DENSITOMETER III

DENSITOMETER III

308 - - - Q200311050003
Scientific Notebook No. 052: Densitometer II–
Thermohydrology Research Project–Design
and Execution of Thermohydrology
Experiments in Unsaturated Media
(06/26/1992-12/13/1994)

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300

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THIS LABORATORY NOTEBOOK IS A CONTINUATION OF CNWRA CONTROLLED LABORATORY NOTEBOOK #028. THIS NOTEBOOK IS REQUIRED TO ALLOW DAILY ENTRIES FROM EXPERIMENTS THAT ARE BEING RUN SIMULTANEOUSLY.

Steve Sieberman

PERIODIC ENTRY (1) 7-30-92
CALIBRATION DATA FOR TEMPERATURE SENSOR FOR TEST 12.

6-26-92 SS

Calibrate Temperature sensors for TEST 12

SETUP: SAME AS FOR CALIBRATION OF TEST 7 AND TEST 8
(SEE P4 IN LAB NOTEBOOK)

TEMPERATURE REFERENCE: BROOKLYN THERMOMETER Co.
ASTM THERMOMETER SET

MODEL #		RANGE	SCALE DIVISION
ASTM 63F	8009-1311	18-88°F	0.2°F
ASTM 65F	7903-3787	122-176°F	0.2°F
ASTM 66F	8003-799	168-220°F	0.2°F

ICE POINT CHECKED ON EACH THERMOMETER - ALL GOOD

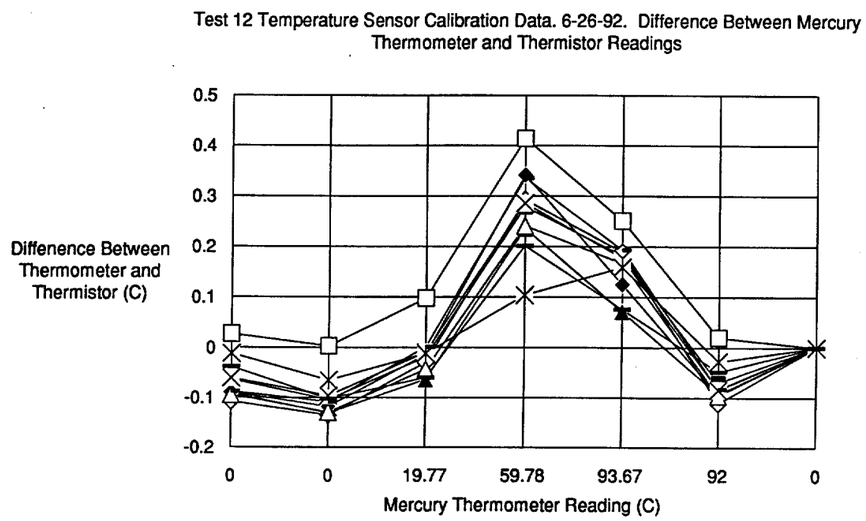
TEST 12 SENSOR CALIBRATION

REFERENCE TEMP	Temperature #1 Reading	
0°C	0.0695 °C	ICE BATH
67.7°F	19.879 °C	20.1°C BATH
139.6°F	59.79 °C	60.0°C BATH
200.6°F	93.7°C	Boiling WATER
197.6	91.8 °C	" "
0°C	0.075°C	ICE BATH

TEST12.CFG FILE CONTAINS CHANNEL #'S AND LINEARIZATIONS
T12TCAL.DAT CONTAINS RECORDED TEMPERATURES

DATA FROM FILE T12TCAL.DAT AND COMPARISON WITH THE MERCURY THERMOMETERS.

	A	B	C	D	E	F	G	H	I	J	K	L
1	CNWRA: 20-3704-023											
2	6/26/92 0:00											
3	Calibration of temperature sensors for Thermohydrology Test 12											
4												
5												
6												
7												
8		Mercury	Temp.	Temp.	Temp.	Temp.	Temp.	Temp.	Temp.	Temp.	Temp.	Temp.
9		Thermom.	Sensor	Sensor	Sensor	Sensor	Sensor	Sensor	Sensor	Sensor	Sensor	Sensor
10		(C)	#1 (C)	#2 (C)	#3 (C)	#4 (C)	#5 (C)	#6 (C)	#7 (C)	#8 (C)	(C)	(C)
11	6/26/92 14:03	0	0.1224	0.0606	0.097	0.1006	0.0947	0.0816	0.059	0.0201	0.0837	0.0428
12	6/26/92 14:10	0	0.0643	-0.0263	0.0899	0.1082	0.0919	0.0947	0.0616	0.0119	0.0885	0.0389
13	6/26/92 14:12	19.77	19.8749	19.7677	19.8886	19.9059	19.9011	19.8992	19.8667	19.836	19.8789	19.8728
14	6/26/92 14:14	59.78	59.7988	59.6825	59.795	59.8106	59.8436	59.8246	59.7893	59.7918	59.779	59.8404
15	6/26/92 14:18	93.67	93.391	93.2556	93.3283	93.3771	93.4343	93.4289	93.3845	93.5668	93.3347	93.4691
16	6/26/92 14:20	92	91.8179	91.7488	91.875	91.811	91.9281	91.8335	91.8227	91.8414	91.8063	91.9241
17	6/26/92 14:24	0	0.0697	-0.0193	0.0938	0.1111	0.0935	0.0958	0.0844	0.0276	0.083	0.0484
18												
19												
20	Difference between mercury thermometer and thermistor readings.											
21												
22		Mercury	Temp.	Temp.	Temp.	Temp.	Temp.	Temp.	Temp.	Temp.	Temp.	Temp.
23		Thermom.	Sensor	Sensor	Sensor	Sensor	Sensor	Sensor	Sensor	Sensor	Sensor	Sensor
24		(C)	#1 (C)	#2 (C)	#3 (C)	#4 (C)	#5 (C)	#6 (C)	#7 (C)	#8 (C)	(C)	(C)
25												
26		0	-0.0643	0.0263	-0.0899	-0.1082	-0.0919	-0.0947	-0.0616	-0.0119	-0.0885	-0.0389
27		0	-0.1049	0.0023	-0.1186	-0.1359	-0.1311	-0.1292	-0.0967	-0.066	-0.1089	-0.1028
28		19.77	-0.0188	0.0975	-0.015	-0.0306	-0.0636	-0.0446	-0.0093	-0.0118	0.001	-0.0604
29		59.78	0.279	0.4144	0.3417	0.2929	0.2357	0.2411	0.2855	0.1032	0.3353	0.2009
30		93.67	0.1821	0.2512	0.125	0.189	0.0719	0.1665	0.1773	0.1586	0.1937	0.0759
31		92	-0.0697	0.0193	-0.0938	-0.1111	-0.0935	-0.0958	-0.0844	-0.0276	-0.083	-0.0484
32		0	0	0	0	0	0	0	0	0	0	0



CALIBRATION RESULTS:

THE ABOVE PLOT SHOWS ALL OF THE TEMPERATURE SENSORS WERE WITHIN ±0.5°C. THIS IS WITHIN THE ACCURACY REQUIRED FOR TEST 12 SO INDIVIDUAL CALIBRATION FACTORS FOR EACH THERMISTOR WILL NOT BE REQUIRED (ALL THERMISTORS USE THE SAME CONVERSION FACTORS FROM OHMS TO °C).

COPIES OF THE CALIBRATION CERTIFICATES FOR THE ASTM THERMOMETERS CAN BE FOUND IN LABORATORY NOTEBOOK # 003 (CNWRA CONTROLLED COPY) ON P. 26 AND p. 35.

END OF PERIODIC ENTRY ① 7-30-92 Steve Sudeman

PERIODIC ENTRY ② 7-30-92
CALIBRATION DATA FOR PRESSURE SENSORS FOR TEST 12.

7-16-92 [illegible]
CALIBRATION OF PRESSURE GAGES FOR TEST 12 - REPEAT CALIBRATION ON 6-30-92. IT LOOKED LIKE A BAD READING WAS TAKEN

SETUP: PRESSURE SENSORS TO BE CALIBRATED:
HONEYWELL - MICROSWITCH #141PC05G (0 to -5 psig)
PRESSURE REFERENCE:
MERIAM INSTRUMENTS U-TUBE MANOMETER 50" SCALE, 0.1" DIVISIONS
MERIAM 924BA FLUID, 2.95 SG (75°F)
PRESSURE SENSORS ARE MANIFOLDED TOGETHER AND ALL DATA WERE TAKEN AT ONE TIME THROUGH THE DATA ACQUISITION SYSTEM.

CALIBRATION:

TIME	MANOMETER READING (IN. 2.95 SG.)	TENSIOMETER #1 READING (PSIG)
14:57	0	-0.016 psig
14:59	6.14	-0.665
15:00	13.82	-1.48
15:01	19.92	-2.13
15:02	25.87	-2.76
15:03	33.27	-3.56
15:04	39.46	-4.22
15:06	45.65	-4.87
15:09	36.60	-3.91
15:11	24.59	-2.65
15:13	13.24	-1.41
15:14	0	-0.016

DATA FROM CALIBRATION STORED IN T12PCAL2.DAT.
LINEARIZATIONS AND CHANNEL ASSIGNMENTS ARE IN FILE TEST12.CFG.

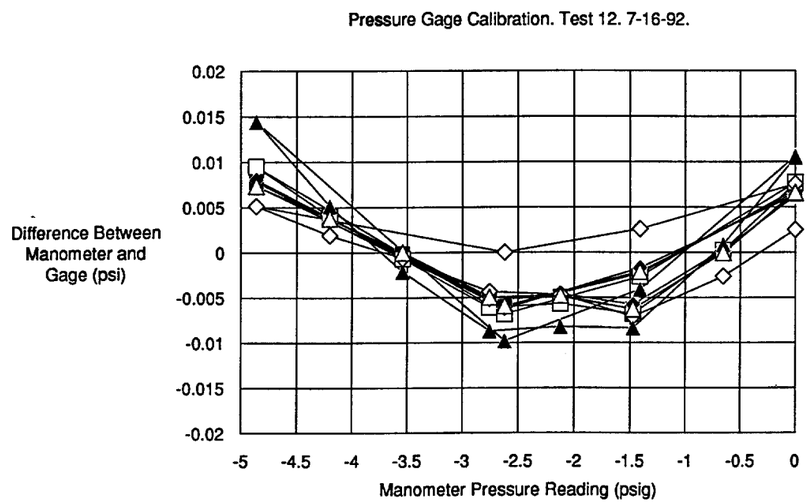
DATA FROM CALIBRATION DATA FILE T12PCAL2.DAT AND CALCULATIONS ARE SHOWN ON THE NEXT 3 PAGES

	A	B	C	D	E	F	G	H	I
145									
146									
147	CNWRA, 20-3704-022								
148	Data from recalibration of Test 12 pressure sensors.								
149	7/16/92								
150									
151									
152									
153		-------Manometer------							
154		-------Reading--------		Press #1	Press #2	Press #3	Press #4	Press #5	Press #6
155		(in 2.95 SG	(psig)	(psig)	(psig)	(psig)	(psig)	(psig)	(psig)
156									
157	7/16/92 14:58	0	0	-0.0164	-0.036	0.0076	0.0317	-0.041	-0.0286
158	7/16/92 14:59	-6.14	-0.653879	-0.665	-0.684	-0.6425	-0.6223	-0.6856	-0.6779
159	7/16/92 15:00	-13.82	-1.471761	-1.4785	-1.4967	-1.4569	-1.4423	-1.4947	-1.4921
160	7/16/92 15:01	-19.92	-2.12138	-2.131	-2.1489	-2.1098	-2.0996	-2.1448	-2.1453
161	7/16/92 15:03	-25.87	-2.755026	-2.7658	-2.7836	-2.7448	-2.7387	-2.7783	-2.7807
162	7/16/92 15:04	-33.27	-3.543089	-3.5608	-3.5789	-3.5401	-3.5369	-3.5734	-3.5762
163	7/16/92 15:05	-39.46	-4.202293	-4.2254	-4.2443	-4.2055	-4.204	-4.2402	-4.2413
164	7/16/92 15:07	-45.65	-4.861497	-4.8902	-4.9105	-4.8715	-4.8718	-4.9091	-4.9061
165	7/16/92 15:12	-24.59	-2.618712	-2.6284	-2.6462	-2.6071	-2.6057	-2.6408	-2.643
166	7/16/92 15:13	-13.24	-1.409994	-1.4206	-1.4389	-1.399	-1.3898	-1.4372	-1.4343
167	7/16/92 15:14	0	0	-0.0166	-0.0361	0.0075	0.0266	-0.0411	-0.0287
168									
169									
170				------Difference between Manometer and Pressure Gage --------					
171				Difference (psig) = Manometer - Pressure Gage					
172			0	0.0164	0.036	-0.0076	-0.0317	0.041	0.0286
173			-0.653879	0.011121	0.030121	-0.011379	-0.031579	0.031721	0.024021
174			-1.471761	0.006739	0.024939	-0.014861	-0.029461	0.022939	0.020339
175			-2.12138	0.00962	0.02752	-0.01158	-0.02178	0.02342	0.02392
176			-2.755026	0.010774	0.028574	-0.010226	-0.016326	0.023274	0.025674
177			-3.543089	0.017711	0.035811	-0.002989	-0.006189	0.030311	0.033111
178			-4.202293	0.023107	0.042007	0.003207	0.001707	0.037907	0.039007
179			-4.861497	0.028703	0.049003	0.010003	0.010303	0.047603	0.044603
180			-2.618712	0.009688	0.027488	-0.011612	-0.013012	0.022088	0.024288
181			-1.409994	0.010606	0.028906	-0.010994	-0.020194	0.027206	0.024306
182			0	0.0166	0.0361	-0.0075	-0.0266	0.0411	0.0287
183									
184				----Percent of Reading Differece Btwn Man. and Press Gage ----					
185				Percent (%) = ((Manom-Gage)/Manom)*100					
186			0	0	0	0	0	0	0
187			-0.653879	-1.700727	8.91E-05	-3.37E-05	-9.34E-05	9.38E-05	7.11E-05
188			-1.471761	1.99E-05	7.38E-05	-4.4E-05	-8.72E-05	6.79E-05	6.02E-05
189			-2.12138	2.85E-05	8.14E-05	-3.43E-05	-6.44E-05	6.93E-05	7.08E-05
190			-2.755026	3.19E-05	8.45E-05	-3.03E-05	-4.83E-05	6.89E-05	7.6E-05
191			-3.543089	5.24E-05	0.000106	-8.84E-06	-1.83E-05	8.97E-05	9.8E-05
192			-4.202293	6.84E-05	0.000124	9.49E-06	5.05E-06	0.000112	0.000115

CALIBRATION DATA

	A	B	C	D	E	F	G	H	I
193			-4.861497	8.49E-05	0.000145	2.96E-05	3.05E-05	0.000141	0.000132
194			-2.618712	2.87E-05	8.13E-05	-3.44E-05	-3.85E-05	6.53E-05	7.19E-05
195			-1.409994	3.14E-05	8.55E-05	-3.25E-05	-5.97E-05	8.05E-05	7.19E-05
196			0	4.91E-05	0.000107	-2.22E-05	-7.87E-05	0.000122	8.49E-05
197									
198		----Convert Pressure Reading back to Voltage (VDC) Readings------							
199		Pressure = -0.8 * VDC + 1.0 for all gages except 4. #4 uses P=-0.78*VDC+0.93							
200									
201			0	1.2705	1.295	1.2405	1.151667	1.30125	1.28575
202			-0.653879	2.08125	2.105	2.053125	1.990128	2.107	2.097375
203			-1.471761	3.098125	3.120875	3.071125	3.04141	3.118375	3.115125
204			-2.12138	3.91375	3.936125	3.88725	3.884103	3.931	3.931625
205			-2.755026	4.70725	4.7295	4.681	4.703462	4.722875	4.725875
206			-3.543089	5.701	5.723625	5.675125	5.726795	5.71675	5.72025
207			-4.202293	6.53175	6.555375	6.506875	6.582051	6.55025	6.551625
208			-4.861497	7.36275	7.388125	7.339375	7.438205	7.386375	7.382625
209			-2.618712	4.5355	4.55775	4.508875	4.532949	4.551	4.55375
210			-1.409994	3.02575	3.048625	2.99875	2.974103	3.0465	3.042875
211			0	1.27075	1.295125	1.240625	1.158205	1.301375	1.285875
212									
213									
214		Curve Fit Above Data for Best Linear Fit Through Data							
215		Slope		-0.798163	-0.798175	-0.797416	-0.773743	-0.799567	-0.797507
216		Intersept		1.007378	1.026056	0.982984	0.888632	1.029968	1.018879
217									
218				----Calculate the resulting Press Readings With New Curve Fit --					
219									
220			0	-0.006688	-0.00758	-0.00621	-0.002461	-0.010469	-0.006517
221			-0.653879	-0.653799	-0.654102	-0.65421	-0.651215	-0.65472	-0.653794
222			-1.471761	-1.46543	-1.464948	-1.465979	-1.464636	-1.463383	-1.465457
223			-2.12138	-2.116432	-2.115661	-2.11677	-2.116663	-2.113131	-2.116622
224			-2.755026	-2.749774	-2.748913	-2.749719	-2.750636	-2.746289	-2.750042
225			-3.543089	-3.542949	-3.542398	-3.54245	-3.542433	-3.540959	-3.543064
226			-4.202293	-4.206022	-4.20628	-4.205701	-4.204181	-4.207398	-4.206091
227			-4.861497	-4.869296	-4.870961	-4.86955	-4.866624	-4.875936	-4.86882
228			-2.618712	-2.61269	-2.611826	-2.612464	-2.618703	-2.608863	-2.612771
229			-1.409994	-1.407663	-1.40728	-1.408266	-1.412557	-1.405914	-1.407837
230			0	-0.006888	-0.00768	-0.00631	-0.00752	-0.010569	-0.006616
231									
232									
233				------Difference between Man. and Curve Fit Press Readings -----					
234									
235			0	0.006688	0.00758	0.00621	0.002461	0.010469	0.006517
236			-0.653879	-8.08E-05	0.000223	0.000331	-0.002665	0.000841	-8.57E-05
237			-1.471761	-0.006331	-0.006813	-0.005781	-0.007125	-0.008378	-0.006304
238			-2.12138	-0.004948	-0.00572	-0.00461	-0.004717	-0.008249	-0.004759
239			-2.755026	-0.005251	-0.006113	-0.005306	-0.004389	-0.008737	-0.004984
240			-3.543089	-0.00014	-0.00069	-0.000638	-0.000656	-0.00213	-2.51E-05

	A	B	C	D	E	F	G	H	I
241			-4.202293	0.00373	0.003988	0.003408	0.001888	0.005105	0.003799
242			-4.861497	0.007799	0.009464	0.008053	0.005127	0.01444	0.007323
243			-2.618712	-0.006022	-0.006886	-0.006248	-8.88E-06	-0.009849	-0.005941
244			-1.409994	-0.00233	-0.002714	-0.001727	0.002564	-0.00408	-0.002157
245			0	0.006888	0.00768	0.00631	0.00752	0.010569	0.006616



CALIBRATION RESULTS:

THE FIRST CALIBRATION OF THE PRESSURE SENSORS HAD A "BAD" LOOKING POINT IN THE CALIBRATION. THIS POINT LOOKED LIKE THE MANOMETER WAS READ INCORRECTLY. THE CALIBRATION WAS REPEATED.

THE GRAPH ON p 8 SHOWS ALL OF THE PRESSURE SENSORS ARE WITHIN ±0.02 psig OF THE MANOMETER READING AFTER INDIVIDUAL CALIBRATION CURVES WERE DEVELOPED FOR EACH SENSOR. THIS IS WITHIN THE REQUIRED ACCURACY RANGE. THE LINEARIZATION FACTORS SHOWN ON p 7 WILL NEED TO BE USED FOR TEST 12. THE DATA ACQUISITION CONFIGURATION FILES FOR THE CALIBRATION AND THAT WILL BE USED FOR TEST 12 ARE ATTACHED BELOW.

TEST 12.CFG DURING CALIBRATION

```
NPLC 1
Barometer            DCV   10.0    .0001   100    PSIa      1  2.4          -3           0
Tensiometer 1        DCV   10.0    .0001   101    PSIg      1  -.8          1            0
Tensiometer 2        DCV   10.0    .0001   102    PSIg      1  -.8          1            0
Tensiometer 3        DCV   10.0    .0001   103    PSIg      1  -.8          1            0
Tensiometer 4        DCV   10.0    .0001   104    PSIg      1  -.78         0.93         0
Tensiometer 5        DCV   10.0    .0001   105    PSIg      1  -.8          1            0
Tensiometer 6        DCV   10.0    .0001   106    PSIg      1  -.8          1            0
YSI Temperature 1    OHM   1e5     .01     200    °C        2  1.0295e-3   2.3908e-4    1.56817e-7
YSI Temperature 2    OHM   1e5     .01     201    °C        2  1.0295e-3   2.3908e-4    1.56817e-7
YSI Temperature 3    OHM   1e5     .01     202    °C        2  1.0295e-3   2.3908e-4    1.56817e-7
YSI Temperature 4    OHM   1e5     .01     203    °C        2  1.0295e-3   2.3908e-4    1.56817e-7
YSI Temperature 5    OHM   1e5     .01     204    °C        2  1.0295e-3   2.3908e-4    1.56817e-7
YSI Temperature 6    OHM   1e5     .01     205    °C        2  1.0295e-3   2.3908e-4    1.56817e-7
Temp Left Plate      OHM   1e5     .01     206    °C        2  1.0295e-3   2.3908e-4    1.56817e-7
Temp right Plate     OHM   1e5     .01     207    °C        2  1.0295e-3   2.3908e-4    1.56817e-7
Room Temp            OHM   1e5     .01     208    °C        2  1.0295e-3   2.3908e-4    1.56817e-7
X position           DCV   10.0    .01     108    Inches    10 3.7330       6.1436       0
Y position           DCV   10.0    .01     109    Inches    11 2.3193       -0.0996      0
YSI Temperature 7    OHM   1e5     .01     408    °C        2  1.0295e-3   2.3908e-4    1.56817e-7
YSI Temperature 8    OHM   1e5     .01     409    °C        2  1.0295e-3   2.3908e-4    1.56817e-7
-------------------*****************************************************************************
Channel label        DMM    DMM     DMM     Relay    Eng.    EQ.    K1          K2          K3
                     Func. Range   Resol.  Numbers  Units   Type
Equation types:
0 - None......... Y = X
1 - Linear....... Y = K1 * X + K2
2 - Thermistor... Y = 1/(K1 + K2 * Ln(X) + K3 * Ln(X)^3 ) - 273.15
10- Linear....... Y = (X - K1) * 10 / (K2 - K1)  (X position - No more than one of these)
11- Linear....... Y = (X - K1) * 10 / (K2 - K1)  (Y position - No more than one of these)
```

END OF PERIODIC ENTRY #2 Steve Siedeman
7-30-92

PERIODIC ENTRY (3) 7-30-92

TEST #12 (TEST NUMBERS ARE NOT IN ORDER OF TESTING SEQUENCE. THE TEST # IS JUST USED TO IDENTIFY THE TEST)

OBJECTIVE:

TEST 12 IS INTENDED TO REPEAT TEST #6 TO SEE IF THE SAME RESULTS ARE OBTAINED (THAT IS, A DRY REGION NEXT TO THE HEATED WALL AND INCREASED SATURATION NEXT TO THE DRY REGION). SOME CHANGES TO THE TEST SETUP WILL BE MADE TO INSTALL MORE SENSORS AND REPLACE THE MEDIA WITH ALUMINA INSTEAD OF GLASS BEADS (TO ELIMINATE UNCERTAINTY ASSOCIATED WITH GLASS DISSOLVING AND CEMENTING).

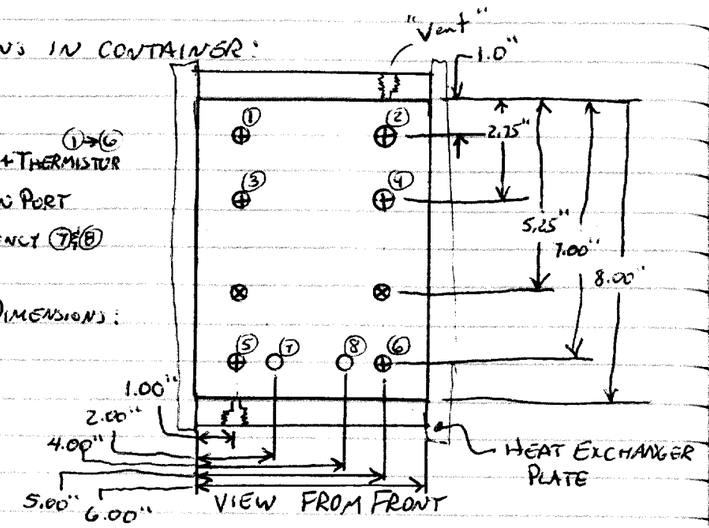
TEST SETUP:

THE SAME DATA ACQUISITION SYSTEM, TRAVERSING SYSTEM FOR THE DENSITOMETER, AND INSTRUMENTATION AS USED WITH TEST #8 WILL BE USED. TEST 12 WILL RUN AT THE SAME TIME AS TEST #8 SO THE DATA ACQUISITION SYSTEM (DAS) SOFTWARE WAS MODIFIED TO ALLOW EACH TEST'S SENSORS TO BE SAMPLED SEQUENTIALLY.

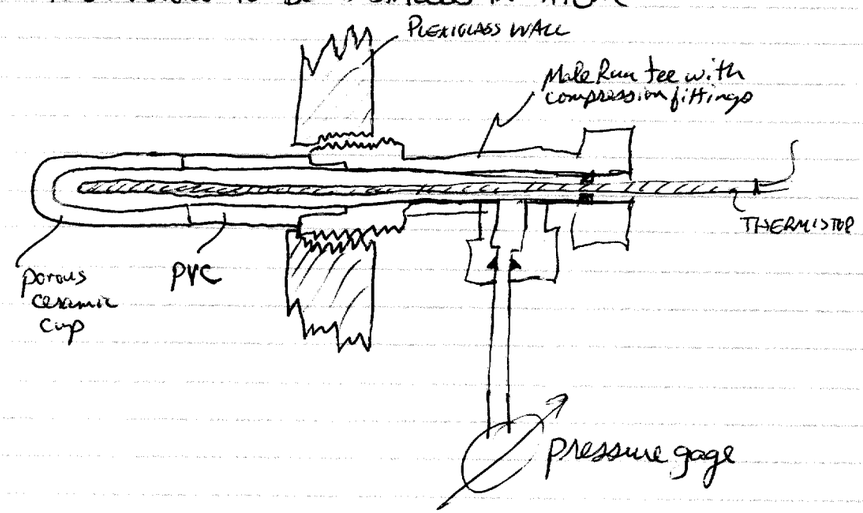
SENSOR LOCATIONS IN CONTAINER:

⊕ TENSIOMETER + THERMISTOR ①→⑥
⊗ DYE INJECTION PORT
O THERMISTOR ONLY ⑦&⑧

CONTAINER INSIDE DIMENSIONS:
8" HIGH
6" WIDE
2.2" DEEP



THE TENSIOMETERS WERE BUILT AS SHOWN BELOW TO ALLOW THERMISTORS TO BE INSTALLED IN THEM



MEDIA: ALCOA T64-100 TABULAR ALUMINA, 99.5% ALUMINA, SCEIVED THROUGH 100 MESH AT FACTORY. FOR THIS TEST, NO FURTHER SCEIVING WAS DONE (FINES WERE NOT REMOVED). OVEN DRIED.

POROSITY OF MEDIA IS ~28 % (See Terry Perry's data)

Media was mixed, by hand in 200ml batches with 28 ml of water for an initial saturation of 50 %. DI water was used.

The 200ml batches of media were mixed and packed by hand into container. Left side of the container was removed to pack media into container.

PACKED IN ~ 1450 ml of beads (dry volume) in container.

7-30-92

5:30PM MEDIA PACKED INTO THE CONTAINER

6:00PM TEST CONTAINER SET IN PLACE ON STAND AND DATA ACQUISITION SYSTEM WAS STARTED

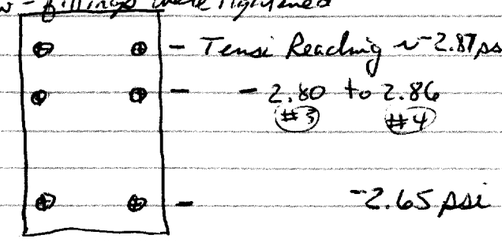
TENSIOMETER PRESSURE GAGES AND THERMISTORS WERE NOT INSTALLED – DID NOT WANT TO WET MEDIA BEFORE ~~OTHER~~ 7-30-92 DENSITOMETER READINGS

A couple of photographs of test container were taken during packing.

7-31-92 9:30AM Looks like DAS is recording data O.K.
9:35AM PHOTO 1.1

8-6-92 4:45PM 20°C water is still circulating through both heat exchanger plates.
Tensiometers were filled with water and the pressure and temperature sensors were installed.

8-7-92 12:10PM Tensiometer readings look consistent.
Except #3 looks low - fittings were tightened

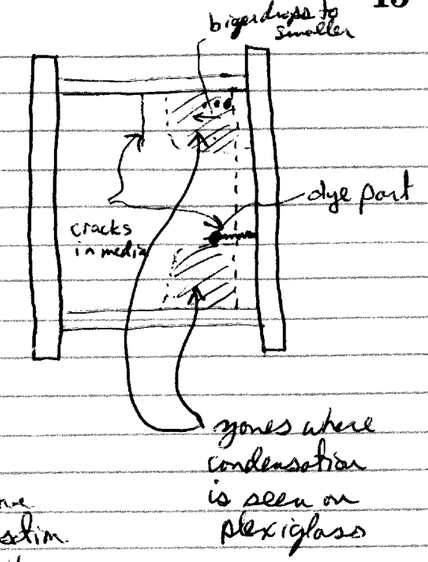


8-12-92 2:30PM PLUMBED ~~LE~~ SS 8-12-92 RIGHT SIDE HEAT EXCHANGER PLATE TO "HOT" FLUID BATH - BATH IS ALSO Being used for Test 8.

Bath Setpoint was changed from 60°C to 90°C
Left heat exchanger plate is still at 20°C.

8-13-92 9:37AM Tensiometer readings have changed very quickly since heating was applied. Before heat was applied the tensiometer read ~-2.8 psig, now the ones near the hot wall read >-5 psig and the ones near the cool wall (left side) are about -1.5 psig.
It appears Tensiometer #2 dried out - it was refilled and quickly came back to ~-3.6 and still going up
Temperature of right side tensimeters is ~69°C

8-13-92 (Con't)



A clear "line" of condensation on the container has formed 0.35" from the right. Very small drops can be seen on the plexiglass on the top and Front faces (back too). The region with condensation goes about 1.5" towards to left and larger condensation drops are near the heater and they get smaller as they move towards the left. The condensation is most visible at top and bottom corners.

Two cracks are now visible in the media. one at left dye port and a much finer on at the center of the container along the top - see drawing above.

8-17-92
12:00 (Noon) DAS down since 8-14-92: it was just "hung up".
Restarted DAS

8-19-92
1:00PM Tensiometer readings are hard to explain. It looks like Tensi #2 (Top right) is starting to dry out so it is going from high SUCTION TO Low Suction pressures. Over last couple of days Tensiometer #4 (middle right) has increased to ~4 psig then it started dropping again - possibly drying out too. Tensi #6 has (lower right) also been Decreasing over last couple of days.

8-27-92 SS

8:30AM PUT IN A DIFFERENT "MOTION" FILE OF POSITIONS FOR THE DENSITOMETER TO Read AND MADE 2 PASSES - READ EVERY 0.2" ACROSS THE TEST CONTAINER AT 3 DIFFERENT HEIGHTS - ~~T12AM~~ SS 8-27-92 "T12FINE.MOT" & "T12FINE.DAT" FILES

3:00PM RESET DAS TO REGULAR DATA AND MOTION FILES
Refilled Tensiometers # 1, 2, 6

8-31-92 SS

2:50PM THE TENSIOMETERS ON THE RIGHT (90°C) SIDE OF THE CONTAINER CONTINUE TO RAPIDLY DRY OUT AFTER THEY ARE FILLED (w/ Deaerated water). The small (~1/4" thick) dry looking region can still be seen next to the right heater plate. Condensation is still seen on the plexiglass near the top and bottom.

9-3-92 SS

1:45PM The 90°C fluid bath had a fuse blow and the bath temperature was ~~up to~~ SS 9-3-92 down to about 32°C. The fuse was replaced and the bath restarted.

The condensation that has been seen on the plexiglass walls is now gone. The dry region next to the heated plate is still visible but less well defined. I also noticed the 2 fractures in the media (see 8-13-92) are not visible now.

9-4-92 SS

12:05PM 90°C BATH IS NOW WORKING FINE.
THE CONDENSATION DROPS ARE BACK ON THE PLEXIGLAS WALL OF THE CONTAINER AS SEEN BEFORE (SEE 8-13-92). The "crack" in the media along the right side of the container is back too - but the one at the top still can not be seen (see 8-13-92 Notes for locations)

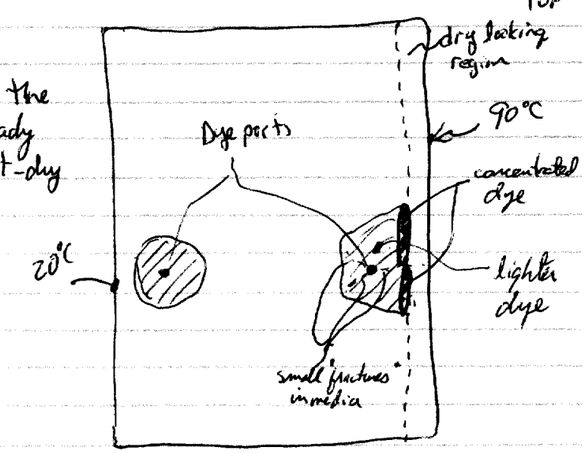
9-17-92 SS

8:55PM No changes to the drying front are visible - the test data file was backed up to a floppy TEST12A.DAT

9-21-92 SS

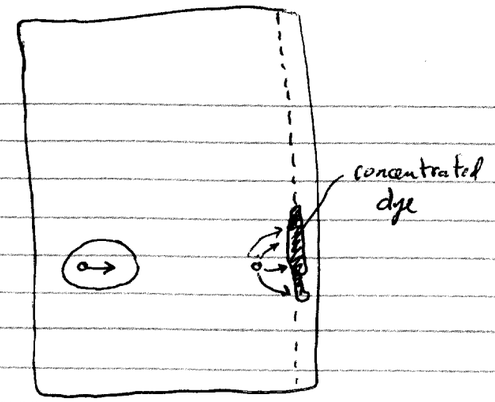
8:20AM INJECTED DYE INTO BOTH DYE PORTS (~0.1-0.2cc's)
PHOTO #1 FLASH NOT FULLY CHARGED
PHOTO #2
THE DYE NEAR THE RIGHT HEATER (90°C) QUICKLY WICKED INTO THE MEDIA. IT MADE A "Y" SHAPED PATTERN THAT MAY BE DUE TO SMALL "CRACKS" IN THE MEDIA - THE "Y" IS ORIENTED LIKE

1:15PM PHOTO #3
Dye injected next to the left heater plate is already concentrated near the wet-dry interface



9-22-92 SS

8:30AM PHOTO 4

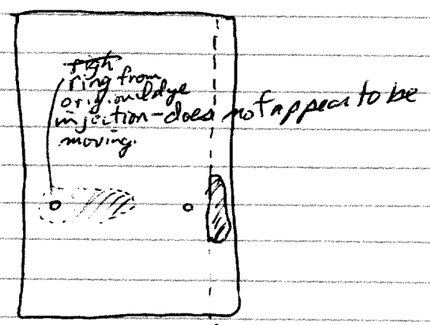


Dye on left side is moving to the right and may be moving down slightly. Dye injected near the hot plate has all moved to the dry-wet interface and it is concentrated there. Some of the dye has moved across the interface, but it is not as concentrated (lighter in color)

4:10PM PHOTO #5 (I think I forgot to put the photo label on the test container)

9-23-92 SS

9:25AM PHOTO 6



Dye from left side is getting very hard to see, but it has moved to the right over 2 inches since it was injected (it is slightly past half way across the container). There may be some slight downward movement

The dye from the right side side dye port is still concentrated along the interface between the wet looking and dry looking media. The dye looks like it is diffusing further to the right through the "dry" media. It is now becoming slightly less concentrated

3:35PM PHOTO 7

10-5-92 SS

9:10AM PHOTO 8

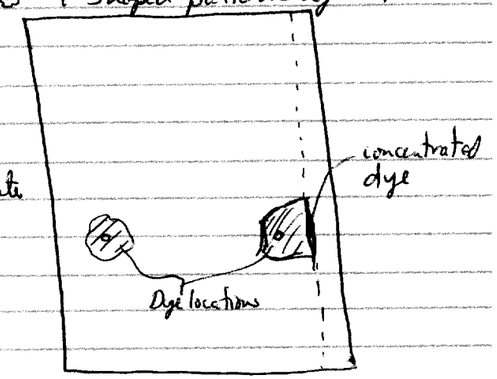
Injected ~ 0.1cc of red dye (food coloring) into each dye port

9:15AM PHOTO 9 Just after dye injection

The dye near the heated plate (90°C) diffused into the media quickly and therefore is lighter than the dye on the left. The dye on the right also made the "Y" shaped pattern again.

12:30PM PHOTO 10

Dye near the heater has already moved over to the wet-dry interface and started to concentrate there

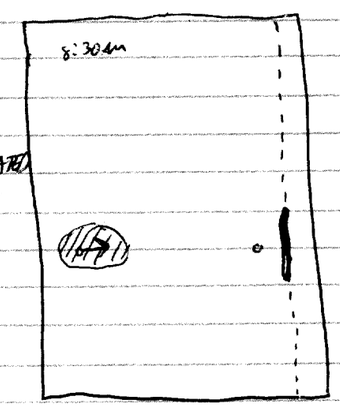


5:10PM PHOTO 11

Only a trace of dye left around the right dye port. All the dye is now concentrated in the wet-dry interface

10-6-92 SS

8:30AM PHOTO 12



ALL THE DYE INJECTED IN THE RIGHT DYE PORT IS CONCENTRATED IN THE WET-DRY INTERFACE REGION.

STARTED FINE SCAN OF TEST CONTAINER (T12FINE.MOT)

2:00PM PHOTO 13

4:40PM PHOTO 14

STOPPED "FINE" SCAN OF TEST CONTAINER - RESTARTED DAS.

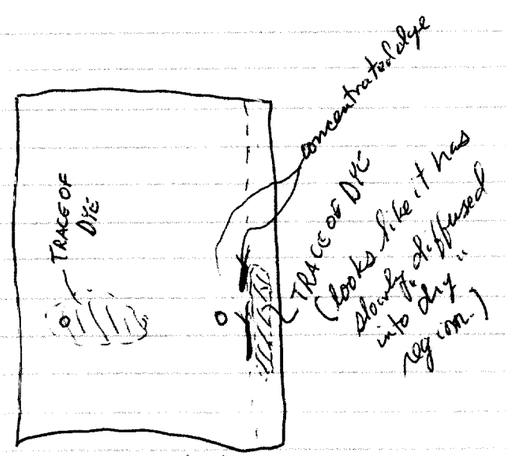
10-7-92 SS
8:25AM PHOTO 15
Dye from left dye port is about ½ way towards right plate (~3" from left plate)

10-8-92 SS PHOTO 16
3:20PM
Standard block had been "bumped" and was repositioned (only slightly moved)

10-9-92 SS
3:15PM PHOTO 17
The dye injected in the left dye port is now very difficult to see - all that is left is a light "stained" area of dye near the ~~bec~~ dye port. SS 10-9-92
The dye that had been moving to the right is no longer visible - it may have been concentrated at the wet-dry interface near the heater.

10-12-92 SS
10:00AM PHOTO 18

10-14-92 SS PHOTO 19
2:10PM



Plug on dye port on left was off, I put it back on

Filled all Tensiometers with water
Tensi #1 ~ -1.97 #2 ~ -4.8
#3 ~ -1.94 #4 ~ -3.66 ↓
#5 ~ -1.98 #6 ~ -2.58 ↓
right after filling
↳ still going down

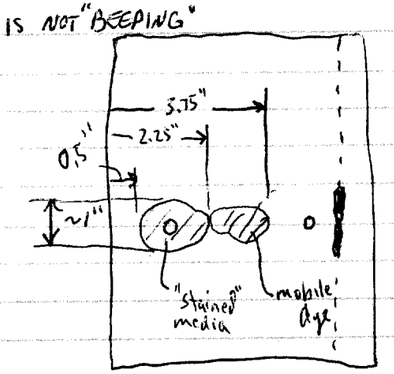
10-19-92 SS
8:20AM PHOTO 20 (TURNED OFF DAS SO PHOTO'S COULD BE TAKEN EVERY 30 MINUTES)

8:37AM PHOTO 21
8:50AM 22
9:15AM 23
9:35AM 24
10:15AM 25
11:00AM 26
12:00AM 27
1:00PM 28
2:00PM 29
4:30PM 30 RESTARTED DAS

10-21-92 SS
9:20AM SHUT DOWN DAS TO RUN A TRAVERSE WITH THE γ-DENSITOMETER THAT TAKES DATA AT CLOSER INTERVALS
MOTION FILE: T12FINEC.MOT (Y=3.5" X=63 LOCATIONS)
DATA FILE: T12FINEC.DAT

10-22-92 SS
8:30AM Changed motion + Data files to scan @ Y=5 X=63 locations
MOTION FILE: T12FINED.MOT
DATA FILE: T12FINED.DAT
PHOTO 31 (Camera had been knocked down prior to this photo)
2 PHOTO'S TAKEN BUT FLASH DOES NOT WORK AND TIMERON CAMERA IS NOT "BEEPING"

4:50PM Restarted DAS on regular scan interval.



10-27-92 SS

8:30am Modified TRAVERSE.BAS PROGRAM TO ALLOW 350 X,Y LOCATIONS TO BERECORDED

SS 10-27-92

~~DATE~~ CHANGED TIME TO STANDARD TIME (NO LONGER ON DAYLIGHT SAVINGS TIME)

SET UP TRAVERSE TO LOOK AT FINE SCAN DATA FILE T12FINEF.DAT (Y=3.5 & 6.5)
MOTION FILE T12FINEF.MOT

10-28-92 SS

9:00am 3 scans with T12FINEF.DAT ARE COMPLETE
STARTED SCANS WITH T12FINEG.~~DAT~~ MOT (Y=4.5" & 4.6") SS 10-28-92
DATA FILE T12FINEG.DAT

10-29-92 SS

9:30am 3 SCANS WITH T12FINEG.MOT COMPLETED SS 10-29
STARTED SCAN WITH T12FINEH.MOT Y=~~4.7 3~~ 3.4", 3.6"
DATA FILE - T12FINEH.DAT

5:20PM 1 SCAN AT T12FINEF.MOT LOCATIONS
STARTED SCAN WITH T12FINEI.MOT (Y=6.4", 6.6")
DATA T12FINEI.DAT

10-30-92 SS

9:00AM 2 SCANS WITH T12FINEI.MOT FILE COMPLETED
STARTED SCAN WITH T12FINEJ.MOT (Y=4.4")
DATA FILE T12FINEJ.DAT

2:20 PM 1 SCAN WITH T12FINEJ.MOT FILE COMPLETED
Set up DAS to SCAN TEST 8

11-2-92 SS

8:40AM Restarted DAS with TEST12.MOT TO Record moisture distribution prior to shutting off heater

11-4-92 SS

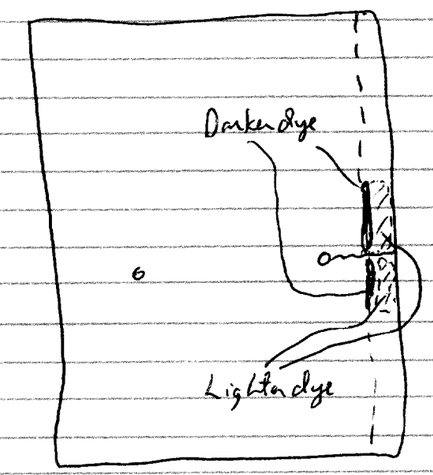
12:00 Noon DAS down - restarted DAS

11-5-92 SS

8:45AM PHOTO 32 (TOOK 1 PHOTO W/O LABEL SO I Re-took photo 32 with Label)

I noticed the Test 12 container had again been bumped - it was slightly out of position - I do not know when this occurred - same with Standard block - it was also repositioned.

Turned off heater to let media cool back to 20°C (heater has been @ 90°C).



4:00 PM I left the Traversing system controls on Manual so DAS was "Stuck" - NO DATA TAKEN FROM 8:45AM TODAY

HOT BATH TEMP DOWN TO 33°C

DYE LOOKS SAME AS EARLIER TODAY

10-6-92

8:15AM PHOTO 33

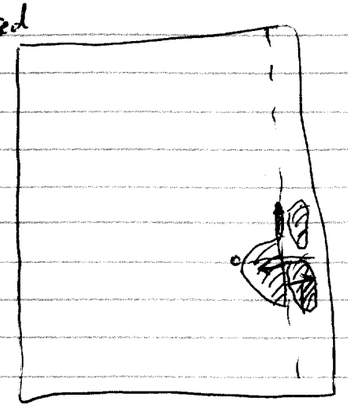
Some of the "concentrated" dye at the wet-dry interface has moved into the dry region

11-9-92 SS

8:25AM DAS Down - Restarted

PHOTO 34

Dye has moved towards the "heated" wall AND it has now moved towards the left too. Dye above the dye port has not migrated as much as the concentrated dye below the dye port.



11-10-92 SS

9:15AM PHOTO 35

DAS Down due to power failure this morning

11-11-92 SS

8:10AM DAS OFF - INTERVAL LAB TOUR LAST NIGHT

DAS RESTARTED

11-13-92 SS

1:00PM Refilled all tensiometers with water.

Ran 20°C (Chilled) bath water line through hot bath to pull it down below 25°C (through the heat exchanger line in back of bath).

11-16-92 SS

8:35AM Turned off DAS to run "fine" SCANS TO SEE IF WATER REDISTRIBUTE

FINE SCAN DATA T12FINEF.DAT

MOTION FILE " .MOT Y=3.5" & 6.5"

11:45 AM Restarted DAS - Failure due to breaker blown in lab.

11-17-92 SS

8:40AM Changed Fine Scan to: T12FINEG.MOT - MODIFIED TO ONLY SCAN AT Y=4.5" (Remove 4.6")

DATA FILE: T12FINEG.DAT

11-18-92 SS

9:25AM STOPPED SCAN WITH T12FINEG.MOT FILE AFTER 4 SCANS

STARTED TO MEASURE TEST 8 WITH "FINE" SCAN.

11-19-92 SS

12:45PM Restarted DAS to record data prior to start of drying media

11-20-92 SS

4:00PM PHOTO 36

4:45PM BOTH constant Temp. Baths were set to 60°C to start drying the media. Nitrogen was connected to the bottom of the container (a line was connected from a N_2 bottle), and the vent on the top was opened.

11-23-92 SS

9:40AM N_2 was not flowing through vent - increased pressure slightly to get flow.

11-30-92 SS

8:30AM PHOTO 37

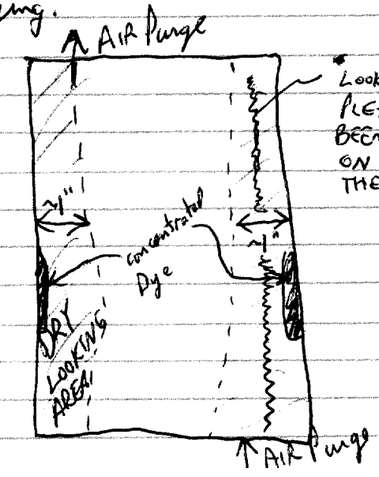
12-2-92 SS

1:50PM Turned both constant temperature baths to 90°C to accelerate drying.

12-9-92 SS

11:50AM PHOTO 38

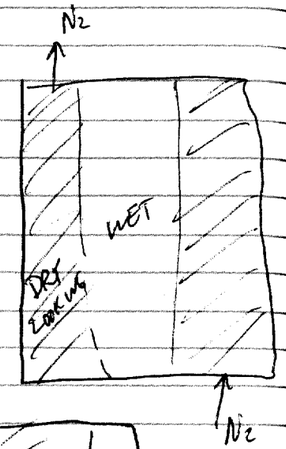
Dry regions have extended out away from the Heated plates



12-10-92 SS
3:45 AM DAS Down - Restarted DAS

12-11-92 SS
5:05 PM Photo 39

12-14-92 SS
1:40 PM THE DRYING FRONT IS DIFFICULT TO SEE - BUT EACH PLATE HAS "DRIVEN OFF" THE WATER NEAR IT AND THE DRY REGION CONTINUES TO GROW



12-18-92 SS
10:05 AM Photo 40
Media is still not completely dry. The center portion near the top still looks wet

The aluminum standard block was slightly off alignment. I do not know when (or how) it was moved. Repositioned it.

1-4-93 SS
9:20 AM THE DAS WAS DOWN
~~ONE OF~~ SS 1-4-93 THE HEATER BATH IS STILL AT 90°C
LOOKS LIKE MEDIA IS DRY
RESTARTED DAS TO RECORD "DRY MEDIA" READINGS FOR A COUPLE OF DAYS
SET HEATER TO 20°C SET POINT

1-5-93 SS
8:25 AM DATA TAKEN OVER THE LAST 2 DAYS DOES NOT PLOT TO SCREEN. MAY BE PROBLEM WITH DATA FILE. DAS Restarted with new Data File "TEST12 C.DAT".

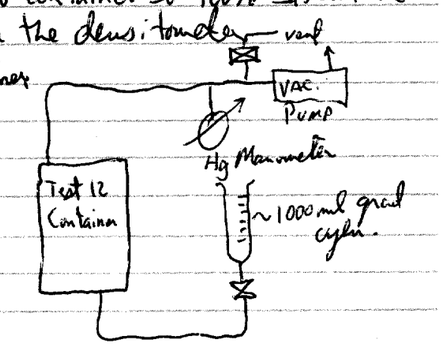
1-8-93 SS
9:10 AM Turned off DAS TO RUN "FINE" SCANS OF Dry media
MOTION FILE T12FINEF.MOT (Y = 3.5" & 6.5")
DATA FILE T12FINEF.DAT

1-11-93 SS
9:00 AM Changed "FINE" SCAN LOCATION TO T12FINEG.MOT
DATA FILE : T12FINEG.DAT (Y = 4.5")
(6 SCANS OF CONTAINER COMPLETED WITH T12FINEF.MOT FILE)

1-12-93 SS 5 SCANS OF CONTAINER COMPLETED WITH T12FINEG.MOT
8:20 AM TURNED OFF DAS SO FINE SCANS COULD BE MADE OF TEST 8.

1-15-93 SS
2:20 PM Restarted DAS to record data prior to saturating media

1-18-93 SS
10:15 am Set up to inject water into container so 100% Saturation readings can be made with the densitometer
Slowly applied a vacuum to the container up to 15 in Hg
Deaerated DI water by boiling



1-18-93 DS (Con't)

11:00 AM STARTED TO FILL CONTAINER WITH WATER

PHOTO 40 @ 11:05 AM

PHOTO 41 @ 11:25 AM

PHOTO 42 @ 12:00 PM (350 ml water injected)

PHOTO 43 @ 12:35 PM (530 ml " ")

THE CONTAINER IS FILLING UNIFORMLY AND THE DYE (CONCENTRATED NEAR THE RIGHT HX PLATE) IS MOVING UPWARD WITH THE WATER. THE "CRACKS" IN THE MEDIA NEAR THE DYE INJECTION PORTS SLOWED WATER MOVEMENT AS IT FLOWED UP FROM THE BOTTOM, IT DOES NOT LOOK LIKE MANY "DRY" AREAS REMAIN IN THE MEDIA.

PHOTO 44 @ 1:00 PM (605 ml Water Injected)

TURNED OF VACUUM PUMP WHEN WATER APPEARED IN TUBE @ TOP

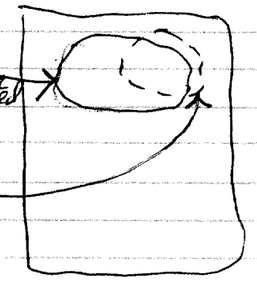
TOTAL WATER ADDED TO CONTAINER = 715 ml DS 1-18-93

Restarted DAS to record 100% Saturation Readings

The media saturated 1ST, then the region between the media and the wall of the container started to fill. Contain started to leak – end plates were tightened 1/8 to 1/4 turn. Leaking reduced but not stopped.

Will not hold hydrostatic pressure

Region next to glass not saturated on front and back



1-19-93 DS

9:10 AM DAS Down. Left DAS off To Fill Test 8 CONTAINER WITH WATER FOR 100% SATURATION READINGS

THE WATER THAT WAS VISIBLE BETWEEN THE GLASS AND THE MEDIA DRAINED OUT OVER NIGHT

10:00 AM PHOTO 45

1-19-93 DS (Con't)

1:20 PM RESTARTED DAS

REINSTALLED CHILLER IN HEAT EXCHANGER BATH LINE TO COOL DOWN TO 20°C (RANDY M. HAD BEEN USING IT).

1-25-93 DS

1:25 PM Set DAS TO "FINE" SCAN. MOTION FILE "T12FINEF.MOT" (Y = 3.5" & 6.5"), DATA FILE T12FINE.DAT

1-28-93 DS

9:00 AM SET DAS TO SCAN AT "FINE" INTERVAL AT Y = 4.5

MOTION FILE T12FINEG.MOT

DATA FILE T12FINEG.DAT

1-29-93 DS

3:30 PM DATA SAMPLING INTERVAL WAS SET TO 3 hours – Data scan must take over 3 hours since data recorded @ 6 hour intervals – only 5 scans recorded. Reset sample interval to 4 hours to record a few more 100% saturation readings at Y = 4.5 and "FINE" interval

2-1-93 DS

8:40 AM DAS DOWN – FAILED over weekend (early SATURDAY MORNING) So only a couple of scans of wet media were obtained.

Restarted DAS w/ T12FINEG.MOT FILE TO GET A COUPLE MORE SCANS AT Y = 4.5" (FINE SCAN)

2-2-93 DS

10:30 AM TURNED OFF DAS TO PERFORM FINE SCAN ON TEST 8

2-8-93 SS
4:15 PM PHOTO 46
FINE SCANS OF TEST 8 COMPLETED -
DAS SHUT DOWN
TEST 12 COMPLETED
- Removed cooling/heating fluid lines and removed container from the test stand.

Removed pressure gages from Tensiometers

Tensi # 1	=	-0.0114 psig	should be 0.000 psig
" 2		-0.0314	
" 3		+0.0073	
" 4		-0.1246	
" 5		-0.0168	
" 6		-0.0179	

2-25-93 SS

TEST MEDIA WAS REMOVED FROM CONTAINER AND WEIGHED WET AND THEN DRIED IN AN OVEN FOR SEVERAL DAYS AND RE-WEIGHED. (KRISTI MEYER DID WORK)

WEIGHT OF WET MEDIA : 5,599.2 g
WEIGHT OF DRY MEDIA : 4,950.0 g

WEIGHT OF WATER IN MEDIA: 649.2 g

VOLUME OF DRY MEDIA = 1,750 ml

BASED ON INITIAL WORK OF Terry Perry, assumed media porosity was 28% (see p 13). It appears this is incorrect. If media was 100% saturated, above data gives a porosity of:

$$\text{VOID FRACTION} \sim \frac{649.2\ \text{ml}}{1750\ \text{ml}} = \underline{0.37}$$

2-25-93 (con't) SS
The data from the γ-densitometer also indicate the initial saturation was significantly less than the 50% value based on 28% void fraction.

Amount of water injected into the container to saturate was 705 ml. Some of this dripped out of the container (~10 ml is estimated). This is quite a bit more water than the 649.2 ml measured by drying media after test. Other sources of error include: evaporation while the container was unpacked, loss of some media and water during unpacking, and loss of moisture while the container sat & before it was unpacked (that is, the media was removed).

2-25-93 JJ

TEST12.CFG

Channel label	DMM Func.	DMM Range	DMM Resol.	Relay Numbers	Eng. Units	EQ. Type	K1	K2	K3
NPLC 1									
Barometer	DCV	10.0	.0001	100	PSIa	1	2.4	-3	0
Tensiometer 1	DCV	10.0	.0001	101	PSIg	1	-.7981	1.007	0
Tensiometer 2	DCV	10.0	.0001	102	PSIg	1	-.7982	1.026	0
Tensiometer 3	DCV	10.0	.0001	103	PSIg	1	-.7974	0.983	0
Tensiometer 4	DCV	10.0	.0001	104	PSIg	1	-.7737	0.889	0
Tensiometer 5	DCV	10.0	.0001	105	PSIg	1	-.7996	1.030	0
Tensiometer 6	DCV	10.0	.0001	106	PSIg	1	-.7975	1.019	0
YSI Temperature 1	OHM	1e5	.01	200	øC	2	1.0295e-3	2.3908e-4	1.56817e-7
YSI Temperature 2	OHM	1e5	.01	201	øC	2	1.0295e-3	2.3908e-4	1.56817e-7
YSI Temperature 3	OHM	1e5	.01	202	øC	2	1.0295e-3	2.3908e-4	1.56817e-7
YSI Temperature 4	OHM	1e5	.01	203	øC	2	1.0295e-3	2.3908e-4	1.56817e-7
YSI Temperature 5	OHM	1e5	.01	204	øC	2	1.0295e-3	2.3908e-4	1.56817e-7
YSI Temperature 6	OHM	1e5	.01	205	øC	2	1.0295e-3	2.3908e-4	1.56817e-7
Temp Left Plate	OHM	1e5	.01	206	øC	2	1.0295e-3	2.3908e-4	1.56817e-7
Temp right Plate	OHM	1e5	.01	207	øC	2	1.0295e-3	2.3908e-4	1.56817e-7
Room Temp	OHM	1e5	.01	208	øC	2	1.0295e-3	2.3908e-4	1.56817e-7
X position	DCV	10.0	.01	108	Inches	10	1.074	3.484	0
Y position	DCV	10.0	.01	109	Inches	11	2.786	0.367	0
YSI Temperature 7	OHM	1e5	.01	408	øC	2	1.0295e-3	2.3908e-4	1.56817e-7
YSI Temperature 8	OHM	1e5	.01	409	øC	2	1.0295e-3	2.3908e-4	1.56817e-7

Equation types:

0 - None..... Y = X
1 - Linear..... Y = K1 * X + K2
2 - Thermistor... Y = 1/(K1 + K2 * Ln(X) + K3 * Ln(X)^3) - 273.15
10- Linear..... Y = (X - K1) * 10 / (K2 - K1) (X position - No more than one of these)
11- Linear..... Y = (X - K1) * 10 / (K2 - K1) (Y position - No more than one of these)

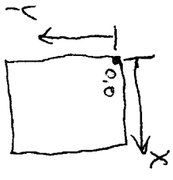
2-25-93 JJ

DWELL TIME = 15

X [in.]	Y [in.]
10.533	-2.570
10.533	-2.570
12.884	-2.570
0.500	1.500
1.500	1.500
2.500	1.500
3.500	1.500
4.500	1.500
5.500	1.500
0.500	3.500
1.500	3.500
2.500	3.500
3.500	3.500
4.500	3.500
5.500	3.500
0.500	4.500
1.500	4.500
2.500	4.500
3.500	4.500
4.500	4.500
5.500	4.500
0.500	6.500
1.500	6.500
2.500	6.500
3.500	6.500
4.500	6.500
5.500	6.500

Park Position
Location of All Blocks

DENSITOMETER SAMPLING LOCATIONS



TEST12.MOT

PERIODIC ENTRY ④ 3-8-93

TEST 12B

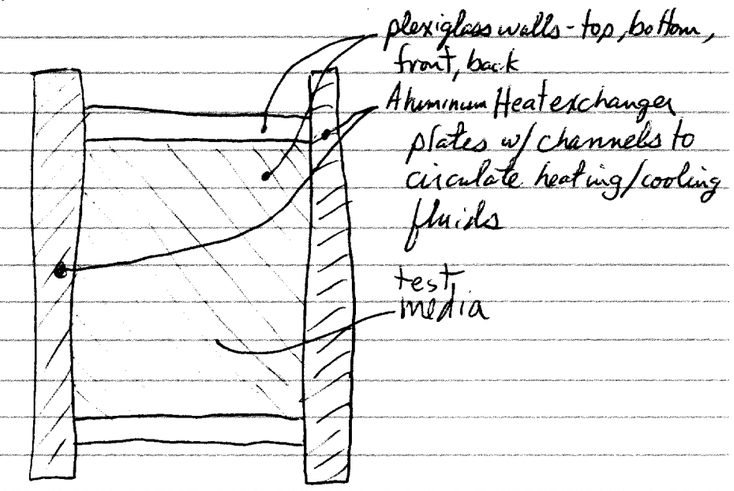
OBJECTIVE: Repeat Test 12 WITH THE FOLLOWING CHANGES:

1) PROVIDE MORE UNIFORM MEDIA PACKING DENSITY (ELIMINATE DIFFICULTIES REDUCING DATA BECAUSE OF VARIATIONS IN PACKING DENSITY)
2) ELIMINATE ALL SENSORS THAT PENETRATED INTO THE CONTAINER. THIS WILL SIMPLIFY TEST AND ALLOW γ-DENSITOMETER TO SCAN ENTIRE CONTAINER WITHOUT INTERFERENCE FROM WIRES, FITTINGS, AND GAGES.

TEST SETUP:

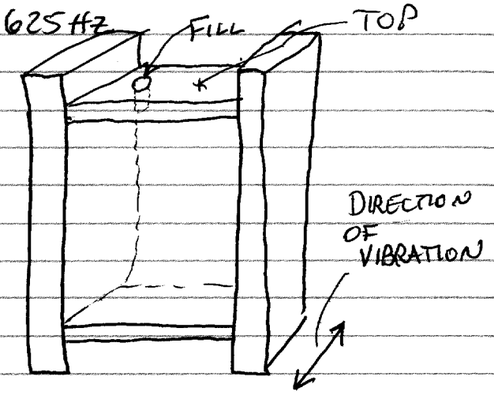
SAME BASIC SET-UP AS TEST 12

A NEW TEST CONTAINER WAS FABRICATED FOR TEST 12B WITHOUT THE PENETRATIONS FOR SENSORS. DIMENSIONS – 6.0" WIDE, 8.0" TALL, AND 2.3" DEEP



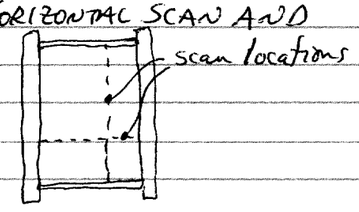
MEDIA PACKING: MEDIA IS ALCOA TABULAR ALUMINA T64-325LI (Factory Sieved through 325 MESH) - Baked @ 95°C overnight

PACKING - THE MEDIA WAS SLOWLY POURED INTO THE CONTAINER FROM A 1/8" NPT HOLE IN THE CONTAINER WHILE THE CONTAINER WAS ON AN ELETROMAGNETIC SHAKER TABLE. SHAKER WAS IN HORIZONTAL PLANE, EXCITATION WAS BROADBAND RANDOM FROM 5 Hz to 625 Hz



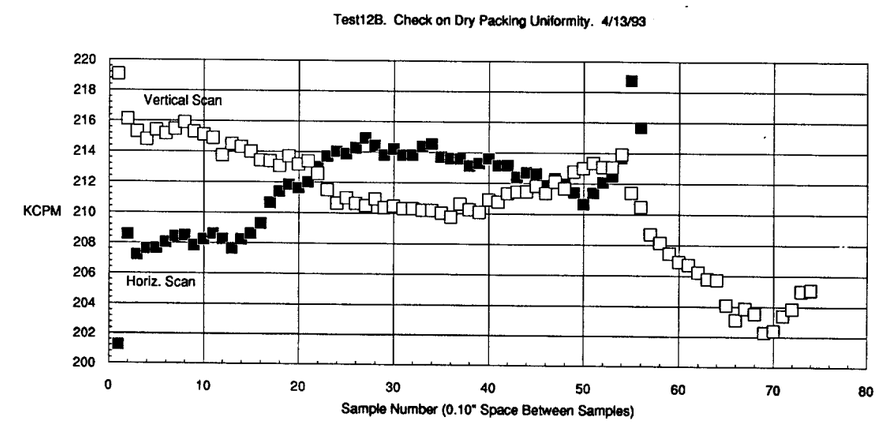
WEIGHT OF CONTAINER + MEDIA (PLUGS WERE INSTALLED IN TOP) = 9866.5g Dry

3-8-93 @ 4:00 PM STARTED DAS TO CHECK PACKING UNIFORMITY OF DRY MEDIA. ONE HORIZONTAL SCAN AND ONE VERTICAL SCAN.



4-13-93

DATA FROM X-DENSITOMETER SCANS SHOWS THE MEDIA PACKING IS NOT VERY UNIFORM. PLOT BELOW SHOWS DENSITOMETER COUNTS AT 0.1" SPACING BETWEEN SAMPLE LOCATIONS -- 1 SCAN FROM LEFT TO RIGHT OF CONTAINER, 1 SCAN FROM TOP TO BOTTOM. IF PACKING WAS UNIFORM, ALL COUNTS WOULD BE VERY CLOSE TO THE SAME VALUE.



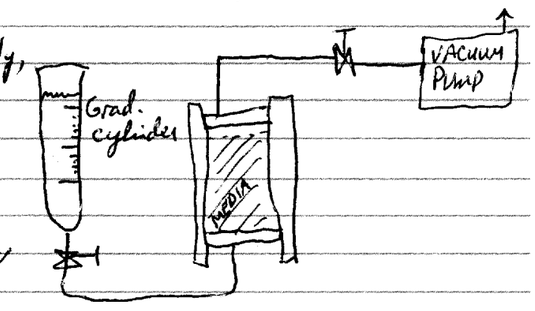
TRY TO SHAKE MEDIA AFTER IT IS SATURATED TO GET IT MORE UNIFORM.

4-14-93

Harry Bishop filled media with water. Setup shown below, vacuum applied very slowly.

Water did not fill uniformly, dry spots developed along with cracks as water put into media.

850 ml injected, quite a bit stands over media, on top.



4-15-93 SS

Container taken to Building 128 to be vibrated on a horizontal, electromagnetic, shaker. Broadband random excitation from 5 to 625 Hz was used. The media near the top moved freely with the liquid. Bubbles migrated to the plexiglass surface. Vibrated for 5 minutes. Shake direction (front to back)

Excess water was removed from the top of the media ~ 67 ml removed.

Weight of container + media + water (w/o plugs) = 10,650.6g before water removed

Weight after water removed = 10,585.5 g

ΔWeight = 75.1 g (some media was removed with the water)

Note: Weight Dry = 9,866.5
Weight Wet = 10,650.6g
Difference = 784.1 g

QTY OF WATER ADDED = 850 ml

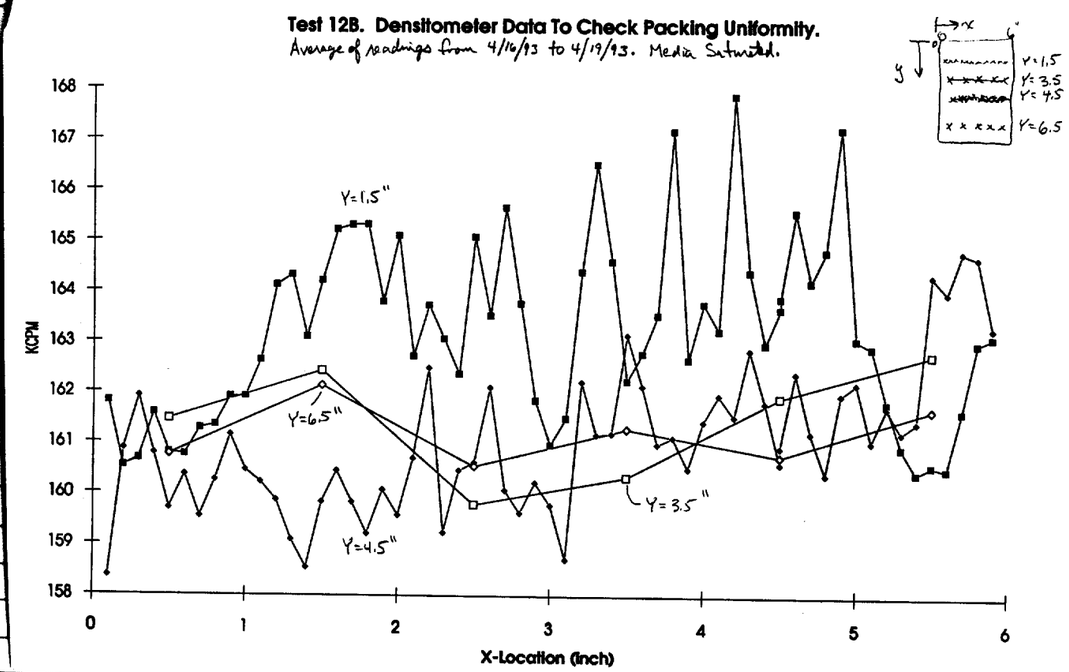
DIFFERENCE OF ~65.9 grams - Must be error in amount of water injected -or- dry weight. Fill Time ~ 2 hours so some evaporation to vacuum pump - I doubt 65.9 ml worth.

Media level is ~ ½" below top of container.

5:00PM Restarted DAS to record γ-densitometer readings for saturated media & check packing uniformity

4-20-93 SS

Media packing is still not very uniform (see plot below). The packing seems to be a bit more uniform nearer the bottom. Near the top (Y=1.5") it is not uniform at all.



It does not appear that further vibration of media will improve the packing. Therefore testing is difficult to perform and data would be hard to interpert. Test is canceled.

END OF PERIODIC ENTRY (4) Steve Sedeman 4-20-93

PERIODIC ENTRY (5) 1-20-94

CALIBRATION OF TEMPERATURE SENSORS FOR USE ON "CERAMIC BLOCK" TEST

SETUP: THE 3 TEMPERATURE SENSORS WERE CONNECTED TO THE DATA ACQUISITION SYSTEM. THE SENSOR OUTPUT WAS READ THROUGH THE DAS. MERCURY-IN-GLASS THERMOMETERS WERE USED TO MEASURE THE TEMPERATURE IN THE WATER BATH (THAT THE TEMPERATURE SENSORS WERE PLACED IN).

MERCURY-IN-GLASS THERMOMETERS:

BROOKLYN THERMOMETER CO.

ASTM THERMOMETER SET

MODEL #		Range	Scale Division
ASTM 63F	8009-1311	18-88°F	0.2°F
ASTM 65F	7903-3787	122-176°F	0.2°F
ASTM 66F	8003-799	168-220°F	0.2°F

Ice point checked on each thermometer - all good.

The data acquisition system channel assignments and multimeter setting are given in the following table.

NPLC 1

Channel label	DMM Func.	DMM Range	DMM Resol.	Relay Numbers	Eng. Units	EQ. Type	K1	K2	K3
Barometer	DCV	10.0	.0001	100	PSIa	1	2.4	-3	0
Temp Plates	OHM	1e5	.01	207	°C	2	1.0295e-3	2.3908e-4	1.56817e-7
Temp Heater	DCV	10.0	.01	407	°C	1	63.854	-49.535	0
Room Temp	OHM	1e5	.01	208	°C	2	1.0295e-3	2.3908e-4	1.56817e-7
Heater Power	DCV	10.0	.0001	408	Watts	1	100.0	0.000	0
X position	DCV	10.0	.01	108	Inches	10	3.7330	6.1436	0
Y position	DCV	10.0	.01	109	Inches	11	2.359	-0.0599	0

Equation types:

0 - None..... Y = X

1 - Linear..... Y = K1 * X + K2

2 - Thermistor... Y = 1/(K1 + K2 * Ln(X) + K3 * Ln(X)^3) - 273.15

10- Linear..... Y = (X - K1) * 10 / (K2 - K1) (X position - No more than one of these)

11- Linear..... Y = (X - K1) * 10 / (K2 - K1) (Y position - No more than one of these)

1-20-94 SS

The data from the calibration check are given in the following table.

	A	B	C	D	E	F	G	H	I	J
1	CNWRA, 20-5704-023, Thermohydrology.									
2	1/20/94									
3	Calibration of Temperature Sensors for Ceramic Block Test.									
4										
5										
6								-----"Error" in Temp Reading----		
7	ASTM		"Plate"	"Heater"		"Room"		"Plate"	"Heater"	"Room"
8	Thermometer		Thermom	TC		Thermom		Thermom	TC	Thermom
9	(F)	(C)	(C)	(VDC)	(C)	(C)		(C)	(C)	(C)
10										
11	78.00	25.56	25.61	1.17	24.86	25.53		-0.054	0.693	0.026
12	140.60	60.33	60.31	1.70	59.05	60.27		0.023	1.288	0.063
13	202.60	94.78	94.81	2.28	95.77	94.79		-0.032	-0.993	-0.012
14	32.00	0.00	0.10	0.79	1.15	0.00		-0.100	-1.151	0.000
15										
16		TC Curve Fit - Slope		63.8536						
17			Intersept	-49.535						

"Heater" Thermocouple (TC) equation: $T(°C) = 63.854 * VDC + {}^{-}49.535$

The "error" in the thermistors ("Plate" and "Room" temperature sensors) is less than 0.1°C.

The "error" in the linearized thermocouple ("Heater" sensor) is about 1.5°C.

These "errors" in the temperature readings are acceptable for the block (ceramic) test since the temperature measurements do not need to be precise.

End of Periodic Entry (5) Steve Siedenman 1-20-94

PERIODIC ENTRY (6) 3-3-94 SS

CHECK SETTINGS ON LUDLUM 2200 SCALER/RATEMETER

PROCEDURE: SS 3-3-94

SET "WINDOW" SETTING TO ~~0.1~~ 1
SET COUNT TIME TO 12 SECONDS
HIGH VOLTAGE SETTING - LEAVE AT 414
VARY THRESHOLD SETTING AND RECORD COUNT AT EACH SETTING.
PLOT COUNT VS. SETTING TO DETERMINE THE PROPER THRESHOLD & WINDOW SETTINGS FOR Cs 137 @ 660 keV.

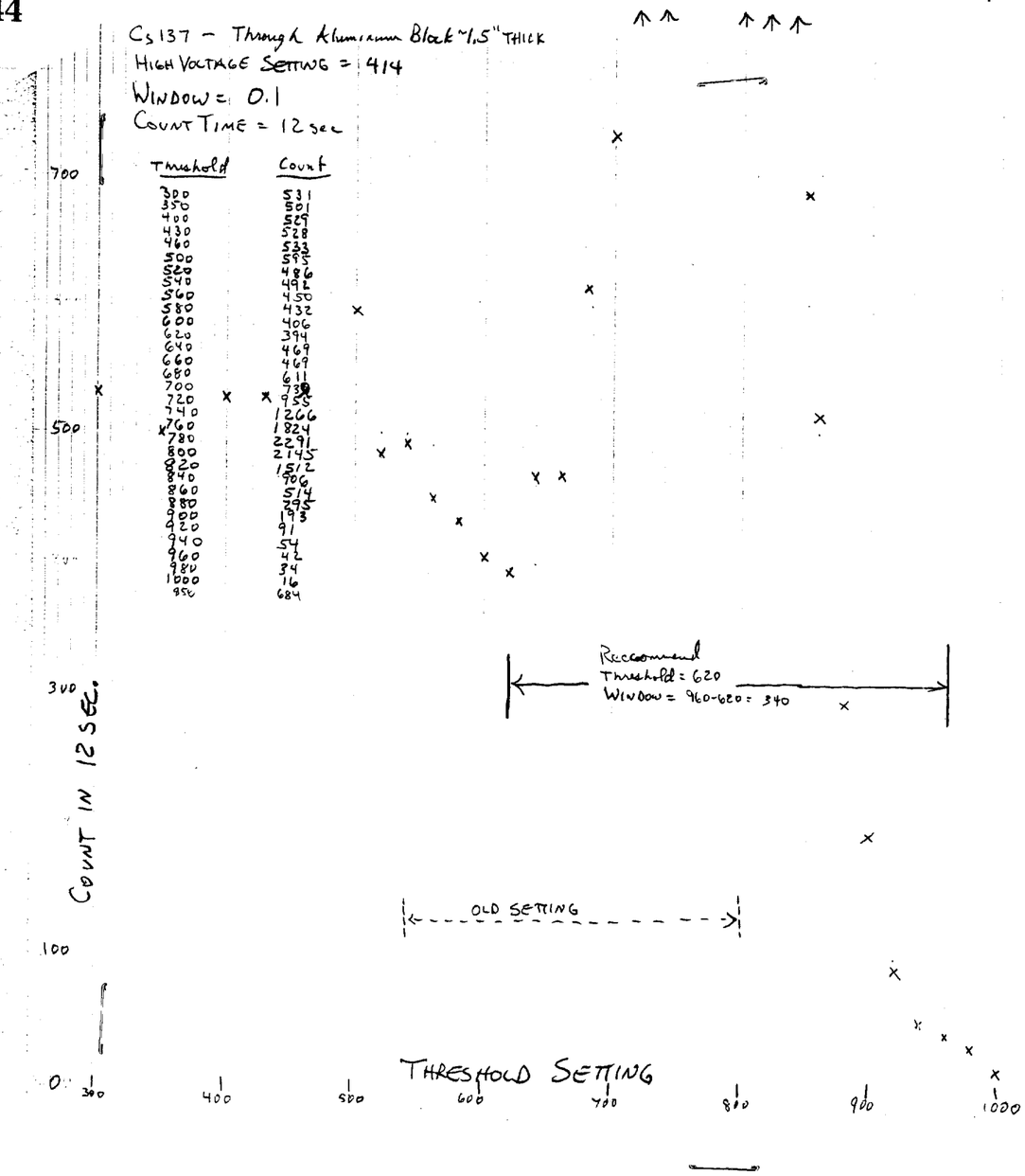
SEE PLOT AND DATA ON FOLLOWING PAGE

PUT SETTINGS AT: (TO CAPTURE 660 keV peak)

		OLD SETTINGS WERE
THRESHOLD	= 620	540
WINDOW	= 340	260
HIGH VOLTAGE	= 414	414

Cs 137 – Through Aluminum Block ~1.5" THICK
HIGH VOLTAGE SETTING = 414
WINDOW = 0.1
COUNT TIME = 12 sec

Threshold	Count
300	531
350	501
400	529
430	528
460	533
500	595
520	486
540	492
560	450
580	432
600	406
620	394
640	469
660	469
680	611
700	738
720	955
740	1266
760	1824
780	2291
800	2145
820	1512
840	906
860	514
880	295
900	193
920	91
940	54
960	42
980	34
1000	16
950	684



3/3/94
S. SVEDEMAN

COUNT = 252,161 (1 MIN COUNT)
W/ Threshold = 540, WINDOW = 260

COUNT = 356,343 (1 MIN COUNT)
W/ Threshold = 620, WINDOW = 340

ENDS OF PERIODIC ENTRY (6) 3-3-94 Steve Sveden

PERIODIC ENTRY #7 3-3-94 AS

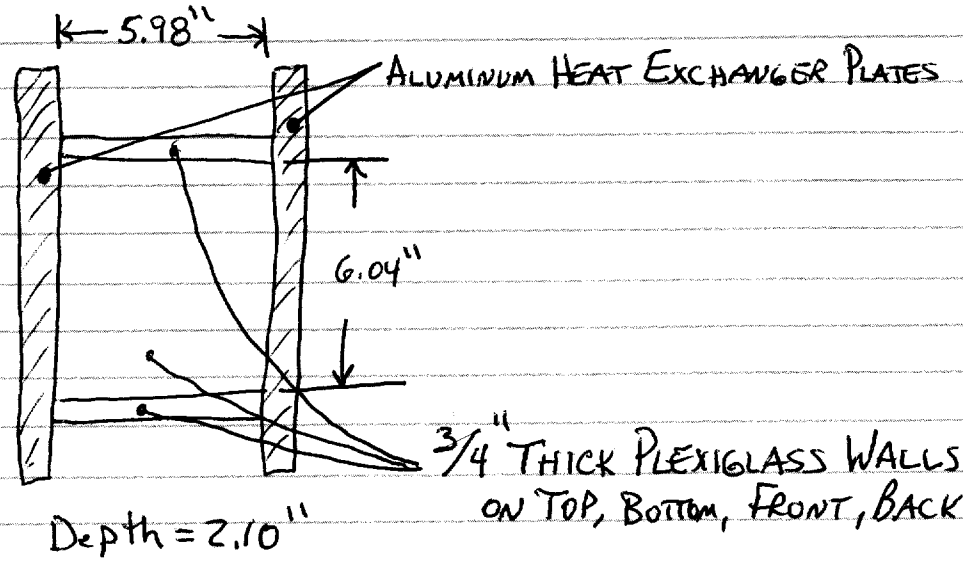
HEATER TEST ON CERAMIC BLOCK

OBJECTIVE:

THE TEST ON THE CERAMIC BLOCK IS INTENDED TO BE SIMILAR TO THE PRIOR TEST PERFORMED ON UNCONSOLIDATED MEDIA (LIKE TESTS 7 & 8). ONE OF THE PROBLEMS WITH THE UNCONSOLIDATED MEDIA IS THE NON-UNIFORM PACKING CAUSES VARIATIONS IN THE LOCAL VOID FRACTION AND PERMEABILITY. THE SOLID CERAMIC BLOCK SHOULD ELIMINATE THIS PROBLEM. THE MOVEMENT OF WATER IN THE BLOCK WILL BE RECORDED AT VARIOUS RATES OF HEATING (WITH A CYLINDRICAL HEATER IN THE BLOCK)

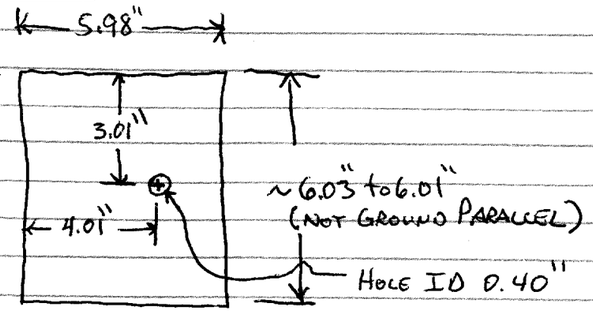
TEST SETUP:

TEST CONTAINER DIMENSIONS



3-3-94 SS

MEDIA: Ceramic Block Dimensions



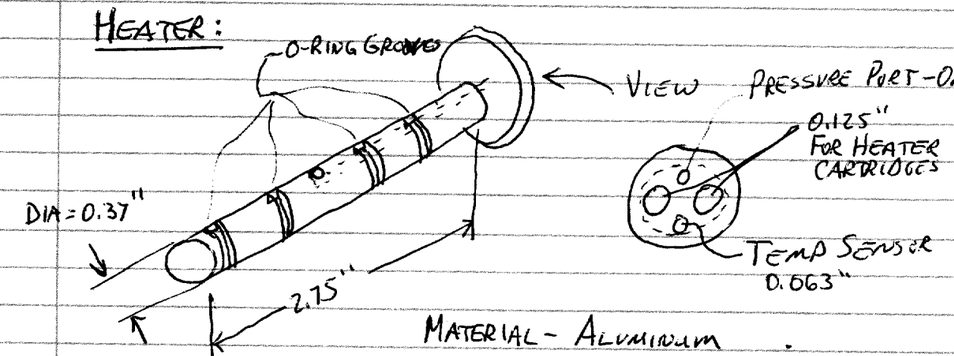
BLOCK THICKNESS = 2.07" (Varies from 2.055" → 2.078")

CERAMIC BLOCKS WERE MADE BY:
REFRACTRON TECHNOLOGIES CORP.
5750 STUART AVE
NEWARK, NY 14513
315-331-6222 (CHAD SHECKER IN ENGRING)

THE BLOCKS ARE MADE OF ALUMINA MATERIAL
90% ALUMINA, 10% ALUMI-SILICATE,
STARTING PARTICLE SIZE IS 15-30 μm
BEFORE PRESSING (REFRACTRON MATERIAL
DESIGNATION AF-4).

BLOCK VOID FRACTION DETERMINED BY WEIGHING
BLOCK DRY & WET IS: 0.459

HEATER:



MATERIAL - ALUMINUM

3-3-94 SS

THE HEATERS USED IN THE HEATER INSERT WERE:
WATLOW FIREROD CARTRIDGE HEATERS
1/8" DIA x 2" SHEATH LENGTH
C2A4, 120VAC, 50 WATTS (2ea)

THE HEATER CARTRIDGES WERE INSERTED INTO THE 0.37" OD ALUMINUM HEATER ROD. THE ROD WAS INSERTED INTO THE BACK OF THE CONTAINER AND INTO THE CERAMIC BLOCK. THE ROD END FLANGE WAS SEALED TO THE OUTSIDE OF THE PLEXIGLASS BOX. A THERMOCOUPLE WAS INSERTED INTO THE ROD TO RECORD THE HEATER TEMP.

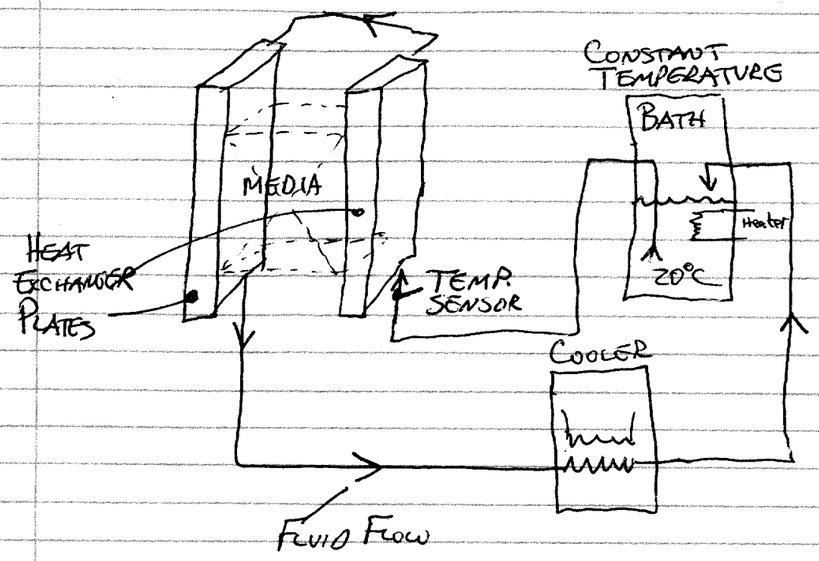
HEATER POWER IS CONTROLLED BY A 120VAC VARIAC. POWER IS RECORDED WITH AN OHIO SEMITRONICS AC WATT TRANSDUCER MODEL GWS-001XS

DATA ACQUISITION SYSTEM (DAS)

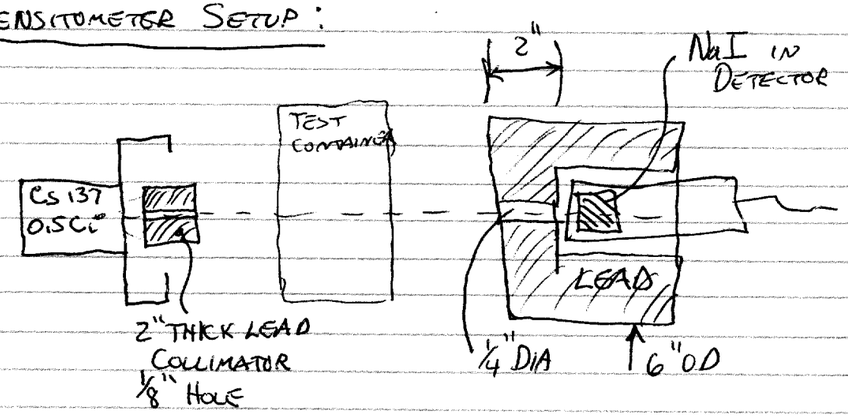
THE DAS IS AN AUTOMATED PC-BASED SYSTEM THAT CONSISTS OF:
IBM PS2 Personal Computer
HEWLET PACKARD HP3458 MULTIMETER
" " HP3488A SWITCH/CONTROL UNIT
INSTRUMENTATION:
LUDLUM 2200 Scaler/Ratemeter (DENSITOMETER)
(500 mCi Cs 137 SOURCE)
YSI Thermistors # 031-46031-4-RPS-120-ST
Position Sensors on Traverse System: HOUSTON Scientific # 1850-40.
Thermocouple for Heater: OMEGA ENGR CO.
TMTSS-062(U)-6, Type T, 1/16" DIA.
TRAVERSE SYSTEM IS THE SAME AS TEST 7 & 8

3-3-94 SJ

HEAT EXCHANGER PLATES ON CONTAINER SETUP:



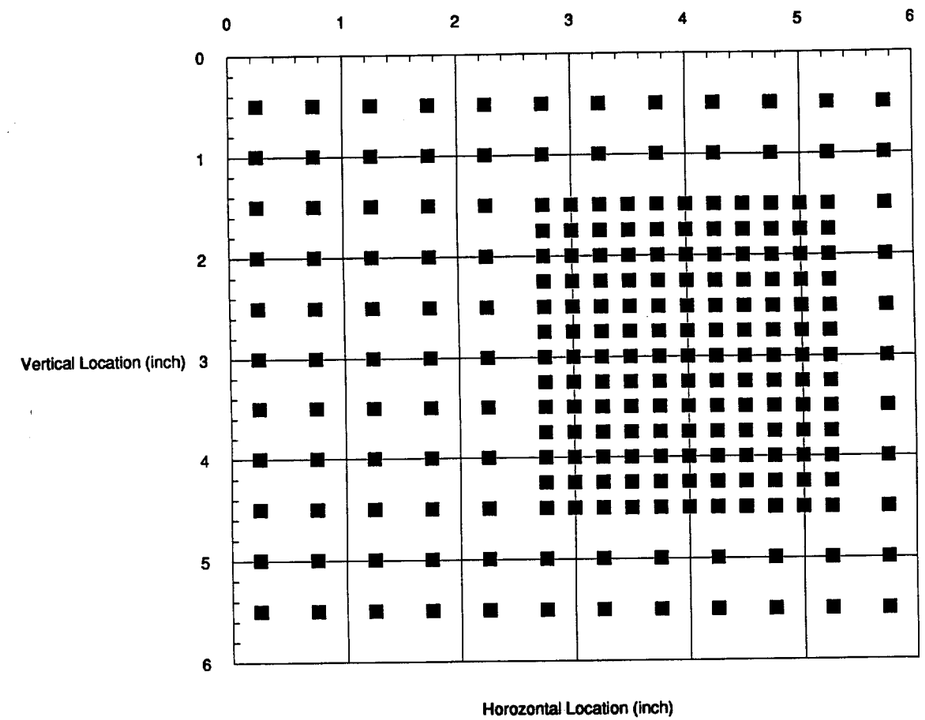
DENSITOMETER SETUP:



SETTINGS ON LUDLUM

3-3-94 SJ

DENSITOMETER READING LOCATIONS:

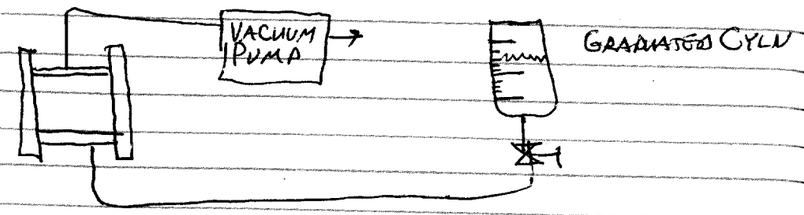


3-3-94 @ 2:00PM SJ
TURNED ON DAS TO RECORD DENSITOMETER READINGS FOR DRY CERAMIC BLOCK
(Block had been heated to 90°C and purged with dry N_2).

SJ
3-8-94 DAS STILL Recording "DRY" READINGS
DAS TURNED OFF TO SATURATE MEDIA.

3-8-94 (CON'T) SJ

SETUP FOR SATURATING MEDIA



WATER PLACED IN GRAD. CYLN. WAS DEAERATED BY BOILING.

3-9-94 SJ WATER WAS LET IN UNDER VACUUM.

628 ml added to fill MEDIA + BOX (space around block between block & plexiglass).

Let water drain from container until no free water in box at media-plexiglass interface.

AMOUNT WATER ADDED 605 ml
(628 - 23 ml removed)

CHECK: MEDIA VOLUME = 5.98 x 6.01 x 2.075 = 74.575 in³
-OR- 1222.06 cm³

WITH VOID FRACTION OF 0.459

VOID SPACE = 1222.06 x 0.459
= 560.9 cm³

DIFFERENCE IN MEASURED 605 AND PREDICTED IS 605 - 560.9 ≅ 44 ml

NOT SURE OF CAUSE FOR DIFFERENCE:
PROBABLY A CONSIDERABLE AMOUNT OF WATER "BOILED OFF" DURING THE 2-4 HOURS FILL TIME (WATER HOT + VACUUM IN CONTAINER).

3-9-94 2:20 PM SJ

Restarted DAS to record 100% Saturation Readings.

3-15-94 SJ

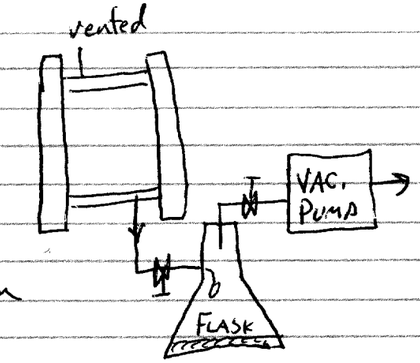
DAS TURNED OFF TO REMOVE SOME WATER FROM THE CONTAINER (TO GET ~80% SATURATION)

WATER WAS "PULLED OUT" THROUGH THE BOTTOM.

129 ml of water were removed over about 1.5 hours.

Some water must have evaporated.

Heater plates set up to 26°C to speed evaporation slightly.



DAS RESTARTED AT 11:18 AM

3-16-94 SJ 9:30 AM

HEATER PLATE TEMPERATURE RESET TO 20°C AT HEATER BATH (I FORGOT YESTERDAY).

PLEXIGLASS WALL OF CONTAINER ARE COVERED WITH SMALL CONDENSATION DROPS.

THIS WILL EFFECT DENSITOMETER READINGS.

4:00 PM DROPS OF WATER ARE STILL ON PLEXIGLASS, I PUT A LIGHT (BULB - FOR HEAT) ABOVE THE CONTAINER. THE LIGHT WILL SHINE ON THE TOP + FRONT OF THE CONTAINER. THIS HAS WORKED IN THE PAST TO HEAT THE DROPS SLIGHTLY AND EVAPORATE THEM.

3-17-94 3:00 PM SJ

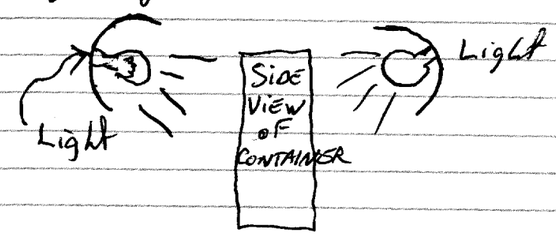
Condensation on the plexiglass walls is gone from the top face and mostly gone from the front face (except for a small amount near the bottom (away from light)). The light was moved to shine on the back face to remove the condensation still sticking to the plexiglass.

3-18-94 10:30AM SS

THE CONDENSATION ON THE PLEXIGLASS WALL IS NOW GONE. I WILL LEAVE THE LIGHT ON TO KEEP WALLS FREE OF CONDENSATION.

3:00 PM SS

I put another light shining on the front of the container. DAS Turned off so light won't be shadowed. The lights are to provide some slight heating at the center to see if any moisture re-distributes



Since the heater sod in the back is black + it is aluminum, it will probably heat block more near the heater than else-where.

3-21-94 8:10AM SS

Removed lights from front & back of container so the DAS could be restarted. Restarted DAS.

3-22-94 9:28AM SS TEST RUNNING FINE - PULLED OFF DATA TO REVIEW CURRENT WATER "DISTRIBUTION".

3:00PM DENSITOMETER DATA SHOWED THE USE OF THE LIGHTS TO HEAT MEDIA & REDISTRIBUTE THE MOISTURE FAILED.

HEATER TURNED ON AND SET AT ~12 WATTS

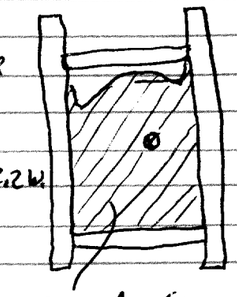
By the time the heater temperature reached 35°C, the plexiglass walls near the heater had a small amount of condensation on them.

3-23-94 11:00AM SS

CONDENSATE IS COVERING MOST OF THE PLEXIGLASS WALLS OF THE CONTAINER EXCEPT ON TOP (WHERE LIGHT HAS BEEN SHINING.

HEATER TEMP = 57°C, HEATER POWER = 12.2W.

LIGHT WAS MOVED TO SHINE ON FRONT



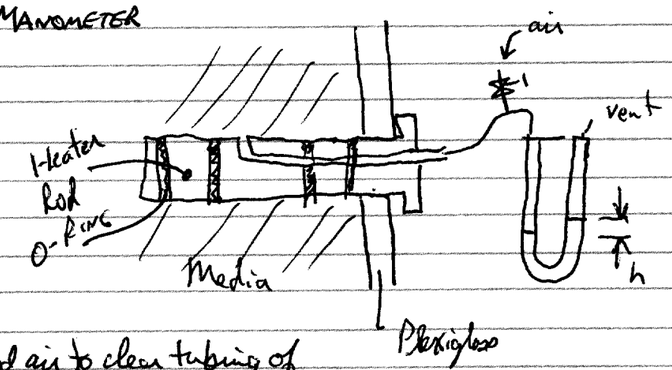
Covered w/ CONDENSATION (IN SMALL DROPS) (SAME ON BACK FACE)

3-24-94 1:15PM SS

Condensation is still covering most of the container walls. Moved the lamp to shine on the back wall.

3-25-94 10:30AM SS

TRIED TO MEASURE PRESSURE AT HEATER WITH WATER MANOMETER



Injected air to clear tubing of any water then let pressure stabilize.

Injected pressure to 2" - fell back to 0.05" H_2O
" " "0.5" " " "0.02" "

Very small pressure @ heater ~ 0.02-0.05" H_2O

3-28-94 8:30AM SS
DAS Down at 9:38PM on 3-26-94 (Thunderstorms caused power failure).
Restarted DAS.

3-29-94 9:30AM SS
Condensation drops are still covering the plexiglass walls.
TURNED UP HEATER TO ~25 WATTS, TEMP OF HEATER ~ 83°C.

3-31-94 12:30PM SS
Container is still covered with condensation drops.
Temp Heater = 91°C Heater Power ≅ 24 watts

4-1-94 8:30AM SS
TURNED HEATER POWER UP
HEATER POWER ~ 34 WATTS HEATER TEMP ~ 115°C ↑
THE CONDENSATION IS STILL covering the container walls. It looks like it builds up until it is thick enough to touch the ceramic block and then it wicks back into the block.

4-4-94 2:30PM SS
DAS Down ~ power failure on 4-3-94 @ 1:00AM
Restarted DAS
Temp heater = 116°C Heater Power = 33 Watts

4-8-94 8:30AM SS
Container walls are still covered with a uniform layer of condensation drops. Heater Temp = 117°C, Heater Power = 33 watts

STOPPED TEST TO REMOVE SOME WATER FROM CONTAINER
THIS IS TO REPEAT HEATING TESTS AT LOWER SATURATION LEVEL.

4-8-94 SS (Con't)

Liquid WATER REMOVED ≈ 157 ml
Vacuum pump connected to bottom and liquid & vapor "pumped" out ~ 3 hours of pumping. Since block was hot, a considerable amount of water probably lost as vapor.

HEATER TURNED OFF
11:30AM DAS RESTARTED TO RECORD THE NEW WATER DISTRIBUTION IN THE MEDIA.

4-11-94 1:25PM SS
The drops of condensation that have been covering the walls are now gone (since the heater is off).

4-12-94 1:00PM SS
HEATER TURNED ON - SET AT ~ 12.1 Watts.
HEATER TEMP. QUICKLY UP TO 45°C ↑.
CONDENSATIONS DROPS FORMED NEAR HEATER ON PLEXIGLASS WALLS.

4-13-94 11:30AM SS
HEATER TEMP ~ 58°C.
CONDENSATION DROPS ARE COVERING MOST OF THE FRONT + BACK PLEXIGLASS WALLS.

4-15-94 4:45PM SS
Heater Temp ~ 58°C, Heater Power ~ 16.7 watts.

4-16-94 10:40AM SS
TURNED HEATER POWER UP TO ~ 25 WATTS

4-18-94 12:50PM SS
HEATER TEMP ~ 97°C

4-19-94 9:00AM SS
HEATER TEMP ~ 98°C.

4-21-94 2:50PM SS
INCREASED HEATER POWER TO ~ 35 Watts
CHANGED DATA STORAGE FILE NAME TO BLK-D.DAT
(OLD FILE GETTING VERY LARGE - SO START A NEW FILE)

4-22-94 2:20PM SS
Heater @ 123°C
Condensation is covering back + front faces. None on top because light is keeping plexiglass slightly heated.

4-25-94 10:45AM SS
DAS DOWN - FAILED ~ 4-23-94 @ 10:26AM. (Rain Storms over weekend).
Restarted DAS

5-2-94 1:05PM SS
TURNED UP HEATER POWER TO ~ 50 WATTS
(FROM ~35 WATTS)

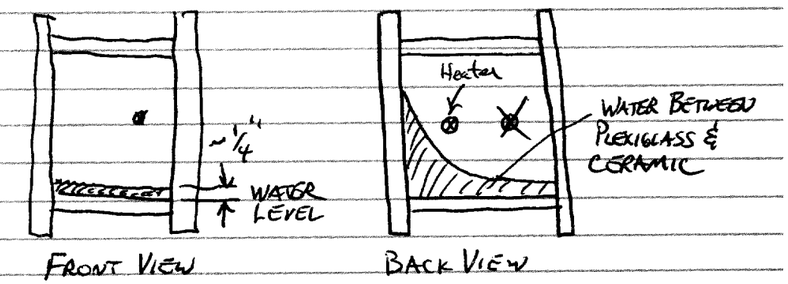
5-6-94 2:00PM SS
Turned OFF HEATER TO ALLOW MEDIA TO COOL.
DATA FILE WAS MISS-TYPED ON 5-2-94 →
SO DATA IS BEING STORED IN
BLD-D.DAT (NOT BLK-D.DAT)

5-10-94 2:31PM SS
TURNED OFF DATA SYSTEM TO REFILL MEDIA WITH WATER (CHECK ON 100% SATURATION READINGS).

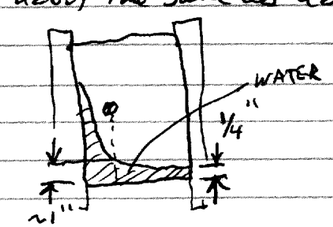
All of the drops of condensation that have covered the plexiglass are gone.
PUT in 300 ml water from top - block @ ~ 70°C, water is in void between Plexiglass & ceramic block. Heater Turned off to let cool overnight.

5-11-94 10:00AM SS
All of the water outside the block (between the plexiglass and the ceramic block) was pulled into the block as it cooled. More water is need to ensure it is saturated. Added ~25ml to container.

5-12-94 10:00AM SS
WATER IS STILL COVERING THE CERAMIC BLOCK - APPEARS TO BE SATURATED.
DRAINED EXCESS WATER THROUGH BOTTOM PORT
Removed ~ 13ml.
A SMALL AMOUNT OF WATER IS LEFT BTWN Plexiglass & Ceramic.



FROM BACK VIEW IT LOOKS LIKE THE GAP BETWEEN THE PLEXIGLASS & CERAMIC VARIES - SO THAT WATER "WICKS" UP THE WALL WHERE GAP IS SMALLER
PLUG ON BOTTOM LEFT OFF TO LET MORE WATER DRAIN.
RESTARTED DAS AT 4:35PM TO RECORD 100% SAT. READINGS.
WATER "LEVEL" ON FRONT FACE IS @ "0" (that is it has dropped to the bottom. Water Level on back is still about the same as above sketch.



5-13-94 1:00 Am SS

The free water in container is almost all gone now - only a very small amount is left on the back of the container.

water between ceramic & plexiglass (very thin film)

5-24-94 TEST SHUT DOWN. SS

HP Multimeter removed for re-calibration.

5-25-94 SS

DENSITOMETER SAMPLING LOCATIONS "MOTION" FILE

X (inch)	Y (inch)	X	Y	X	Y	X	Y
DWELL TIME = 5		3.500	2.000	5.750	3.000	4.000	4.250
-3.900	6.300	3.750	2.000	-3.900	6.300	4.250	4.250
-3.900	6.300	4.000	2.000	-6.300	6.300	4.500	4.250
-6.300	6.300	4.250	2.000	2.750	3.250	4.750	4.250
0.250	0.500	4.500	2.000	3.000	3.250	5.000	4.250
0.750	0.500	4.750	2.000	3.250	3.250	5.250	4.250
1.250	0.500	5.000	2.000	3.500	3.250	0.250	4.500
1.750	0.500	5.250	2.000	3.750	3.250	0.750	4.500
2.250	0.500	5.750	2.000	4.000	3.250	1.250	4.500
2.750	0.500	2.750	2.250	4.250	3.250	1.750	4.500
3.250	0.500	3.000	2.250	4.500	3.250	2.250	4.500
3.750	0.500	3.250	2.250	4.750	3.250	2.750	4.500
4.250	0.500	3.500	2.250	5.000	3.250	3.000	4.500
4.750	0.500	3.750	2.250	5.250	3.250	3.250	4.500
5.250	0.500	4.000	2.250	0.250	3.500	3.500	4.500
5.750	0.500	4.250	2.250	0.750	3.500	3.750	4.500
0.250	1.000	4.500	2.250	1.250	3.500	4.000	4.500
0.750	1.000	4.750	2.250	1.750	3.500	4.250	4.500
1.250	1.000	5.000	2.250	2.250	3.500	4.500	4.500
1.750	1.000	5.250	2.250	2.750	3.500	4.750	4.500
2.250	1.000	0.250	2.500	3.000	3.500	5.000	4.500
2.750	1.000	0.750	2.500	3.250	3.500	5.250	4.500
3.250	1.000	1.250	2.500	3.500	3.500	5.750	4.500
3.750	1.000	1.750	2.500	3.750	3.500	0.250	5.000
4.250	1.000	2.250	2.500	4.000	3.500	0.750	5.000
4.750	1.000	2.750	2.500	4.250	3.500	1.250	5.000
5.250	1.000	3.000	2.500	4.500	3.500	1.750	5.000
5.750	1.000	3.250	2.500	4.750	3.500	2.250	5.000
0.250	1.500	3.500	2.500	5.000	3.500	2.750	5.000
0.750	1.500	3.750	2.500	5.250	3.500	3.250	5.000
1.250	1.500	4.000	2.500	5.750	3.500	3.750	5.000
1.750	1.500	4.250	2.500	2.750	3.750	4.250	5.000
2.250	1.500	4.500	2.500	3.000	3.750	4.750	5.000
2.750	1.500	4.750	2.500	3.250	3.750	5.250	5.000
3.000	1.500	5.000	2.500	3.500	3.750	5.750	5.000
3.250	1.500	5.250	2.500	3.750	3.750	0.250	5.500
3.500	1.500	5.750	2.500	4.000	3.750	0.750	5.500
3.750	1.500	2.750	2.750	4.250	3.750	1.250	5.500
4.000	1.500	3.000	2.750	4.500	3.750	1.750	5.500
4.250	1.500	3.250	2.750	4.750	3.750	2.250	5.500
4.500	1.500	3.500	2.750	5.000	3.750	2.750	5.500
4.750	1.500	3.750	2.750	5.250	3.750	3.250	5.500
5.000	1.500	4.000	2.750	0.250	4.000	3.750	5.500
5.250	1.500	4.250	2.750	0.750	4.000	4.250	5.500
5.750	1.500	4.500	2.750	1.250	4.000	4.750	5.500
2.750	1.750	4.750	2.750	1.750	4.000	5.250	5.500
3.000	1.750	5.000	2.750	2.250	4.000	5.750	5.500
3.250	1.750	5.250	2.750	2.750	4.000		
3.500	1.750	0.250	3.000	3.000	4.000		
3.750	1.750	0.750	3.000	3.250	4.000		
4.000	1.750	1.250	3.000	3.500	4.000		
4.250	1.750	1.750	3.000	3.750	4.000		
4.500	1.750	2.250	3.000	4.000	4.000		
4.750	1.750	2.750	3.000	4.250	4.000		
5.000	1.750	3.000	3.000	4.500	4.000		
5.250	1.750	3.250	3.000	4.750	4.000		
0.250	2.000	3.500	3.000	5.000	4.000		
0.750	2.000	3.750	3.000	5.250	4.000		
1.250	2.000	4.000	3.000	5.750	4.000		
1.750	2.000	4.250	3.000	2.750	4.250		
2.250	2.000	4.500	3.000	3.000	4.250		
2.750	2.000	4.750	3.000	3.250	4.250		
3.000	2.000	5.000	3.000	3.500	4.250		
3.250	2.000	5.250	3.000	3.750	4.250		

SENSOR "CONFIGURATION" FILE. BLOCK.CFG

BLOCK.CFG

NPLC 1

Channel label	DMM Func.	DMM Range	DMM Resol.	Relay Numbers	Eng. Units	EQ. Type	K1	K2	K3
Barometer	DCV	10.0	.0001	100	PSIa	1	2.4	-3	0
Temp Plates	OHM	1e5	.01	207	øC	2	1.0295e-3	2.3908e-4	1.56817e-7
Temp Heater	DCV	10.0	.01	407	øC	1	63.854	-49.535	0
Room Temp	OHM	1e5	.01	208	øC	2	1.0295e-3	2.3908e-4	1.56817e-7
Heater Power	DCV	10.0	.0001	408	Watts	1	100.0	0.000	0
X position	DCV	10.0	.01	108	Inches	10	3.7330	6.1436	0
Y position	DCV	10.0	.01	109	Inches	11	2.5851	0.1663	0

```
Equation types:
0 - None......... Y = X
1 - Linear....... Y = K1 * X + K2
2 - Thermistor... Y = 1/(K1 + K2 * Ln(X) + K3 * Ln(X)^3 ) - 273.15
10- Linear....... Y = (X - K1) * 10 / (K2 - K1)   (X position - No more than one of these)
11- Linear....... Y = (X - K1) * 10 / (K2 - K1)   (Y position - No more than one of these)
```

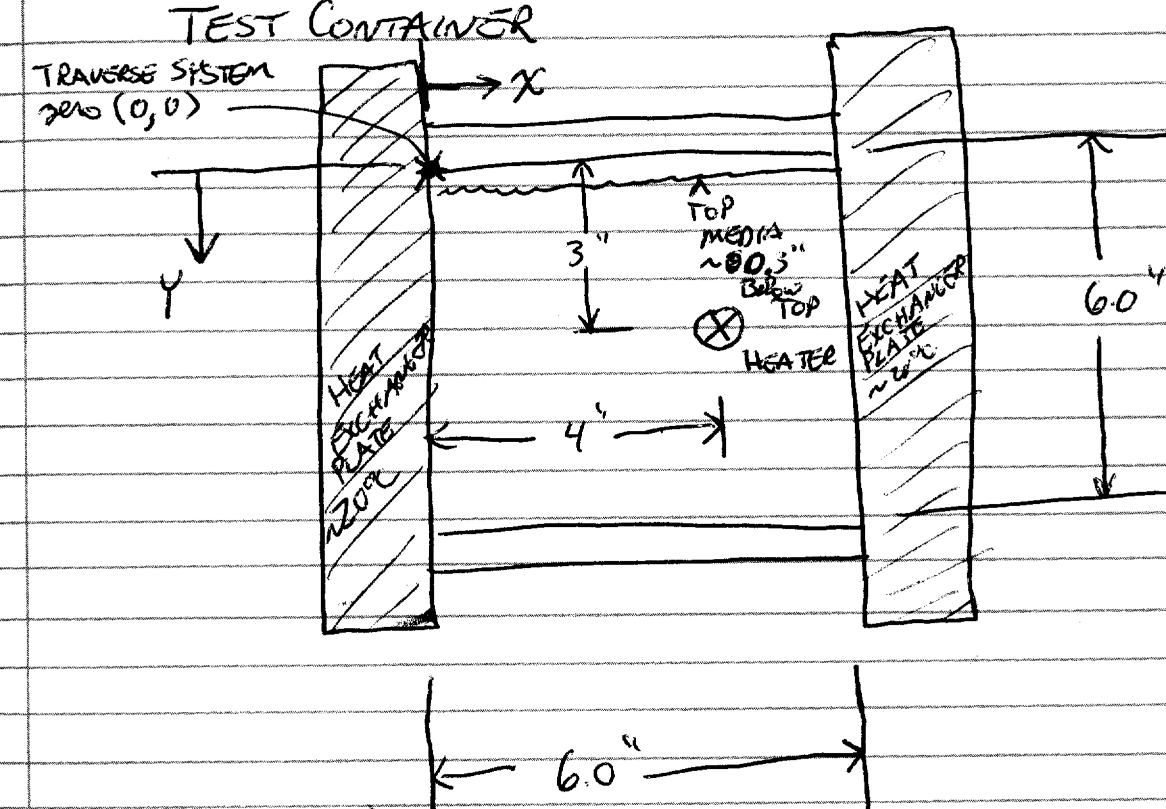
END PERIODIC ENTRY #7 [signature] 5-25-94

PERIODIC ENTRY #8 [signature] 8-4-94

CEMENT BLOCK TEST

TEST SETUP - SAME AS PREVIOUS TEST (SEE PERIODIC ENTRY #7).

TEST CONTAINER



DEPTH = 2.55"

MEDIA IS CEMENT - Poured into container and allowed to set up. Cement is designated "C3" - see p3 of Lab Book 98.

8-4-94 SS 4:30PM
DAS Turned on to allow Densfometer to record the starting saturation level. No moisture added to container - only sand w/ residual from making cement.
Heater Temperature Sensor is not connected.

8-8-94 SS 8:20AM

8-9-94 J.S.B (Steve Bird) 8:15 AM
FOUND D.A.S. CRASHED AT 23:20
20 RECORDS WERE TAKEN
FIXED PROGRAM PROBLEM. (HOPEFULLY)
RE STARTED AT 9:01

8-16-94 10:15AM SS
INSTALLED THERMOCOUPLE INTO HEATER ELEMENT
RESTARTED DAS WITH A NEW DATA FILE NAME - "CMTBLK-B.DA
HEATER NOT TURNED ON (NEED TO RECORD READINGS WITH NEW TC IN PLACE).

8-19-94 10:00AM SS
TURNED ON HEATER - 20 WATTS, HEATER QUICKLY WENT TO 150°C.
OPENED FITTING ON TOP OF CONTAINER TO LET ANY PRESSURE BUILD-UP VENT.

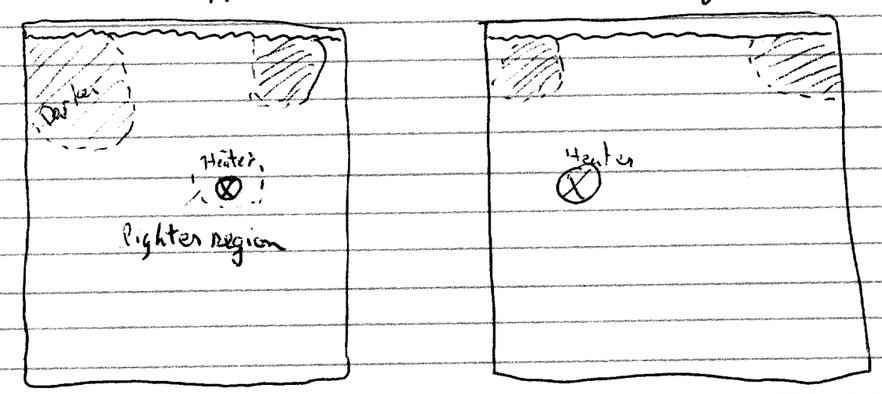
3:50PM SS
Heater at 215°C - REDUCED POWER TO 14 WATTS (TOO HOT FOR PLEXIGLASS)
12 SS 8-19-94

8-23-94 10:00AM SS
Heater Temp = 141 °C, Heater Power = 12.6 watts
There is a lighter color region at the end of the heater and around the heater ~ 3/4" DIAmeter. It appears the cement in that region is drier than the rest of the cement.

9-1-94 8:15AM SS
DAS down - Restarted DAS (Power failure yesterday)
Heater Temp = 152°C, Heater Power 12.8 watts

9-2-94 1:40PM SS
Heater Temp = 152°C

Container front & Back show darker regions near the top that appear "wetter" than the rest of the media.



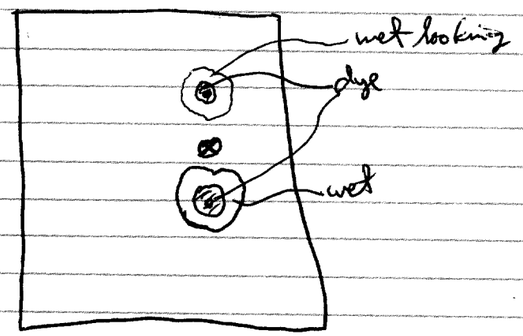
View from Front View from Back

Cause may be liquid condensation on top of container & drip down into media. Would condense towards cool Heat exchanger plates at sides.

9-6-94 10:00 AM SS
Heater Temp = 146°C, Heater Power = 12.7 watts.

9-12-94 9:00 AM SS
Drilled holes for dye injection -
(4.0", 4.125"), (4.0", 1.875")

10:40 AM -
Photo #1 Before dye injected
Photo #2 After dye injected



small amount of dye injected into container.
it quickly wicked into the media along plastic face. Dye did not go with liquid
Top water "spot" was not symmetric - more fluid towards top. Bottom one spread more (more injected) but it stopped below heater

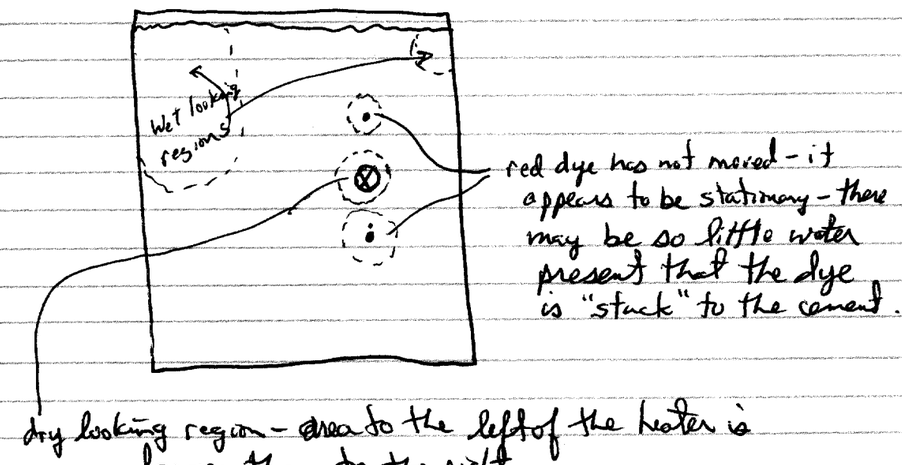
4:20 PM "Ring" of water (dark spot is gone) - dye still about in the same location - centered near dye port. Very light red color. ~1" dia at bottom, ¼" at top.

Photo #3
Photo #4 after put in another drop of dye, (less than 0.1 cc injected
5:40 PM Photo #5

9-13-94 8:15 AM SS
Dye is still centered about injection port. The ~~upper~~ dye in the port above the heater may have moved slightly upward. Heater Temp = 158°C

Photo #6
4:00 PM Photo #7

9-14-94 8:40 AM SS
Photo #8
Heater Power = 13 watts Heater Temp = 160°C



Heater Turned off to start cooldown

5:30 PM Photo #9
Container cracked along left side - right next to the heat exchanger plate. It looks like the cement block has expanded.

9-19-94 SS

10:55 AM

The red dye has not migrated from the injection points.

The region around the heater still look dry.

A crack is now visible that is ~ 4" long and it runs horizontally through the heater.

The "wet spots" on the upper left and right corners are now gone

Photo # 10.

9-23-94 SS

3:15 PM DAS working fine

Dye still has not moved

The dry looking region at the heater still looks dry, but may be slightly darker (that is "wetter") than before.

9-27-94 SS

9:30 AM DAS Down from 9-25-94 @ 1:48am, due to power failure.

STOPPED TEST ON CEMENT BLOCK.

Photo # 11

Dye is still located near dye injection points

DENSITOMETER MOTION FILE AND DAS CONFIGURATION FILE ARE ATTACHED

CEMENT BLOCK MOTION FILE - CMTBLK.MOT. GIVES X AND Y LOCATIONS OF DENSITOMETER READING LOCATIONS (INCHES).

DWELL TIME = 5

-4.400	6.300	2.750	1.750	2.750	2.750	2.750	3.750
-4.400	6.300	3.000	1.750	3.000	2.750	3.000	3.750
-6.900	6.300	3.250	1.750	3.250	2.750	3.250	3.750
0.250	0.500	3.500	1.750	3.500	2.750	3.500	3.750
0.750	0.500	3.750	1.750	3.750	2.750	3.750	3.750
1.250	0.500	4.000	1.750	4.000	2.750	4.000	3.750
1.750	0.500	4.250	1.750	4.250	2.750	4.250	3.750
2.250	0.500	4.500	1.750	4.500	2.750	4.500	3.750

0.250	5.000		
0.750	5.000		
1.250	5.000		
1.750	5.000		
2.250	5.000		
2.750	5.000		
3.250	5.000		
3.750	5.000		

CEMENT BLOCK MOTION FILE - CMTBLK.MOT. GIVES X AND Y LOCATIONS OF DENSITOMETER
READING LOCATIONS (INCHES).

DWELL TIME = 5

-4.400	6.300	2.750	1.750	2.750	2.750	2.750	3.750	0.250	5.000		
-4.400	6.300	3.000	1.750	3.000	2.750	3.000	3.750	0.750	5.000		
-6.900	6.300	3.250	1.750	3.250	2.750	3.250	3.750	1.250	5.000		
0.250	0.500	3.500	1.750	3.500	2.750	3.500	3.750	1.750	5.000		
0.750	0.500	3.750	1.750	3.750	2.750	3.750	3.750	2.250	5.000		
1.250	0.500	4.000	1.750	4.000	2.750	4.000	3.750	2.750	5.000		
1.750	0.500	4.250	1.750	4.250	2.750	4.250	3.750	3.250	5.000		
2.250	0.500	4.500	1.750	4.500	2.750	4.500	3.750	3.750	5.000		
2.750	0.500	4.750	1.750	4.750	2.750	4.750	3.750	4.250	5.000		
3.250	0.500	5.000	1.750	5.000	2.750	5.000	3.750	4.750	5.000		
3.750	0.500	5.250	1.750	5.250	2.750	5.250	3.750	5.250	5.000		
4.250	0.500	0.250	2.000	0.250	3.000	0.250	4.000	5.750	5.000		
4.750	0.500	0.750	2.000	0.750	3.000	0.750	4.000	0.250	5.500		
5.250	0.500	1.250	2.000	1.250	3.000	1.250	4.000	0.750	5.500		
5.750	0.500	1.750	2.000	1.750	3.000	1.750	4.000	1.250	5.500		
0.250	1.000	2.250	2.000	2.250	3.000	2.250	4.000	1.750	5.500		
0.750	1.000	2.750	2.000	2.750	3.000	2.750	4.000	2.250	5.500		
1.250	1.000	3.000	2.000	3.000	3.000	3.000	4.000	2.750	5.500		
1.750	1.000	3.250	2.000	3.250	3.000	3.250	4.000	3.250	5.500		
2.250	1.000	3.500	2.000	3.500	3.000	3.500	4.000	3.750	5.500		
2.750	1.000	3.750	2.000	3.750	3.000	3.750	4.000	4.250	5.500		
3.250	1.000	4.000	2.000	4.000	3.000	4.000	4.000	4.750	5.500		
3.750	1.000	4.250	2.000	4.250	3.000	4.250	4.000	5.250	5.500		
4.250	1.000	4.500	2.000	4.500	3.000	4.500	4.000	5.750	5.500		
4.750	1.000	4.750	2.000	4.750	3.000	4.750	4.000				
5.250	1.000	5.000	2.000	5.000	3.000	5.000	4.000				
5.750	1.000	5.250	2.000	5.250	3.000	5.250	4.000				
0.250	1.500	5.750	2.000	5.750	3.000	5.750	4.000				
0.750	1.500	2.750	2.250	-3.900	6.300	2.750	4.250				
1.250	1.500	3.000	2.250	-6.300	6.300	3.000	4.250				
1.750	1.500	3.250	2.250	2.750	3.250	3.250	4.250				
2.250	1.500	3.500	2.250	3.000	3.250	3.500	4.250				
2.750	1.500	3.750	2.250	3.250	3.250	3.750	4.250				
3.000	1.500	4.000	2.250	3.500	3.250	4.000	4.250				
3.250	1.500	4.250	2.250	3.750	3.250	4.250	4.250				
3.500	1.500	4.500	2.250	4.000	3.250	4.500	4.250				
3.750	1.500	4.750	2.250	4.250	3.250	4.750	4.250				
4.000	1.500	5.000	2.250	4.500	3.250	5.000	4.250				
4.250	1.500	5.250	2.250	4.750	3.250	5.250	4.250				
4.500	1.500	0.250	2.500	5.000	3.250	0.750	4.500				
4.750	1.500	0.750	2.500	5.250	3.250	1.750	4.500				
5.000	1.500	1.250	2.500	0.250	3.500	2.250	4.500				
5.250	1.500	1.750	2.500	0.750	3.500	2.750	4.500				
5.750	1.500	2.250	2.500	1.250	3.500	3.250	4.500				
		2.750	2.500	1.750	3.500	3.750	4.500				
		3.000	2.500	2.250	3.500	4.250	4.500				
		3.250	2.500	2.750	3.500	4.750	4.500				
		3.500	2.500	3.000	3.500	5.250	4.500				
		3.750	2.500	3.250	3.500	5.750	4.500				
		4.000	2.500	3.500	3.500						
		4.250	2.500	3.750	3.500						
		4.500	2.500	4.000	3.500						
		4.750	2.500	4.250	3.500						
		5.000	2.500	4.500	3.500						
		5.250	2.500	4.750	3.500						
		5.750	2.500	5.000	3.500						
				5.250	3.500						
				5.750	3.500						

Densitometer Motion File and DAS Configuration File are
Attached

DENSITOMETER MOTION FILE AND DAS CONFIGURATION FILE ARE ATTACHED

NPLC 1

Barometer	DCV	10.0	.0001	100	PSIa	1	2.4	-3	0
Temp Plates	OHM	1e5	.01	207	øC	2	1.0295e-3	2.3908e-4	1.56817e-7
Temp Heater	DCV	10.0	.01	407	øC	1	63.854	-49.535	0
Room Temp	OHM	1e5	.01	208	øC	2	1.0295e-3	2.3908e-4	1.56817e-7
Heater Power	DCV	10.0	.0001	408	Watts	1	100.0	0.000	0
X position	DCV	10.0	.01	108	Inches	10	3.8511	6.2659	0
Y position	DCV	10.0	.01	109	Inches	11	2.3643	-0.05370	0

Channel label	DMM Func.	DMM Range	DMM Resol.	Relay Numbers	Eng. Units	EQ. Type	K1	K2	K3

Equation types:

0 - None..... Y = X

1 - Linear..... Y = K1 * X + K2

2 - Thermistor... Y = 1/(K1 + K2 * Ln(X) + K3 * Ln(X)^3) - 273.15

10- Linear..... Y = (X - K1) * 10 / (K2 - K1) (X position - No more than one of these)

11- Linear..... Y = (X - K1) * 10 / (K2 - K1) (Y position - No more than one of these)

Pages 1 through 67 of this Scientific Notebook were reviewed for compliance with QAP-001 in response to Corrective Action Request 94-02. Corrections and clarifications were made as appropriate. In some cases, the date of a change will reflect the date of this review rather than the date of the original Scientific Notebook entry.

Randy Falk
SwRI-QA
12/13/94

9/21/95 Notebook closed out
9/21/95

ADDITIONAL INFORMATION FOR SCIENTIFIC NOTEBOOK #: 052

Document Date:	06/26/1992
Availability:	Southwest Research Institute® Center for Nuclear Waste Regulatory Analyses 6220 Culebra Road San Antonio, Texas 78228
Contact:	Southwest Research Institute® Center for Nuclear Waste Regulatory Analyses 6220 Culebra Road San Antonio, TX 78228-5166 Attn.: Director of Administration 210.522.5054
Data Sensitivity:	■"Non-Sensitive" □ Sensitive □"Non-Sensitive - Copyright" □ Sensitive - Copyright
Date Generated:	1990 through 1999
Operating System: (including version number)	Windows
Application Used: (including version number)	Various
Media Type: (CDs, 3 1/2, 5 1/4 disks, etc.)	(15) 3 ½ disks; (1) mini data cartridge tape
File Types: (.exe, .bat, .zip, etc.)	Various
Remarks: (computer runs, etc.)	Media contains: Thermohydrology tests data; and separate effects tests data. Photographs and slides of the separate effects tests.