93176 HDC 0233 ©
7-24-33W
15-055-21045

K & A
LABORATORIES

June 19, 1993

Amoco Production Company
P. O. Box 800
Denver, Colorado 80201

Attention: Mr. Marty Williams

Re: Final Report
Unsteady-State Relative
Permeability Results
Well-Amoco Shrimplin
G.U. No. 2HI
Hugoton Field
Finney County, Kansas
K&A Job No. 93-5006-03

API: 15/055/2104500

Gentlemen:

This report presents the final results from the unsteady-state gas-water relative permeability tests that were performed on core material from the subject well. These tests were verbally authorized by Mr. Marty Williams and an API well number was not provided. The results from these tests indicate an average gas saturation of 20.5% at a KgKw = 1.0. The end-point relative permeability to gas ranged from 0.500 to 0.231 and averaged 0.391. The procedures used for these tests are provided below.

The selected core plugs used for these tests were dried and the porosity was measured. Next the samples were fully saturated with the standard Amoco sulphate brine and brine permeability was measured using a net confining pressure of 2,000 psi. Note that the remainder of these tests was conducted at 2,000 psi confining pressure. Humidified gas was then injected into each sample at a constant pressure and incremental volumes of gas and brine were recorded. Relative permeability was calculated from the production data by using the theory of Welge and Johnson Bossler-Naumann, which relates relative permeability with core end saturations.

The conditions, under which this report is presented, are described immediately following this report. We request that the report be used in its entirety if reproductions are to be made. Please contact us if you have any questions concerning these data, or if we may be of further service.

Respectfully submitted,

K&A LABORATORIES

JML/peg

K & A Laboratories

6849 East 13th Street • Tulsa, Oklahoma 74112-5613 USA • Tel: 918/835-9524 • Fax: 918/835-9132 • Telex: 796375 KEPPET TUL

SUMMARY OF UNSTEADY-STATE GAS-WATER RELATIVE PERMEABILITY TEST RESULTS

AMOCO PRODUCTION COMPANY
WELL AMOCO SHRIMPLIN G.U. NO. 2HI
HUGOTON FIELD
FINNEY COUNTY, KANSAS

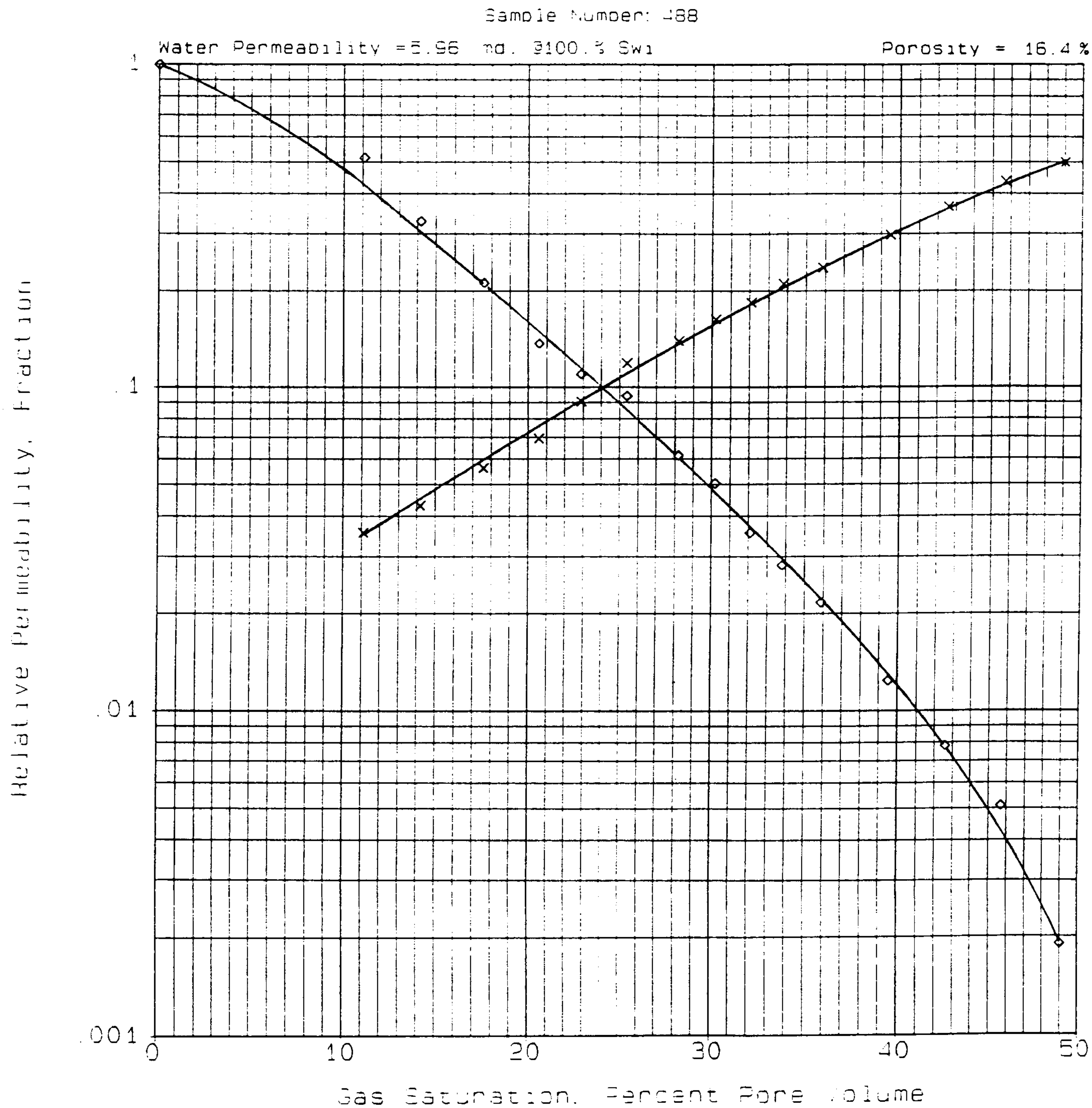
Sample Number	Depth, feet	Air Permeability, md	Porosity, percent	Water Saturation, Percent Pore Volume	Initial Water Permeability,* md	Percent Gas Saturation @ Kg/Kw=1.0
Formation: D-Lime						
488	2,907.	8.08	16.4	100	5.96	24.1
490	2,909.	0.720	10.0	100	0.291	20.1
Formation: E-Lime						
522	2,941.	0.201	12.6	100	0.0680	15.4
525	2,944.	1.09	15.9	100	0.458	22.4
Formation: F-Lime						
510	2,929.	0.118	9.0	100	0.00360	30.6
					Average	22.5

* Base permeability used to calculate relative permeability.
Note: Test conducted at 2,000 psi net confining pressure.

K & A
LABORATORIES

UNSTEADY-STATE
GAS-WATER RELATIVE PERMEABILITY TEST RESULTS

AMOCO PRODUCTION COMPANY
WELL AMOCO SHRIMPLIN G.U. NO. 2HI
HUGOTON FIELD
FINNEY COUNTY, KANSAS



Any interpretations or opinions derived from these data are subject to the conditions described elsewhere in this report.

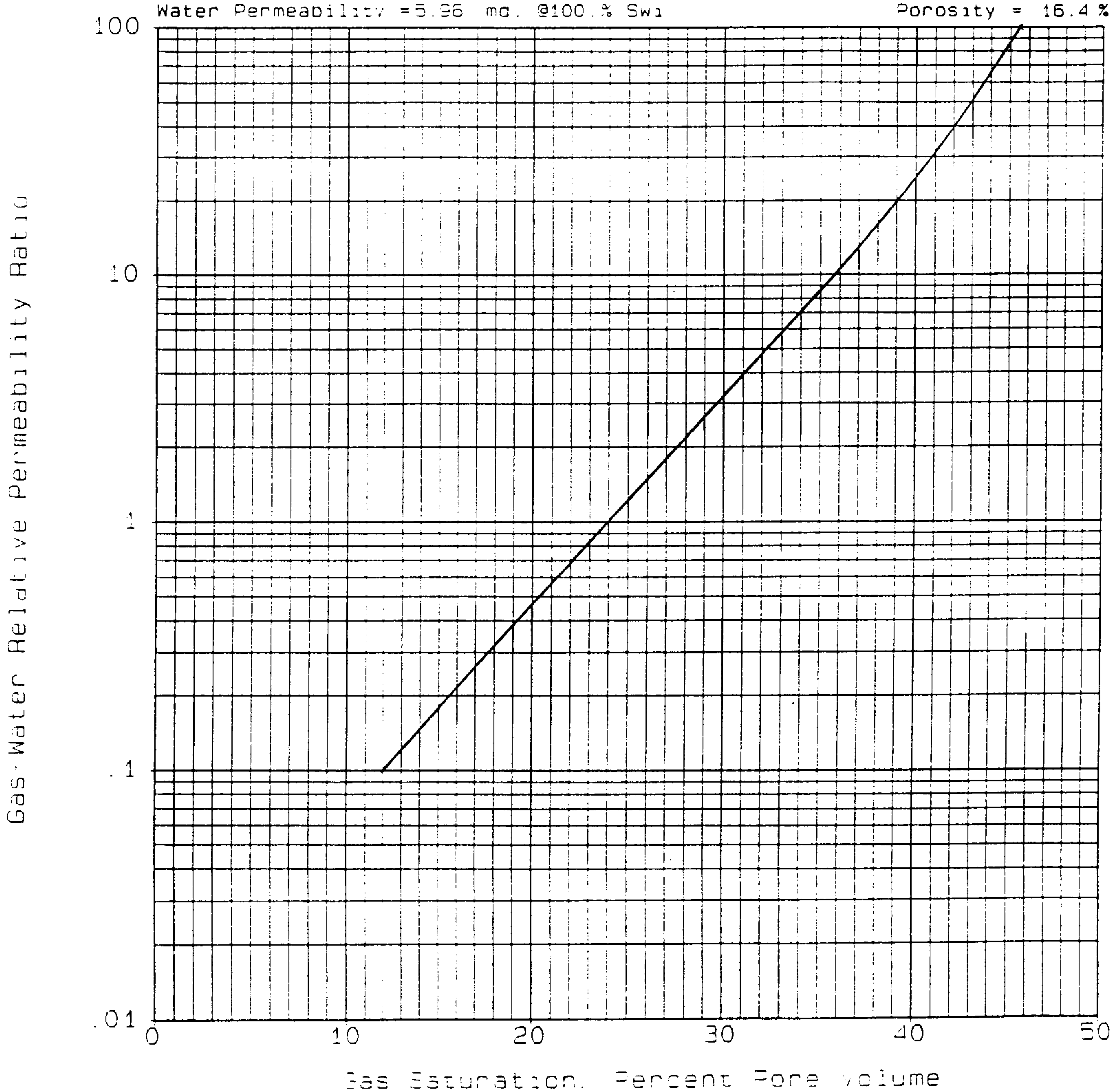
K & A
LABORATORIES

UNSTEADY-STATE
GAS-WATER RELATIVE PERMEABILITY TEST RESULTS

AMOCO PRODUCTION COMPANY
WELL AMOCO SHRIMPLIN G.U. NO. 3HI
HUGOTON FIELD
FINNEY COUNTY, KANSAS

Sample Number: 488

Water Permeability =5.96 md. @100.% Swi   Porosity = 16.4 %



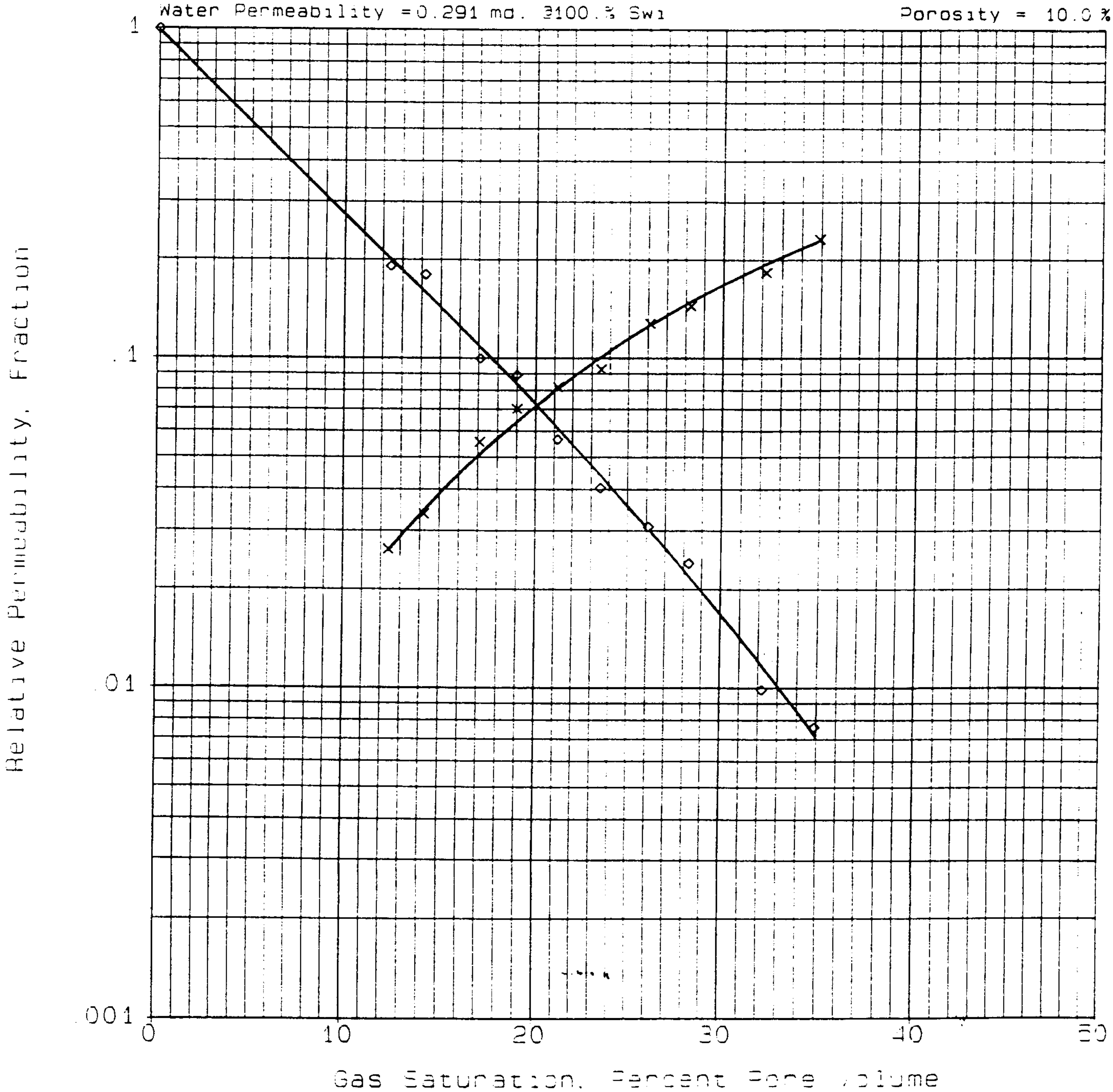
K & A
LABORATORIES

UNSTEADY-STATE
GAS-WATER RELATIVE PERMEABILITY TEST RESULTS

AMOCO PRODUCTION COMPANY
WELL AMOCO SHRIMPLIN G.U. NO. 2HI
HUGOTON FIELD
FINNEY COUNTY, KANSAS

Sample Number: 490

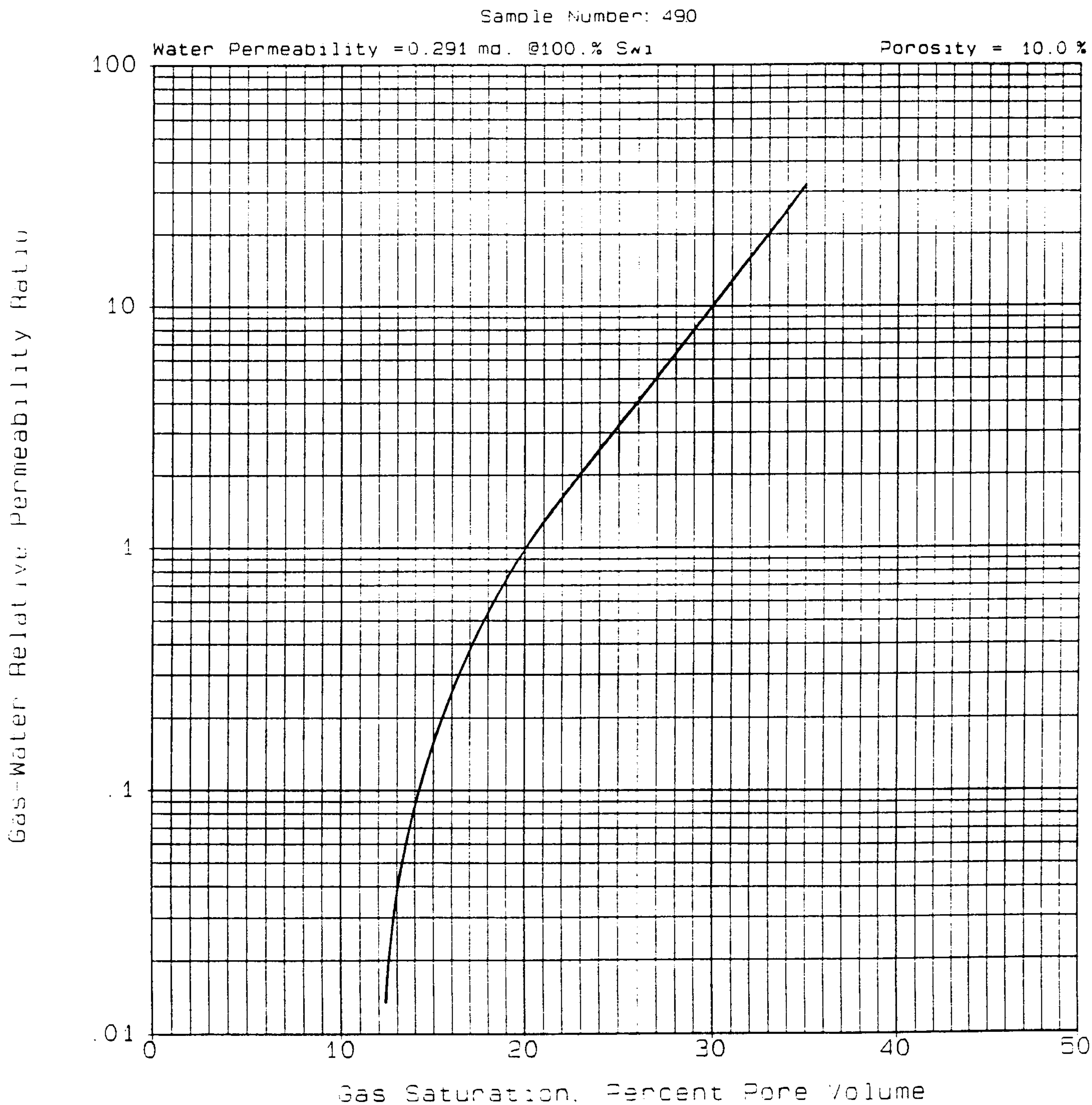
Water Permeability =0.291 md. @100.% Swi   Porosity = 10.0 %



K & A
LABORATORIES

UNSTEADY-STATE
GAS-WATER RELATIVE PERMEABILITY TEST RESULTS

AMOCO PRODUCTION COMPANY
WELL AMOCO SHRIMPLIN G.U. NO. 2HI
HUGOTON FIELD
FINNEY COUNTY, KANSAS

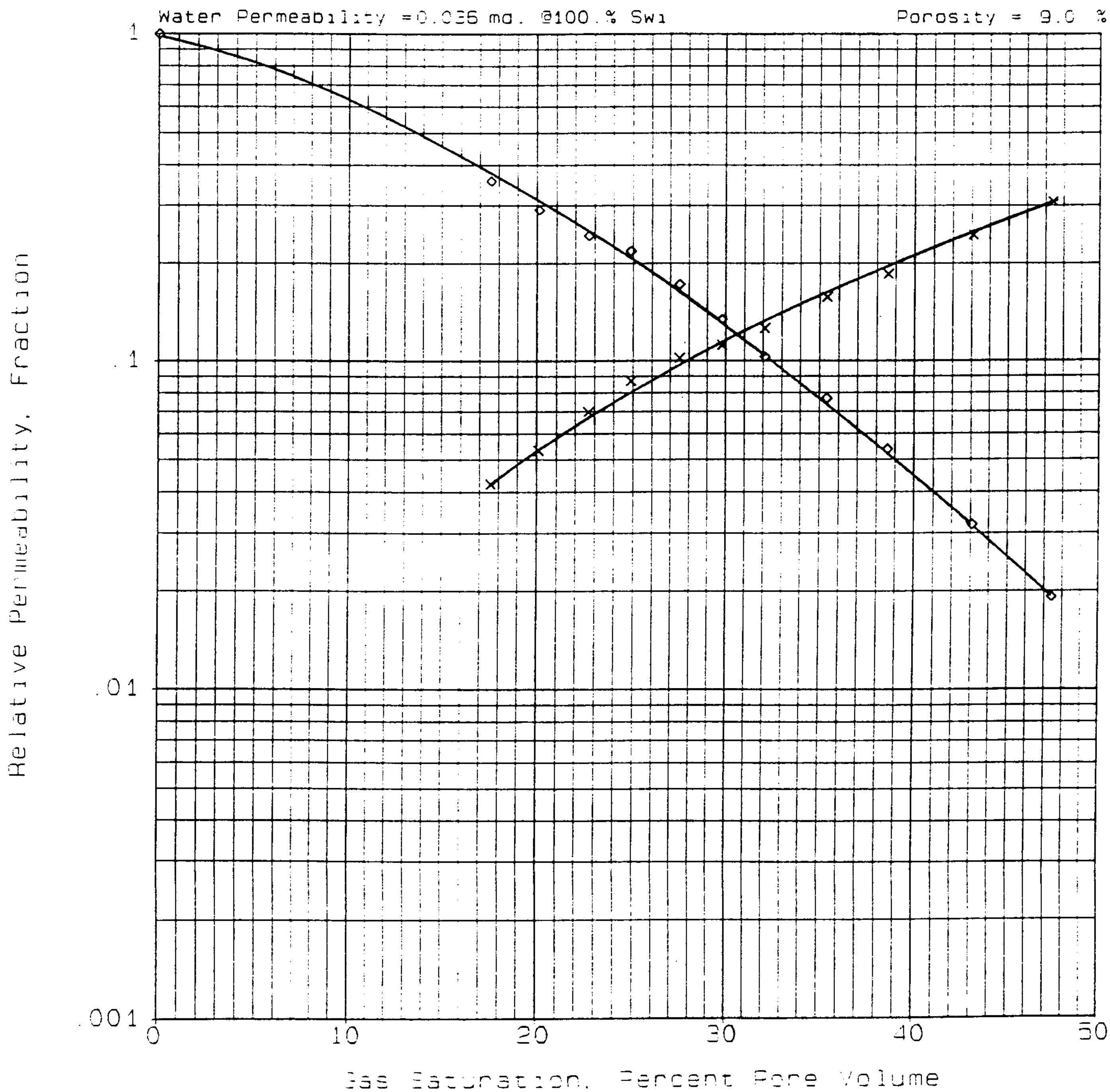


K & A
LABORATORIES

UNSTEADY-STATE
GAS-WATER RELATIVE PERMEABILITY TEST RESULTS

AMOCO PRODUCTION COMPANY
WELL AMOCO SHRIMPLIN G.U. NO. 2HI
HUGOTON FIELD
FINNEY COUNTY, KANSAS

Sample Number: 510



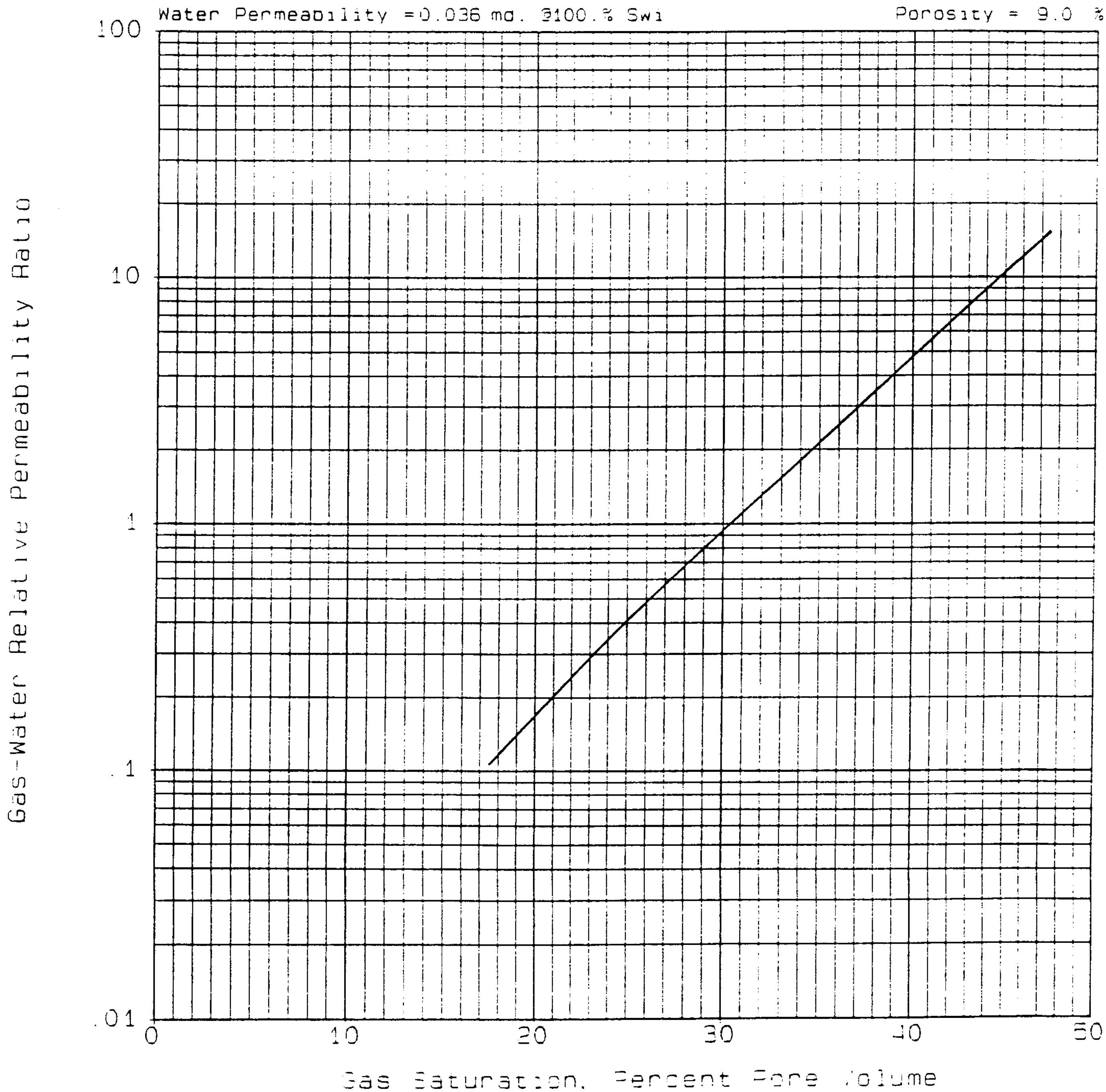
Any interpretations or opinions derived from these data are subject to the conditions described elsewhere in this report.

K & A
LABORATORIES

UNSTEADY-STATE
GAS-WATER RELATIVE PERMEABILITY TEST RESULTS

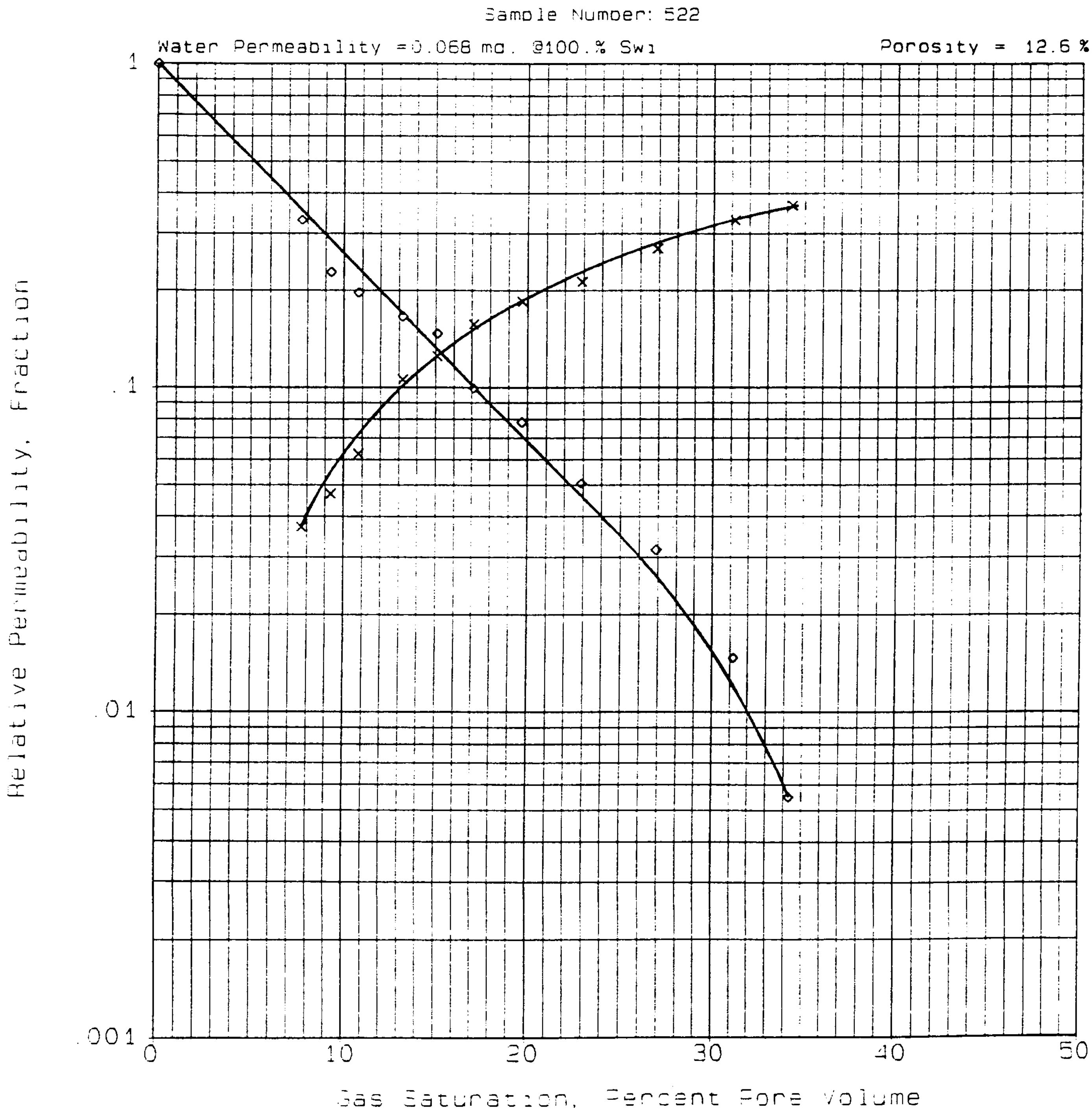
AMOCO PRODUCTION COMPANY
WELL AMOCO SHRIMPLIN G.U. NO. 3HI
HUGOTON FIELD
FINNEY COUNTY, KANSAS

Sample Number: 510



UNSTEADY-STATE
GAS-WATER RELATIVE PERMEABILITY TEST RESULTS

AMOCO PRODUCTION COMPANY
WELL AMOCO SHRIMPLIN G.U. NO. 3HI
HUGOTON FIELD
FINNEY COUNTY, KANSAS



K & A
LABORATORIES

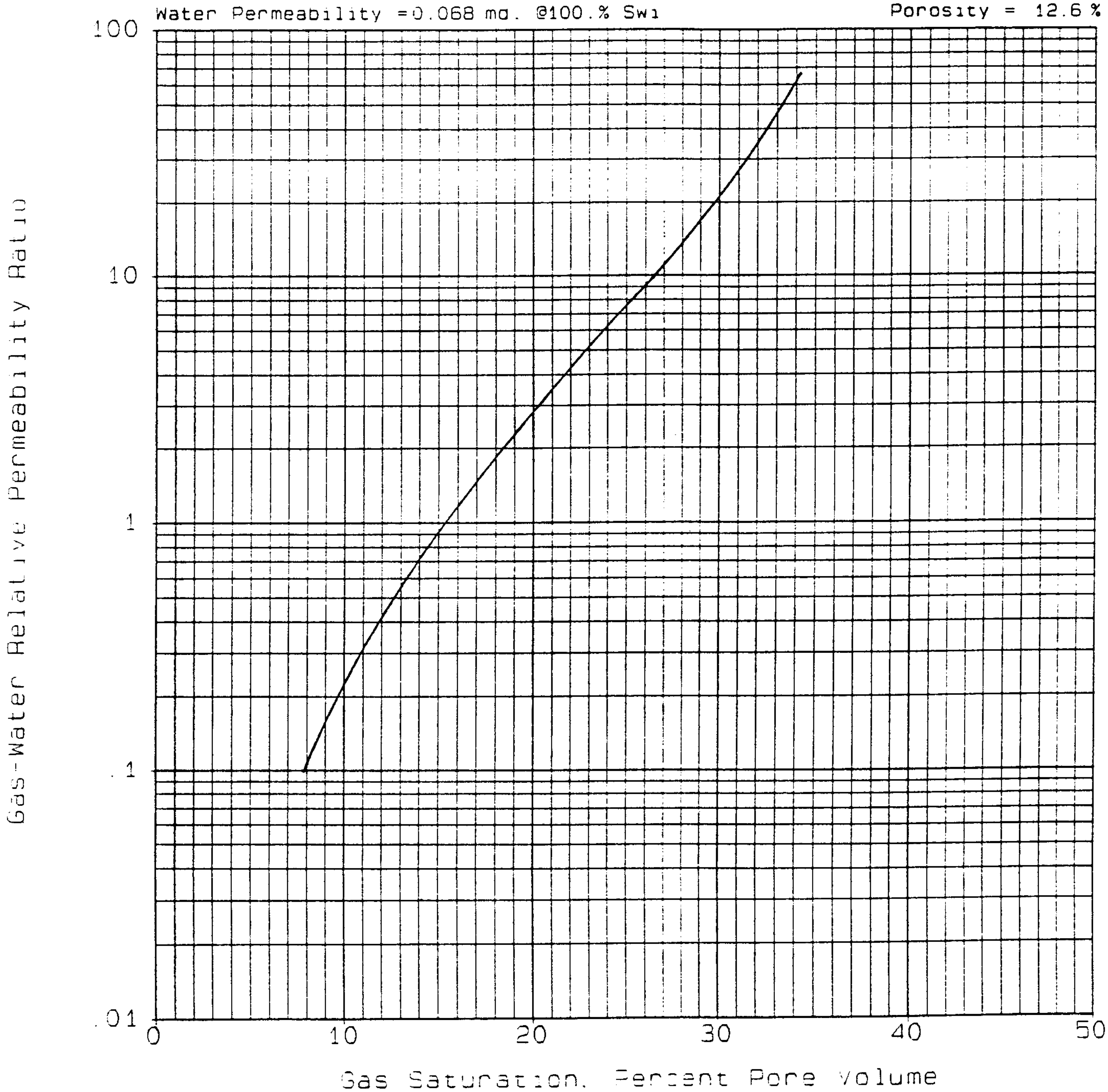
UNSTEADY-STATE GAS-WATER RELATIVE PERMEABILITY TEST RESULTS

AMOCO PRODUCTION COMPANY
WELL AMOCO SHRIMPLIN G.U. NO. 2HI
HUGOTON FIELD
FINNEY COUNTY, KANSAS

Sample Number: E22

Water Permeability =0.068 md. @100.% Swi

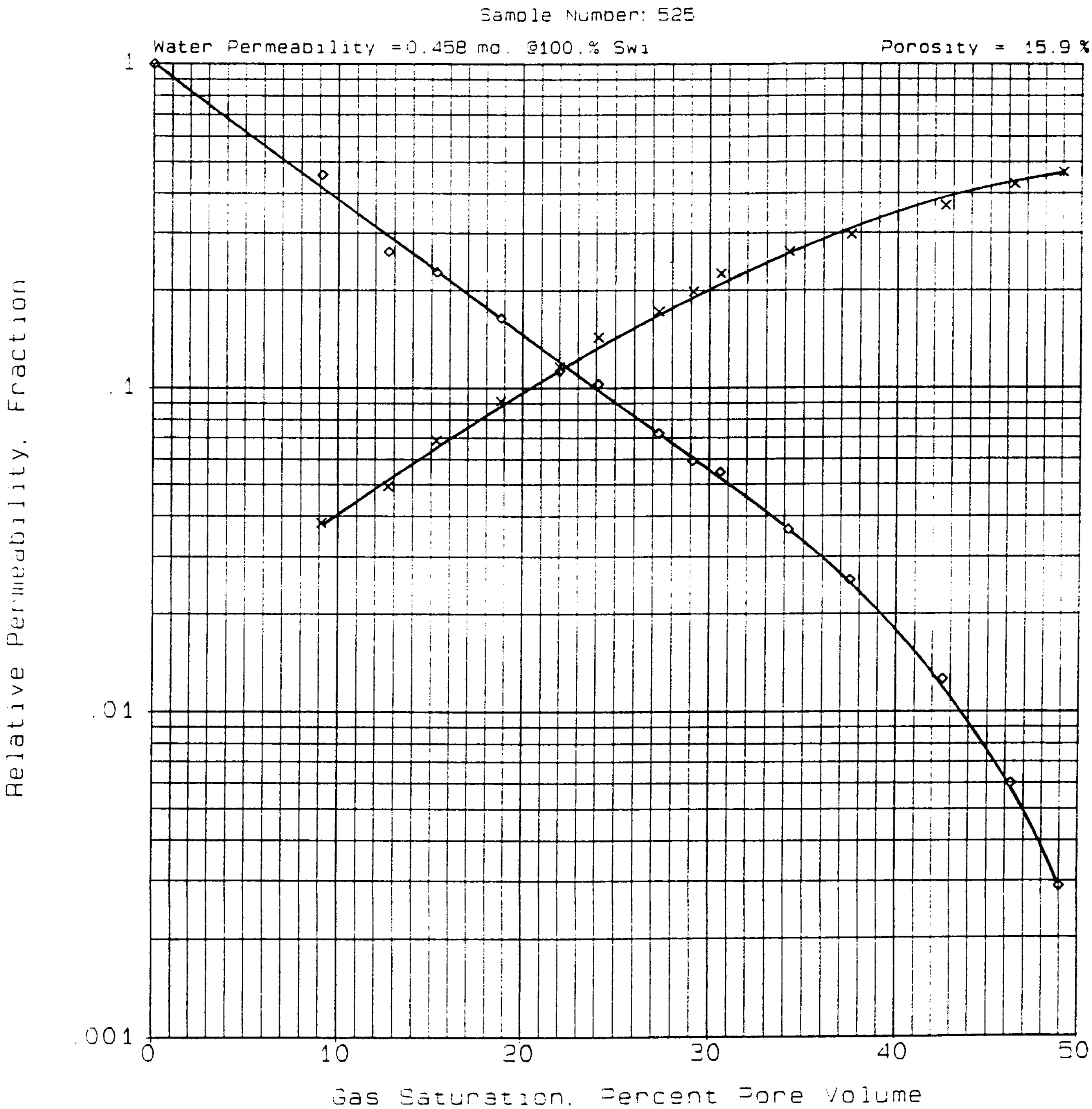
Porosity = 12.6 %



K & A
LABORATORIES

UNSTEADY-STATE
GAS-WATER RELATIVE PERMEABILITY TEST RESULTS

AMOCO PRODUCTION COMPANY
WELL AMOCO SHRIMPLIN G.U. NO. 2HI
HUGOTON FIELD
FINNEY COUNTY, KANSAS

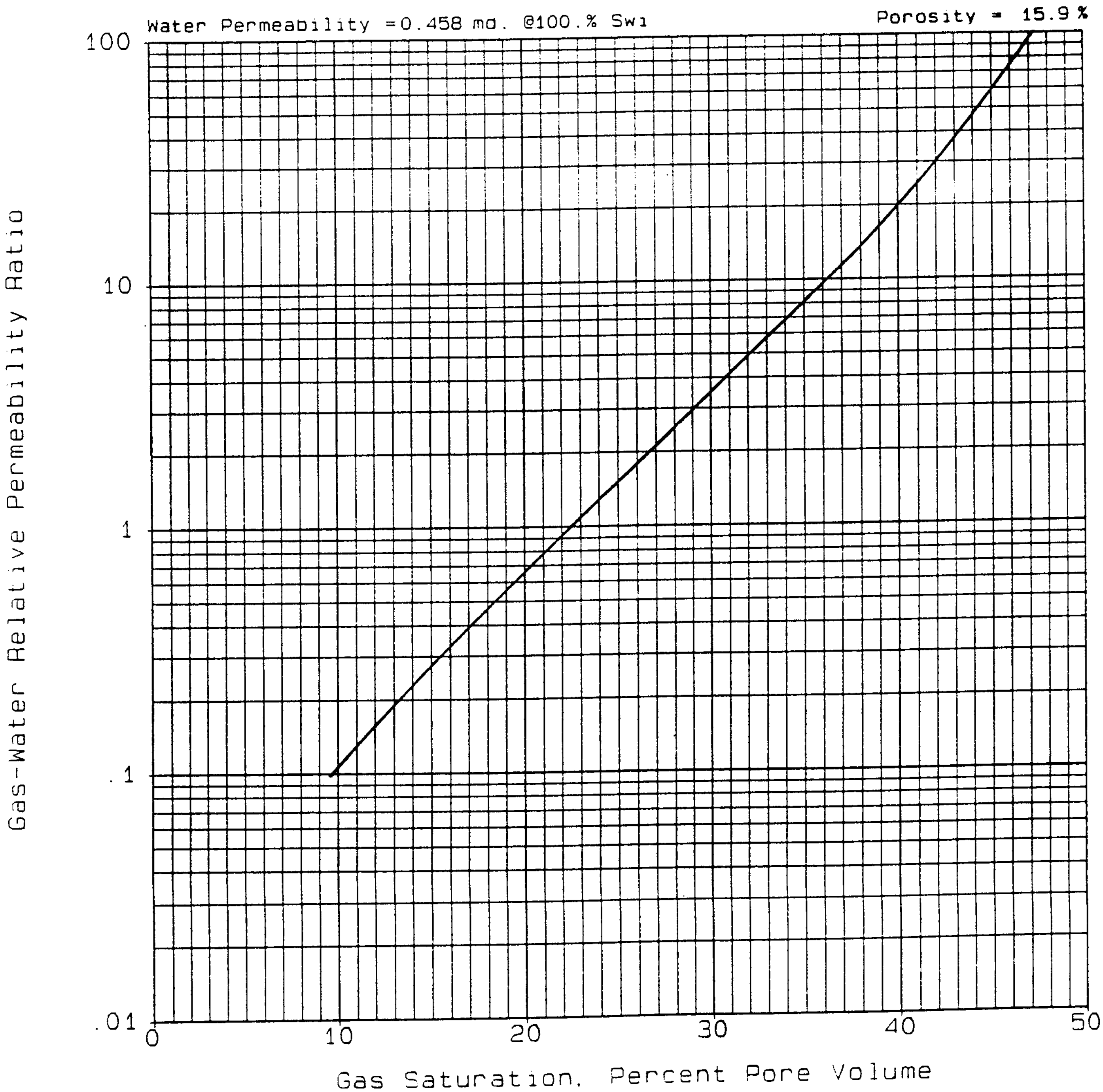


K & A
LABORATORIES

UNSTEADY-STATE
GAS-WATER RELATIVE PERMEABILITY TEST RESULTS

AMOCO PRODUCTION COMPANY
WELL AMOCO SHRIMPLIN G.U. NO. 2HI
HUGOTON FIELD
FINNEY COUNTY, KANSAS

Sample Number: 525



Any interpretations or opinions derived from these data are subject to the conditions described elsewhere in this report.

UNSTEADY-STATE GAS-WATER PERMEABILITY TEST RESULTS

Sample Number 488 Water-Permeability = 5.96 md 100% Swi Porosity = 16.4%

Gas Saturation, Percent Pore Volume	Gas-Water Relative Permeability Ratio	Relative Permeability To Gas*, Fraction	Relative Permeability To Water*, Fraction
0.0	-	-	1.0
11.1	0.0690	0.0356	0.516
14.2	0.131	0.0430	0.328
17.6	0.266	0.0563	0.212
20.6	0.507	0.0694	0.1357
22.9	0.821	0.0903	0.110
25.4	1.26	0.119	0.0941
28.2	2.26	0.139	0.0615
30.2	3.23	0.163	0.0504
32.1	5.18	0.184	0.0355
33.8	7.48	0.211	0.0282
35.9	10.9	0.236	0.0216
39.5	24.0	0.298	0.0124
42.6	46.4	0.364	0.00784
45.7	85.3	0.436	0.00511
49.0	27.0	0.500	0.00185

* Relative to oil permeability at initial water saturation.

K & A
LABORATORIES

UNSTEADY-STATE GAS-WATER PERMEABILITY TEST RESULTS

Sample Number 490 Water-Permeability = 0.291 md 100% Swi Porosity = 10.0%

Gas Saturation, Percent Pore Volume	Gas-Water Relative Permeability Ratio	Relative Permeability To Gas*, Fraction	Relative Permeability To Water*, Fraction
0.0	-	-	1.0
12.4	0.138	0.0264	0.191
14.2	0.187	0.0337	0.180
17.1	0.556	0.0556	0.100
19.0	0.790	0.0702	0.0889
21.2	1.44	0.0817	0.0567
23.5	2.29	0.0926	0.0404
26.1	4.14	0.128	0.0309
28.3	6.04	0.145	0.0240
32.2	18.4	0.183	0.00994
34.9	30.4	0.231	0.00759

* Relative to oil permeability at initial water saturation.

K & A
LABORATORIES

UNSTEADY-STATE GAS-WATER PERMEABILITY TEST RESULTS

Sample Number 510 Water-Permeability = 0.0360 md 100% Swi Porosity = 9.0%

Gas Saturation, Percent Pore Volume	Gas-Water Relative Permeability Ratio	Relative Permeability To Gas*, Fraction	Relative Permeability To Water*, Fraction
0.0	-	-	1.0
17.6	0.118	0.0423	0.357
20.1	0.183	0.0533	0.291
22.7	0.288	0.0700	0.243
24.9	0.399	0.0869	0.218
27.5	0.593	0.102	0.172
29.8	0.836	0.112	0.134
32.1	1.22	0.126	0.103
35.4	2.05	0.157	0.0767
38.6	3.44	0.185	0.0538
43.1	7.65	0.244	0.0319
47.4	16.0	0.308	0.0192

* Relative to oil permeability at initial water saturation.

K & A
LABORATORIES

UNSTEADY-STATE GAS-WATER PERMEABILITY TEST RESULTS

Sample Number 522 Water-Permeability = 0.0680 md 100% Swi Porosity = 12.6%

Gas Saturation, Percent Pore Volume	Gas-Water Relative Permeability Ratio	Relative Permeability To Gas*, Fraction	Relative Permeability To Water*, Fraction
0.0	-	-	1.0
7.7	0.112	0.0371	0.331
9.3	0.206	0.0470	0.228
10.8	0.317	0.0625	0.197
13.2	0.639	0.106	0.166
15.1	0.850	0.125	0.147
17.1	1.58	0.157	0.0996
19.7	2.35	0.184	0.0783
22.9	4.21	0.213	0.0506
26.9	8.52	0.270	0.0317
31.2	22.5	0.331	0.0147
34.3	67.2	0.367	0.00546

* Relative to oil permeability at initial water saturation.

K & A
LABORATORIES

UNSTEADY-STATE GAS-WATER PERMEABILITY TEST RESULTS

Sample Number 525 Water-Permeability = 0.458 md 100% Swi Porosity = 15.9

Gas Saturation, Percent Pore Volume	Gas-Water Relative Permeability Ratio	Relative Permeability To Gas*, Fraction	Relative Permeability To Water*, Fraction
0.0	-	-	1.0
9.1	0.0836	0.0381	0.456
12.7	0.188	0.0495	0.263
15.3	0.302	0.0686	0.227
18.8	0.556	0.0912	0.164
22.0	1.03	0.116	0.113
24.1	1.39	0.143	0.103
27.3	2.38	0.172	0.0723
29.1	3.34	0.198	0.0593
30.6	4.11	0.225	0.0547
34.2	7.21	0.263	0.0365
37.5	11.6	0.297	0.0255
42.6	29.0	0.365	0.0126
46.3	71.7	0.428	0.00597
49.0	161.0	0.465	0.00288

* Relative to oil permeability at initial water saturation.

CONDITIONS AND QUALIFICATIONS

K&A Laboratories will endeavor to provide accurate and reliable laboratory measurements of the cores provided by the client. The results of any core analysis are necessarily affected by the condition in which the core is received and the selection of the samples to be analyzed. In the absence of direction by the client, K&A Laboratories will utilize its best geological and engineering judgment in selecting the samples to be analyzed. It should be recognized that most cores do not have uniform properties and that selection of truly representative samples is rarely possible. Unless otherwise directed, the samples will normally be selected from the highest quality segments. Thus, use of the properties measured in this report in reservoir calculations could result in an overestimation in reservoir volume and/or deliverability. K&A Laboratories assumes no responsibility nor offers any guarantee of the productivity or performance of any oil or gas well or hydrocarbon recovery process based upon the data presented in this report.