

P-V-T, Inc.

*Physical and Design Data Research
K-Values • PVT • Enthalpy
Chemical Process & Petroleum Fluids
Reservoir Analysis and Computer Programs*

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May 23, 1978

Southern Union Exploration Company
1st International Building
Suite 1800
Dallas, Texas 75270

Attn: Mr. R. G. Sharrock

Dear Mr. Sharrock:

Enclosed is the final report on the Gas Company of New Mexico Coal desorption project. The invoice will be sent shortly.

If there are questions or additional information required, please contact us. Thank you for this opportunity to be of service.

Very truly yours,

James M. Berryman
James M. Berryman

JMB/jm

NMOCD CASE #11996
PENDRAGON ENERGY
EXHIBIT

N-21

May 23, 1978

FINAL REPORT

I DESORPTION

On January 24th, 1978, seven samples from two 20 foot cores were collected and placed in cannisters for desorption measurements. The sample numbers, depths and time of collection are given in Table I

TABLE I - Samples collected

Sample No.	Depth	Time collected, MST	Comments
1	1039-40	12:44 P.M.	Transition from shale to coal seam. Primarily shale.
2	1042-42.5	12:42 P.M.	85 ft/ton
3	1046-47	12:40 P.M.	
4	1048.5-49.5	12:37 P.M.	
5	1054.5-55	12:48 P.M.	
6	1056-56.9	6:39 P.M.	Sample at bottom of first 20 foot core. Fragmented.
			First sample from 2nd 20 foot core. At bottom of main core seam.
7	1070.3-71	6:28 P.M.	"Finger" surrounded by shale.

The desorption tests were run at 80° F using the U.S. Bureau of Mines procedure outlined in RI 8043. The total amount of desorbed gas is given in Table II. These figures include corrections for gas lost in transfer from seam to container and residual gas left in coal. Both corrections were by U.S. Bureau of Mines procedure in RI 8043.

TABLE II - Total volume of gas desorbed

Sample No.	Weight, Grams	Total Vol. Desorbed, cc at STP*	cc/g	Methane Ft ³ /ton PP/ton	
1	777	470.8	0.60	19.9	18.7
2	545	1487.4	2.73	83.1	83.9
3	655	2263.8	3.46	111.7	109.6
4	611	2165.4	3.55	114.6	109.5
5	553	1120.9	2.03	65.5	60.1
6	815	1651.5	2.03	65.5	60.0
7	596	1198.6	2.01	64.9	55.1

* STP - 0° C and 1 Atm.

II Adsorption

Adsorption tests were run on three crushed samples of number 4, 5 and 8. The amount of methane adsorbed by the coal was determined at 5 pressures, 150, 300, 450, 675 and 1000 psia at 30° C. In each case the results plotted smoothly as a Langmuir isotherm. The form used for this data fit is:

$$\frac{P}{V} = \frac{P}{a} + \frac{1}{ab} \quad (1)$$

where P is the pressure of the gas, V is volume adsorbed per gram of coal, and a and b are constants. The volume of a and b for each sample are given in Table V.

TABLE V
Adsorption of Methane on Coal

	Sample Number		
	4	5	6
a, cc g ⁻¹	6.024	5.038	4.727
b, cc g ⁻¹ psia ⁻¹	4.187 x 10 ⁻³	2.238 x 10 ⁻³	2.613 x 10 ⁻³

The volume of gas adsorbed per gram of coal can be calculated from equation (1) by inserting the pressure at the coal seam in psia for P and the constants a and b in the units given. Comparison of the results obtained should show general agreement with that from desorption. Calculated values at 250 psia are given in Table VI in cc/g.

TABLE VI
Comparison of Adsorption and Desorption Data

	Sample Number		
Sample No.	4	5	8
Adsorption	3.08	1.81	1.87
Desorption	3.55	2.03	2.01

Gas compositions were measured at 24 hours, 48 hours, 1 week and just prior to termination of the desorption test. From these measurements an accurate composition of the desorbed gas can be calculated. The overall composition of the gas from each sample is given in Table III.

TABLE III
Composition of Desorbed Gas

	Sample No.						
	1**	2	3	4	5	6	7
Methane	96.75	94.66	93.60	91.16	91.76	91.55	84.97
Carbon dioxide	0.13	2.74	2.88	4.00	3.29	3.05	3.64
Ethane	3.11	2.59	3.51	4.83	4.92	5.39	11.35
Propane	0.01	0.007	0.002	0.002	0.010	0.003	0.015
iso-Butane	-	0.003	0.001	0.001	0.006	0.001	0.021
n-Butane	-	0.004	0.001	0.001	0.008	0.001	0.003

*Lower down
into PC*

** Amount of gas evolved from this sample is so small that composition given here is questionable.

Tutweiler tests for hydrogen sulfide were run on desorbed gas from samples number 4, 6 and 8. No hydrogen sulfide was found. Since the limit of detectability for our Tutweiler procedure is 16 ppm, the concentration is reported as less than 16 ppm.

Two gas samples were analyzed by Mass Spectrometer. The concentration of gases not determined by gas chromatography are given in Table IV in mole percent.

TABLE IV
Mass Spectrometer Analysis

	Sample	
	#3, 1 week	#4, 48 hours
Argon	0.33	0.07
Hydrogen	1.03	0.11
Helium	0.26	0.18

Differences between data are due to uncertainty in pressure at seam, different composition of adsorbed and desorbed gas, temperature, and structure of the coal in the seam. Considering these variables the agreement between adsorption and desorption is good.

III, Comments

The following comments point out some major observations of the study.

- I. Sample 1 proved to be mostly shale, so little gas was desorbed and no good analysis obtained on the gas.
- II. The amount of adsorbed gas is greatest at the center of the seam samples, 3 and 4, somewhat less at the top, sample 2, and the bottom, samples 5 and 6.
- III. The amount of ethane present in the adsorbed gas increased with depth.
- IV. The sample from the "finger" to the seam, number 8, ^{1? NO PS WAS RUN.} exhibited a number of differences from the other samples. The most significant of these was the very high ethane content, 11.35%. It also was much slower in the release of the gas than the other samples.
- V. Although it is not shown in this report, a general trend followed for most samples was an increase in ethane evolution and a decrease in carbon dioxide evolution with time.
- VI. Some adsorption of oxygen from the air in the containers was observed. This amount to a volume change of 2 to 6 percent with no apparent relation to depth or time.

54550
Lansdale - Federal

ft methane / ton

18.74
83.4
104.6
109.5

60.1
60.6

55.1

PVT Core
Samples

1
2
3
4

5
6

7

1

2

3

4

1100

5

6

7

Induction Resistivity

Short Normal - AM 6"

Conductivity

-272 (Re)
-37 (SP)