



CMS-300 CONVENTIONAL PLUG ANALYSIS

Chevron
University 16-18 A1
Ward County, Texas

CL File Number: HOU-131210

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CMS-300 CONVENTIONAL PLUG ANALYSIS

Sample Number	Depth (ft)	Net Confining Stress (psig)	Porosity (%)	Permeability		b(air) psi	Beta ft(-1)	Alpha (microns)	Saturation		Grain Density (g/cm3)	Footnote
				Klinkenberg	Kair				Oil	Water		
				(md)	(md)				% Pore Volume			
27H	11176.00	1760	2.37	6.13E-05	.001	356.56	1.41E+18	3.05E+05	29.45	10.67	2.700	
29H	11191.00	1760	6.94	N/A	N/A	N/A	N/A	N/A	22.48	32.91	2.701	(2)
33H	11248.00	1760	11.55	1.25E-03	.006	123.61	4.73E+15	2.03E+04	20.90	26.15	2.678	
35H	11273.50	1760	11.65	9.14E-02	.176	23.57	2.53E+12	7.46E+02	15.06	43.85	2.653	(1)
38H	11326.50	1760	11.18	4.19E-03	.015	82.25	5.24E+14	7.14E+03	15.62	42.52	2.655	
40H	11335.75	1760	14.22	2.93E-03	.011	92.57	9.75E+14	9.57E+03	16.96	35.34	2.627	(1)

Footnotes :

- (1) : Denotes fractured or chipped sample. Permeability and/or porosity may be optimistic.
 - (2) : Sample permeability below the measurement range of CMS-300 equipment at indicated net confining stress (NCS). Data unavailable.
 - (3) : Denotes very short sample, porosity may be optimistic due to lack of conformation of boot material to plug surface.
 - (4) : Sample contains bitumen or other solid hydrocarbon residue.
 - (5) : Denotes sample unsuitable for measurement at stress. Porosity determined using Archimedes bulk volume at ambient conditions.
- Permeability greater than 0.1 mD measured using helium gas. Permeability less than 0.1 mD measured using nitrogen gas. All b values converted to b (air)



APPENDIX A: EXPLANATION OF CMS-300 TERMS "b", "Beta, and "Alpha"

K_{∞}	=	Equivalent non-reactive liquid permeability, corrected for gas slippage, mD
K_{air}	=	Permeability to Air, calculated using K_{∞} and b, mD
b	=	Klinkenberg slip factor, psi
β (Beta)	=	Forcheimer inertial resistance factor, ft^{-1}
α (Alpha)	=	A factor equal to the product of Beta and K_{∞} . This factor is employed in determining the pore level heterogeneity index, H_i .
H_i	=	$\log_{10} (\alpha\phi/RQI)$ α , microns = $3.238E^{-9} \beta K_{\infty}$
ϕ	=	Porosity, fraction
RQI	=	Reservoir Quality Index, microns
RQI	=	$0.0314(K/\phi)^{0.5}$

For further information please refer to:

Jones, S.C.: "Two-Point Determination of Permeability and PV vs. Net Confining Stress" SPE Formation Evaluation (March 1988) 235-241.

Jones S.C.: "A Rapid Accurate Unsteady-State Klinkenberg Permeameter," Soc. Pet. Eng. J. (Oct. 1972) 383-397.

Jones, S.C.: "Using the Inertial Coefficient, β , To Characterize Heterogeneity in Reservoir Rock: SPE 16949 (September 1987).

Amaefule, J.O.; Kersey, D.G.; Marschall, D.M.; Powell, J.D.; Valencia, L.E.; Keelan, D.K.: "Reservoir Description: A Practical Synergistic Engineering and Geological Approach Based on Analysis of Core Data," SPE Technical Conference (Oct. 1988) SPE 18167.



CMS-300 CONVENTIONAL PLUG ANALYSIS PROTOCOL

Sample Preparation

1.0" diameter plugs were drilled with liquid nitrogen and trimmed into right cylinders with a diamond-blade trim saw.
All sample trims were archived.

Core Extraction

Plugs selected for routine core analysis were placed in Dean Stark equipment using toluene, followed by Soxhlet extraction cycling between a chloroform / methanol (87:13) azeotrope and methanol.

Sample Drying

Samples were oven dried at 240° F to weight equilibrium (+/- 0.001 g).

Porosity

Porosity was determined using Boyle's Law technique by measuring grain volume at ambient conditions & pore volume at indicated net confining stresses (NCS)

Grain Density

Grain density values were calculated by direct measurement of grain volume and weight on dried plug samples.
Grain volume was measured by Boyle's Law technique.

Permeability

Permeability to air was measured on each sample using unsteady-state method at indicated NCS.

Fluid Saturations

Fluid saturations were determined by the Dean Stark technique using the following fluid properties:

Brine	1.032 g/cc (50000 ppm TDS)
Oil	0.845 g/cc (36° API)

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Sample Number	Depth ft	Net Confining Stress psig	Pore Volume cm3	Porosity %	Permeability		Grain Volume cm3	Grain Density g/cm3	Dry Weight g	Length cm	Diameter cm
					Klinkenberg	Kair					
					(md)	(md)					
27H	11176.00	1760	0.476	2.37	0.000	0.001	19.610	2.700	52.942	4.032	2.528
29H	11191.00	1760	1.544	6.94	N/A	N/A	20.703	2.701	55.917	4.447	2.532
33H	11248.00	1760	1.944	11.55	0.001	0.006	14.891	2.678	39.880	3.322	2.535
35H	11273.50	1760	2.550	11.65	0.091	0.176	19.334	2.653	51.289	4.333	2.546
38H	11326.50	1760	2.869	11.18	0.004	0.015	22.796	2.655	60.513	4.972	2.544
40H	11335.75	1760	3.452	14.22	0.003	0.011	20.829	2.627	54.727	4.710	2.534