Reference #

Data Inventory Sheet

1. Commodity OS
2. Author Turner, ~~[illegible]~~ t. F ~~[illegible]~~
3. Title (or description)
   ~~Data from "Tracer Tests on Test 570"~~ 10 Ton Retort tracer tests ~~memo to B. Travis~~
4. Date ~~Feb 17, 1982~~ June 7-8, '83 printed 2/1984
5. Reference
   Sand 83-2403
   Proc., In-Situ Oil Shale Briefing pp. 353-366
6. Source
   in house research (Also in Author file - In Situ O.S. Briefing)
7. Location of Data
   ~~Sudduth's outer office~~ Dr. 4 "~~Flow Distribution & Rubble Evaluation~~"
   Author File
8. Form of Data
9. Type of Work
10. Description of Work
11. Types of Data
12. Quantity of Data
13. Quality of Data
14. Priority

Ref OK

Turner

SANDIA REPORT SAND83-2403•UNLIMITED RELEASE•UC-91
Printed February 1984

Proceedings of In Situ Oil Shale Briefing June 7-8, 1983

Paul J. Hommert, Editor

Prepared by
Sandia National Laboratories
Albuquerque, New Mexico 87185 and Livermore, California 94550
for the United States Department of Energy
under Contract DE-AC04-76DP00789

SF 2900-Q(6-82)

10 TON RETORT TRACER TESTS

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ABSTRACT

The 10 ton retort tracer tests are part of a large effort at the University of Wyoming Research Corporation (UWYRC) and I will describe that effort before discussion of the 10 ton tests in detail. The objective of the tracer program at UWYRC is to reduce the cost and effort involved in characterizing the flow in a modified in situ oil shale retort. This objective is being approached in three ways.

First, UWYRC is conducting extensive tracer testing on both the 150 ton and 10 ton retorts north of Laramie. In the 150 ton retort, Sandia Labs and UWYRC teams just completed a series of tests to study flow around an impermeable object. The 10 ton retort is being used to study flow channeling and its effect on tracer response curves, steam front movement, and oil yield.

The second method involves the development of remote release tracer canisters which can be placed in a retort during blasting and then activated at a later time.[1] These canisters could reduce the need for mining instrumentation access drifts around a retort.

The third approach is to help in developing tracer models that aid in understanding and implementing the properties of a retort rubble bed. Current work is aimed at implementing and checking the code developed by Brian Travis at Los Alamos National Labs.

The 10 ton retort tests are being used to investigate flow channeling in nonuniform rubble chimneys. A nonuniform rubble chimney causes maldistribution of air flow which in turn causes poor sweep efficiency resulting in poor product yield. Sweep efficiency is defined as the fraction of shale contacted by the retorting front and can be related to overall product yield with the expression

$$\text{Product Yield} = \text{Sweep Efficiency} \times (1\text{-Yield loss})$$

where

$$(1\text{-Yield loss}) = \text{Oil Yield.}^{2}$$

The yield loss is that portion of the contacted shale oil which is burned, coked, or otherwise not incorporated into the product oil and gas. Obviously, if a region is by-passed because of poor sweep efficiency there is a higher probability of burning or coking in that region. Sweep efficiency is thus the key term in the above equation.

Sweep efficiency can be predicted quantitatively before the retort is ignited by using gas tracer tests or after the retort is ignited by monitoring the steam front's passage through the retort. Both of these methods have serious problems. Extensive tracer testing is expensive and impractical on a commercial scale plant. It requires placement of many sample ports and requires instrumentation ports and either ignition of the retort or large scale steam generation. Both options are expensive, especially if the retort is so badly formed that it should never be ignited. What is needed is a simple diagnostic test that can be made prior to ignition that will predict the retort's performance.

The latest series of 10 ton retort runs have been designed to study the effect of changes in sweep efficiency on tracer response and on yield loss. It is hoped that from these tests a correlation can be made between an inlet-to-outlet tracer response curve and both sweep efficiency and yield loss. If this proves possible, then we will have the diagnostic test needed.

The nominally sized 10-ton oil shale retort is a six-foot-O.D. by twelve-foot high, refractory lined steel shell. At the top is an opening for loading oil shale. The bottom has a grate to support the oil shale. Both top and bottom have hinged semi-spherical covers. The retort is lined with a 4-1/2 in. thick layer of firebrick and a 4-1/2 in. thick layer of castable insulating material resulting in an ID of 4.5 ft. The grate is covered with a 4 in. thick granite base to prevent fines from passing and to prevent overheating of the grate. Above this, shale is loaded using a bucket and overhead crane. During loading, thermocouples and gas sampling taps are positioned.

Each of the nine tests has the same operating conditions, but the shale load is different. In all tests there is a central cylindrical core of a larger shale distribution: 4 in. x 3 in., 4 in. x 2 in. or 4 in. x 1 in., dependinng on the test. The annular volume is in all cases filled with 6 in. x 1/2 in. shale. Besides varying the shale size distribution in the core, the core diameter itself is 12 in., 18 in. or 24 in., depending on the test. There are four levels of tracer taps and five levels of thermocouples in the retort. Each level of taps is constructed using a 3/4 in. stainless steel tube with slots at the appropriate tap locations. Inside the 3/4 in. tube is a sliding 1/4 in. stainless steel tube plugged at the end and perforated between two packers.

Contour plots of the tracer residence times show nonuniform flow, however, in most cases the flow distribution was not as we desired. There were two main reasons for this. The first is that although a certain range of particle sizes was requested, in most cases the shale received contained large amounts of smaller material. The infiltration of finer material into the top of the channel created a local low permeability region and the diversion of air flow around it. The second problem was that the firebrick lining the retort was in poor shape and could have been allowing some air flow between bricks.

Since the object of the tests is to compare tracer tests with steam front and retorting data, the actual distribution of nonuniform air flow has little impact. All planned correlations can still be made at the end of the test series.

REFERENCES

1. D. F. Moore and T. F. Turner, "Remote Control of Tracer Gas Injection Using VLF Electromagnetic Waves", proceedings of 1981 Symposium on Instrumentation and Control of Fossil Energy Processes, ANL-81-62, CONF-810607, p. 613.

2. M. L. Gregg and J. H. Campbell, "Sweep Efficiency Modeling of Modified In Situ Retorts", proceedings of the 13th Annual Oil Shale Symposium, Colorado School of Mines.

NON-UNIFORM FLOW

OBJECTIVE:

TO REDUCE THE NUMBER OF GAS TRACER TESTS NECESSARY TO CHARACTERIZE THE GAS FLOW DISTRIBUTION IN AN IN SITU OIL SHALE RETORT

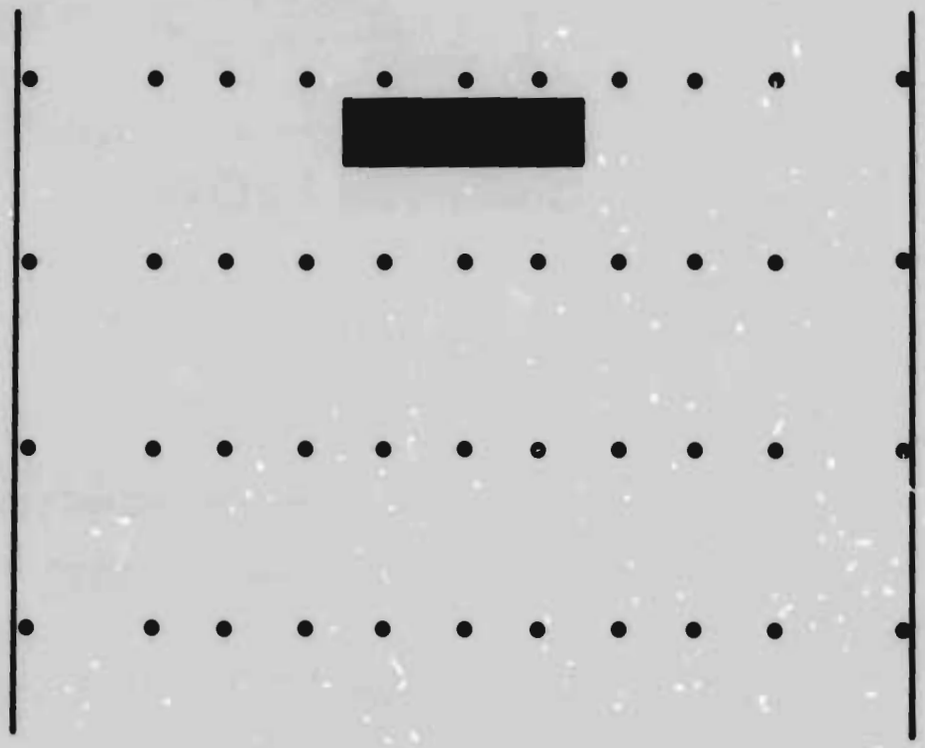
NON-UNIFORM FLOW

APPROACHES:

1. TRACER TESTING TO STUDY:
   a. FLOW BLOCKAGE (150 TON RETORT)
   b. CHANNELING (10 TON RETORT)
2. REMOTE RELEASE OF TRACER GASES
3. MATHEMATICAL MODELING

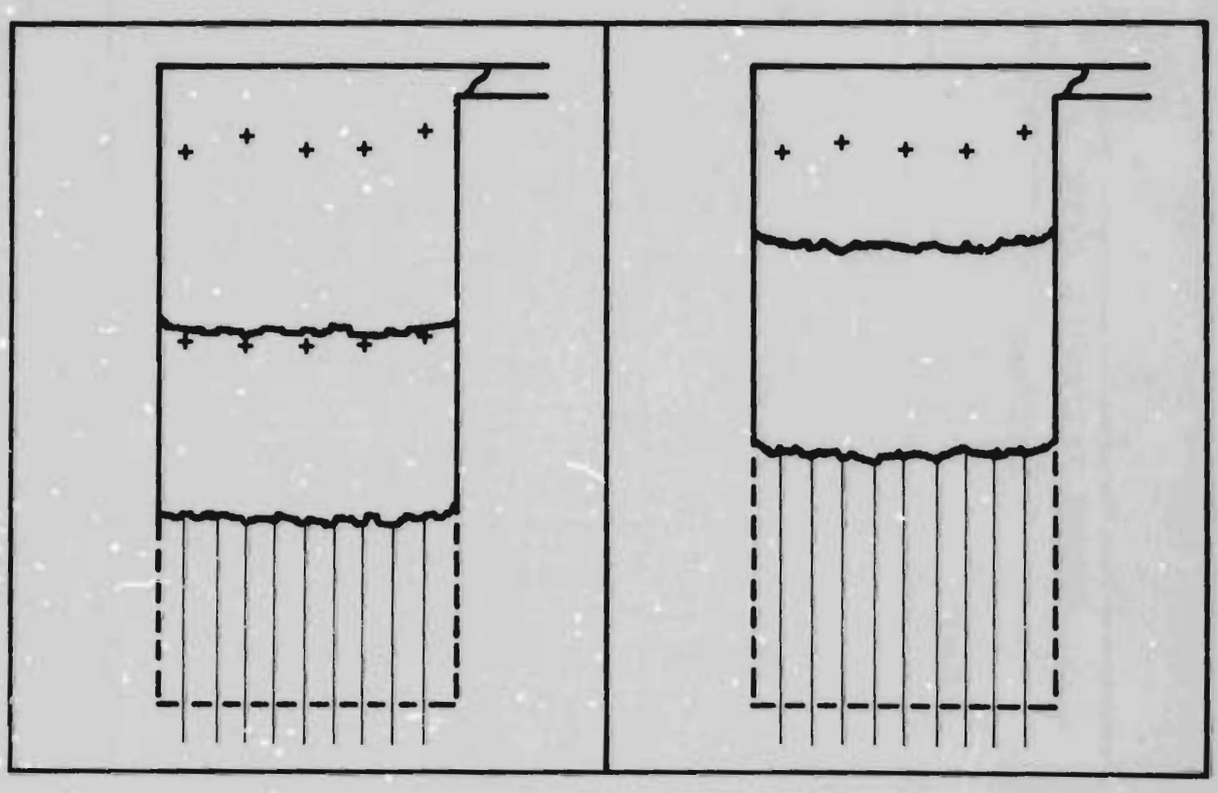
150 TON RETORT TEST

150 TON RETORT



REMOTE RELEASE

TRACER CANISTERS



10 TON RETORT TESTS

CORE PARTICLE SIZE (inches)	CORE DIAMETER (inches) 12	18	24
4x1	2	7	5
4x2	6	1	8
4x3	3	9	4

10 TON RETORT

PARTICLE SIZE IN CHANNEL:

4"x1"

4"x2"

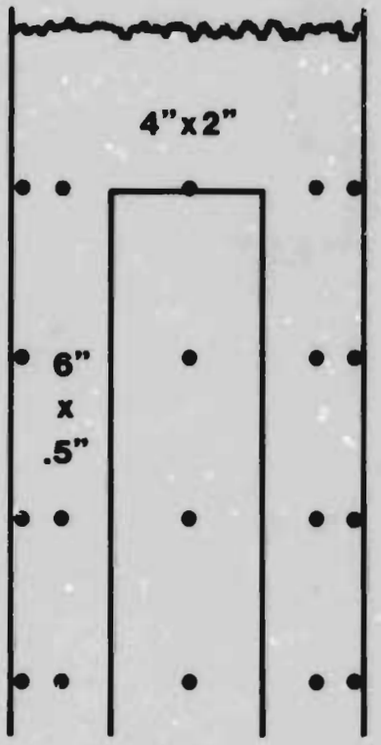
4"x3"

CHANNEL DIAMETER:

12"

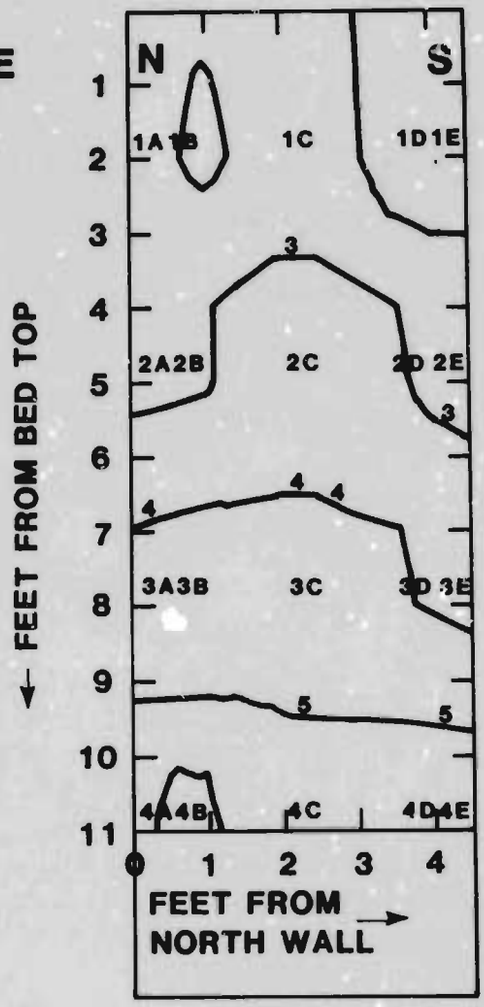
18"

24"



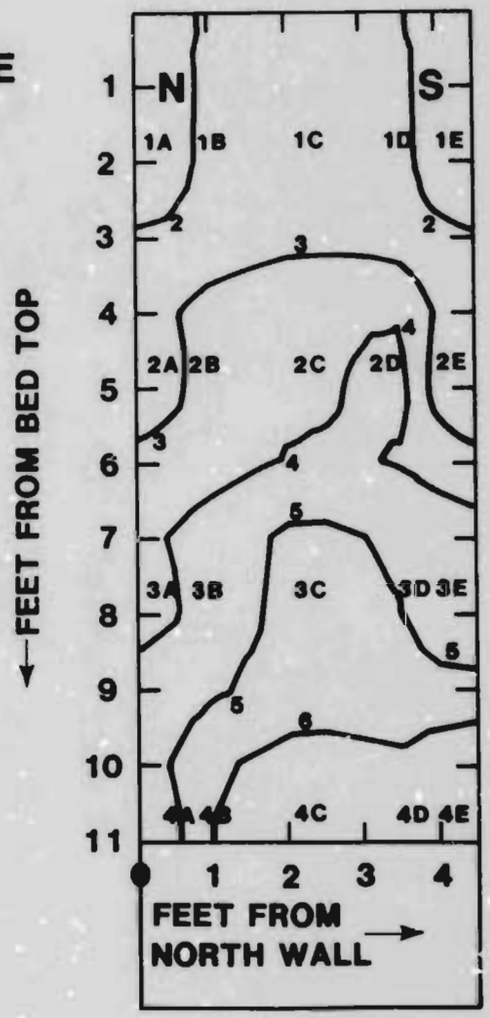
RESIDENCE TIME CONTOURS

TEST S-71-1



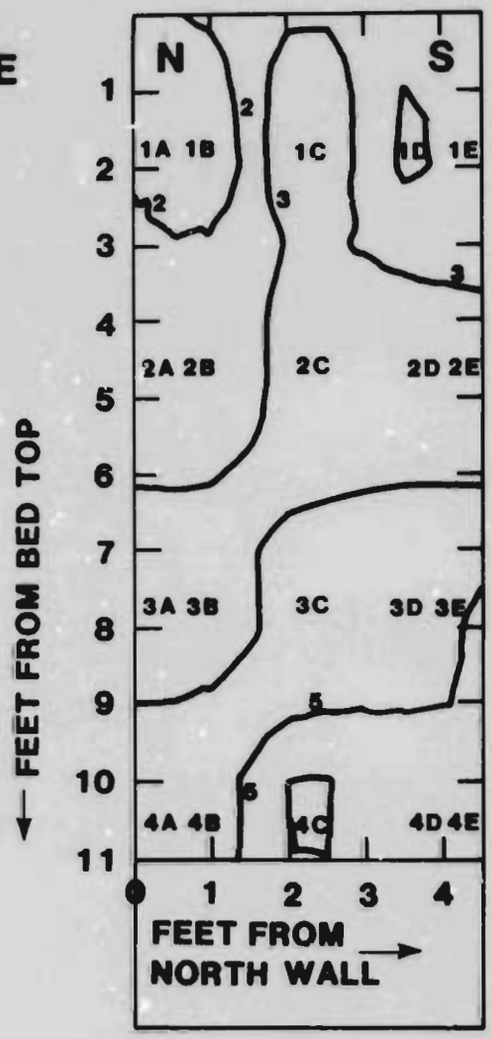
RESIDENCE TIME CONTOURS

TEST S-72-2



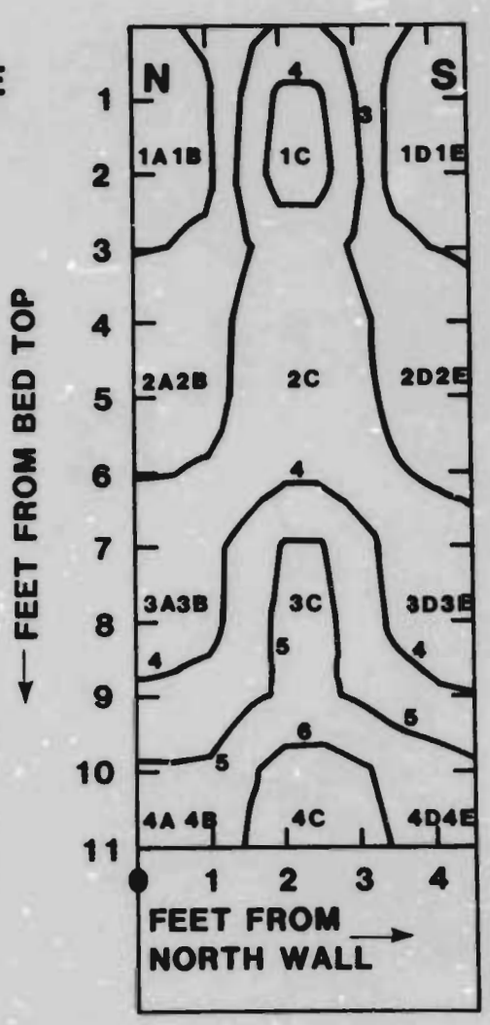
RESIDENCE TIME CONTOURS

TEST S-73-3



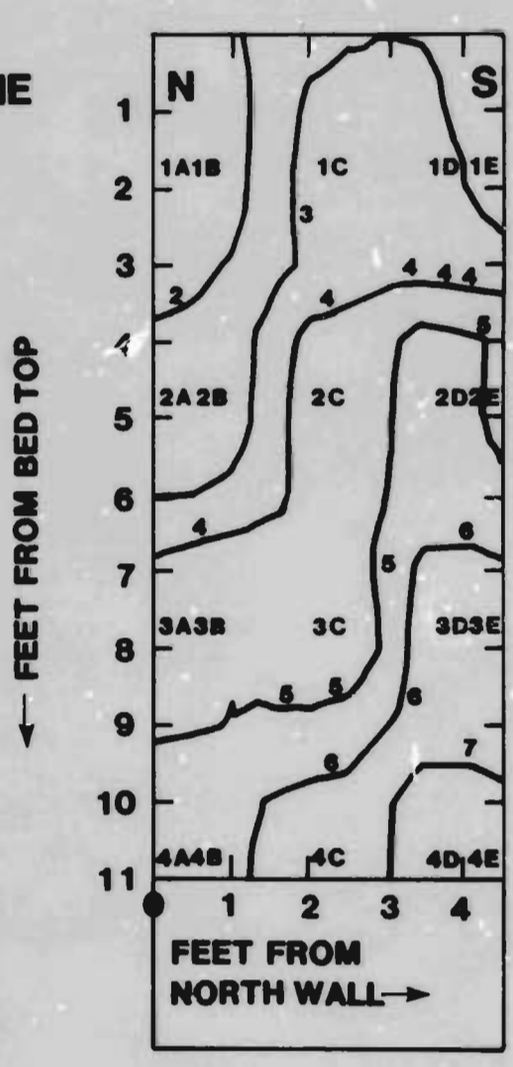
RESIDENCE TIME CONTOURS

TEST S-74-4



RESIDENCE TIME CONTOURS

TEST S-75-4B



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