

OIL and GAS DIVISION

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HYDROCARBON REPORT

FLOUNDER-1

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OIL and GAS DIVISION

ESSO PRODUCTION RESEARCH COMPANY

HYDROCARBON REPORT - SUBSURFACE OIL
ESSO STANDARD OIL (AUSTRALIA) LTD.
FLOUNDER NO. 1 WELL

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Contents

	<u>Page</u>
FLOUNDER NO. 1 SUBSURFACE OIL SAMPLE	1
Pressure-Volume Relations of Subsurface Oil Sample	2
Flash Liberation and Differential Liberation Results	3
Comparison of Experimental and Computed Flash Liberation Results	4
Hydrocarbon Analysis of Subsurface Oil Sample	5
Viscosity of Reservoir Oil at 233° F	6
Viscosity of Reservoir Oil at 80° F	7

FLOUNDER NO. 1 SUBSURFACE OIL SAMPLE

Source: Esso Standard Oil (Australia) Ltd., Flounder No. 1 Well

Date Taken: August 21, 1968

Sampling Data

Sampled in the one-half gallon isolation chamber of an FIT subsurface tool, and transferred into shipping containers on the rig floor.

*Saturation Pressure (Sample container No. 38 was used in tests)

2770 psig at 75° F
3568 psig at 233° F

Reservoir Data

Elevation RDB
Depth, bdf
Original reservoir pressure
Reservoir temperature

93 ft 28.3m
8296 ft 2529m
3645 psig
233° F 111.7°c

Properties of Samples

Pressure-Volume Relations	Table I
Flash Liberation and Differential Liberation Results	Table II
Comparison of Experimental and Computed Flash Liberation Results	Table II-A
Hydrocarbon Analysis of Subsurface Oil Sample	Table III
Viscosity of Reservoir Oil at 233° F	Table IV
Viscosity of Reservoir Oil at 80° F	Table IV-A

*The sample in container No. 325 had a gas-oil ratio less than the 1240 cu ft/bbl measured in the field, and a saturation pressure of 1895 psig at 75° F (2690 psig, estimated P_s , at 233° F).

TABLE I

Pressure-Volume Relations of Subsurface Oil Sample

Source: Esso Standard Oil (Australia) Ltd., Flounder No. 1 Well

Date Taken: August 21, 1968

Temperature: 233° F

<u>Pressure, psig</u>	<u>Relative Volume, V/V_{bp}</u>	<u>*Y = $\frac{P_s - P}{P(\frac{V_t}{V_{bp}} - 1)}$</u>
4000	0.9862	
3900	0.9891	
3800	0.9924	
3700	0.9957	
3600	0.9991	
P _s = 3568	1.0000	
3522	1.0054	2.340
3298	1.0350	2.270
3143	1.0605	2.225
3035	1.0807	2.182
2723	1.1474	2.094
2483	1.2150	2.020
2292	1.2828	1.956
1997	1.4188	1.864
1780	1.5551	1.794
1608	1.6917	1.746
1358	1.9653	1.667
1137	2.3169	1.602
914	2.8656	1.531
700	3.7443	1.462
543	4.8433	1.411

Specific Volume at Saturation Pressure = 0.02922 cu ft/lb

*Calculated data for use in correcting subsurface oil sample

P_s = Saturation pressure of sample at 233° F, psia

P = Pressure below saturation pressure, psia

V_t = Two-phase relative volume factor at 233° F and P

V_{bp} = Saturated oil relative volume at 233° F and 3583 psia (3568 psig)

TABLE II

Flash Liberation and Differential Liberation Results
Subsurface Oil Sample

Source: Esso Standard Oil (Australia) Ltd., Flounder No. 1 Well

Date Taken: August 21, 1968

Properties of Saturated Oil: Temperature, °F 233 Saturation Pressure, psig 3568

Gas Liberation and Shrinkage of Oil:
(Flash)

Pressure (p1), psig	Temperature, °F	PI	Gas-Oil Ratio: cu ft at 60° F and 14.7 psia/bbl Residual Oil Flashed at		Residual Oil Gravity, °API at 60° F	Specific Gravity Gas at 60° F (air = 1)	VR/VS*
			PI	PI to 0			
0	75	1804	-	-	46.7	0.9259	0.4741
20	75	1427	12	12	48.8	-	0.5289
150	75	1187	141	141	49.7	-	0.5602

(Differential at 233° F)

Pressure, psig	Compressibility, Z	Viscosity, cp	Properties of Liberated Gas at 233° F and Indicated Pressure***		Gas-Oil Ratio: cu ft at 14.7 psia and 60° F/bbl Reservoir Oil at 3568 psig, 233° F	Residual Oil Gravity, °API at 60° F	V**/VS
			Pressure, psig	Compressibility, Z			
3568	-	-	-	-	0	-	1.0000
3375	0.835	0.0232	82	82	82	-	0.9480
2965	0.831	0.0212	226	226	226	-	0.8628
2554	0.825	0.0194	334	334	334	-	0.8010
2143	0.833	0.0176	425	425	425	-	0.7515
1728	0.848	0.0156	502	502	502	-	0.7095
1365	0.868	0.0144	570	570	570	-	0.6726
920	0.888	0.0135	636	636	636	-	0.6385
562	0.913	0.0129	697	697	697	-	0.6050
200	0.940	0.0111	768	768	768	-	0.5599
0	-	-	828	828	828	47.4	0.5249

1FVF
1.9051
1.896
1.6437
1.5260
1.4317
1.3517
1.2814
1.2166
1.1526
1.0667

*VR = Volume residual oil at 0 psig, 60° F
VS = Volume saturated oil at 3568 psig, 233° F
**V = Volume saturated oil at indicated pressure, 233° F
*** = Determined from calculated composition of equilibrium gas

TABLE II-A

Comparison of Experimental and Computed Flash Liberation Results
Subsurface Oil Sample

Source: Esso Standard Oil (Australia) Ltd., Flounder No. 1 Well
Date Taken: August 21, 1968

(P ₁) Pressure psig	Temperature °F	Gas-Oil Ratio - cu ft/bbl Residual Oil Flashed from P ₁ to 0		Residual Oil Gravity °API at 60°F		V _R /V _S	
		Experimental	Computed	Experimental	Computed	Experimental	Computed
0	75	1804	-	46.7	-	0.4741	-
0	60	-	1847	0.794 g/cc	46.7	-	0.4703

Data Used in Flash Calculations

Subsurface Oil Sample Component	Mol %	gal/mol
Hydrogen Sulfide	0.00	
Carbon Dioxide	2.08	
Nitrogen	0.41	
Methane	46.32	
Ethane	9.16	
Propane	7.64	
Iso-Butane	1.88	
N-Butane	3.81	
Iso-Pentane	1.63	
N-Pentane	1.84	
Hexanes	2.49	15.52
Heptanes	2.64	16.43
Octanes	2.67	17.55
Nonanes	1.99	18.61
Heavier Fraction	15.44	28.68
Total	100.00	

K-value Source: NGAA (1957)
Convergence Pressure: 10,000 psia

Unadjusted Flash Data*

Molecular weight of heavier fraction	196
Density of heavier fraction, gm/cc at 60°F	0.8190
Specific volume of reservoir fluid at 3568 psig bubble point and 233°F, cu ft/lb	0.02922
Mols per barrel	3.153

*The computed flash shown was obtained using 60°F K-values and a plus one percent adjustment to the C₁₀₊ density. We were unable to obtain a satisfactory computed match of experimental data over the pressure range investigated.

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TABLE III

Hydrocarbon Analysis of Subsurface Oil Sample

Source: Esso Standard Oil (Australia) Ltd., Flounder No. 1 Well

Date Taken: August 21, 1968

<u>Component</u>	<u>Weight Percent</u>	<u>Density, g/cc at 60° F</u>	<u>Molecular Weight</u>
Hydrogen Sulfide	0.00		
Carbon Dioxide	1.50		
Nitrogen	0.19		
Methane	12.18		
Ethane	4.52		
Propane	5.52		
Iso-Butane	1.79		
N-Butane	3.63		
Iso-Pentane	1.93		
N-Pentane	2.18		
Hexanes	3.76	0.7102	92
Heptanes	4.37	0.7364	101
Octanes	4.86	0.7580	111
Nonanes	3.95	0.7790	121
Heavier Fraction	49.62	0.8190	196
Total	100.00		
Pentane-Free Fraction		0.7964	160

Orsat Analysis of Gas Liberated at 0 psig and 75° F

<u>Component</u>	<u>Volume Percent</u>
Hydrocarbons	97.10
Hydrogen Sulfide	0.00
Carbon Dioxide	2.90
Total	100.00

Residual Crude Oil

Wax Content	12.7 % by wt
Sulfur Content	0.09 % by wt
Pour Point	70° F

TABLE IV

Viscosity of Reservoir Oil at 233° F

Source: Esso Standard Oil (Australia) Ltd., Flounder No. 1 Well

Date Taken: August 21, 1968

<u>Pressure, psig</u>	<u>Viscosity, cp</u>	<u>Density, gm/cc</u>
3800	0.243	0.5523
3750	0.238	0.5514
3700	0.237	0.5505
P _s = 3568	0.230	0.5481
3400	0.235	0.5559
3000	0.249	0.5744
2600	0.260	0.5929
2200	0.285	0.6114
1800	0.302	0.6299
1400	0.325	0.6484
1000	0.352	0.6669
600	0.383	0.6854
200	0.426	0.7039
0	0.563	0.7132

TABLE V

Viscosity of Reservoir Oil at 80° F*

Source: Esso Standard Oil (Australia) Ltd., Flounder No. 1 Well

Date Taken: August 21, 1968

<u>Pressure, psig</u>	<u>Viscosity, cp</u>	<u>Density, gm/cc</u>
3800	0.392	0.6364
3600	0.383	0.6348
3400	0.378	0.6332
3200	0.372	0.6316
3000	0.367	0.6300
$P_s = 2775$	0.361	0.6268
0	1.936	0.7823

*Viscosity data was obtained at 80° F instead of 60° F due to 70° F pour point. Viscosity data above saturation pressure of 2775 psig at 80° F was determined prior to viscosity measurements at 233° F. Data for pressures below 2775 psig at 80° F were not obtained due to shortage of sample.