	8.25	72.73
61.1	7.31	82.08
71.3	6.42	93.45
80.7	5.71	105.08
90.6	5.20	115.38
~~100.~~ 100 (HC 12/21/93)	4.77	125.79

10ml pipet exchanged for 25ml buret →

ADM 1000	BUBBLEMETER sec/25ml	= ml/min
73	15.77	95.1
81	14.40	104.17
89	13.40	111.94
89	13.00	115.38
100	12.18	123.15
105	11.60	129.31
110	11.17	134.29
120	10.29	145.77
128	9.69	154.80
135	9.39	159.74

AFTER SETTING UP 25ml BURET ADM 1000 READOUT UNSTABLE
READOUT VARIES (HC 12/21/93) ± 5ml/min - POSSIBLY DUE TO MOISTURE
TOOK MIDDLE VALUE

HC 12/22/93 ADM 1000 FLOWMETER - CALIBRATION
USING 25ml buret

ADM 1000 FLOWRATE (ml/min)	BUBBLEMETER FLOWRATE (sec/25ml)	= ml/min
135	9.34	160.6
142	8.92	168.2
153	8.53	175.8
153	8.45	177.5
167	7.63	196.6
167	7.68	195.3
177	7.37	203.5

at 177 ml/min ADM READOUT BECAME UNSTABLE AGAIN.
TOOK MIDDLE VALUE

185	7.13	210.4
190	6.88	218.0
205	6.33	236.9
211	6.22	241.2
211	6.23	240.8
227	5.81	258.2
234	5.45	275.2
237	5.52	271.7

1000cc BURET

ADM (ml/min)	BUBBLE METER sec/100ml	= ml/min
299	17.97	333.9
380	14.52	413.2
488	11.48	522.6
602	8.72	688.1
704	7.12	842.7
817	6.13	978.8
910	5.57	1077.2
1000	5.00	1200.0

RDM 1/1/94 — Termination —

This project is being haulted because of competing priorities, lack of key personel, difficulties in constructing apparatus. No significant amount of resources have been invested. No data has been generated that will be used in licensing a HLW repository.