

Partial Reservoir Fluid Study
for
Chevron Canada Resources Limited
Chevron Virden 7-8-9-25 (WLM)
Virden Field, Manitoba

File Number: 55377-87-383

1988 02 17



CORE LABORATORIES

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Chevron Canada Resources Limited
500 - Fifth Avenue S.W.
Calgary, Alberta
T2P 0L7

Attention: Ms. Bonnie Nickel

Subject: Partial Reservoir Fluid Study
Chevron Virden 7-8-9-25 (W1M)
Vidren Field, Manitoba
File Number: 55377-87-383

Gentlemen:

Samples of separator gas and oil were collected from the subject well by a representative of Core Laboratories on 1987 12 11. The samples were then submitted to our Calgary laboratory for use in a reservoir fluid study.

Initially, the separator samples were physically recombined to the specified gas-oil ratio of 21.60 m³/m³ stock tank liquid. A portion of the fluid was then transferred, under pressure, to a high-pressure, windowed cell and heated to the reported reservoir temperature of 32.0°C. The saturation pressure and the pressure-volume relations of the fluid were determined at this temperature. The differential vaporization test could not be conducted due to the low saturation pressure. The viscosity of the fluid was measured at 32.0°C for pressures exceeding the saturation pressure to atmospheric pressure. A two-stage separator test was also conducted, simulating field operating conditions at the time of sampling. The composition of the recombined reservoir fluid was determined by low temperature, fractional distillation.

Thank you for the opportunity to be of service. Please contact me if you have any questions concerning the enclosed data.

Yours truly,

CORE LABORATORIES CANADA

Tom B. Martin
Supervisor
PVT Laboratory

TC/cmdc

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SECTION I
Tabular Data

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VOLUMETRIC DATA OF RESERVOIR FLUID SAMPLE

1. Saturation pressure (P_g) (bubble point) 1 427 kPa (gauge) at 32.0 °C.
2. Thermal expansion (β_o) of reservoir fluid: $\frac{\text{Volume @ } 32.0^\circ\text{C}}{\text{Volume @ } 19.4^\circ\text{C}}$

At 34 474 kPa (Gauge) = 1.00896
3. Compressibility (C_o) of reservoir fluid @ reservoir temperature: Vol/Vol/kPa:

From 34 474 kPa to 27 579 kPa = 6.84×10^{-7}
From 27 579 kPa to 20 684 kPa = 7.10×10^{-7}
From 20 684 kPa to 13 790 kPa = 7.51×10^{-7}
From 13 790 kPa to 6 895 kPa = 8.06×10^{-7}
From 6 895 kPa to 3 447 kPa = 8.45×10^{-7}
From 3 447 kPa to 1 427 kPa = 8.93×10^{-7}

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PRESSURE VOLUME RELATIONS AT 32.0 °C

<u>PRESSURE</u> kPa (Gauge)	<u>RELATIVE</u> <u>VOLUME</u> V/Vsat (1)	<u>Y</u> <u>FUNCTION (2)</u>	<u>OIL</u> <u>DENSITY</u> kg/m ³
34 474	0.9753		856.8
27 579	0.9799		852.7
20 684	0.9847		848.6
13 790	0.9898		844.2
6 895	0.9953		839.5
3 447	0.9982		837.1
2 758	0.9988		836.6
<u>1 427</u>	<u>1.0000</u>		<u>835.6</u>
1 248	1.0228	5.823	
1 158	1.0399	5.357	
1 034	1.0734	4.713	
889	1.1372	3.961	
772	1.2237	3.352	
689	1.3196	2.922	
586	1.5130	2.385	
517	1.7261	2.027	
462	1.9845	1.740	

(1) Cubic metres at indicated pressure and temperature per cubic metre of saturated oil.

(2) $Y = \frac{(P_{sat} - P)}{(P + 101.325)(Relative\ Volume - 1)}$

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RESERVOIR FLUID VISCOSITY

<u>PRESSURE,</u> kPa <u>(GUAGE)</u>	<u>OIL</u> <u>VISCOSITY</u> <u>mPa.S</u>
34 474	5.631
27 579	5.269
20 684	4.900
13 790	4.537
6 895	4.164
3 447	3.976
<u>1 472</u>	<u>3.870</u>
0	5.573

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SEPARATOR TEST OF RESERVOIR FLUID SAMPLE

SEPARATOR PRESSURE kPa (Gauge)	SEPARATOR TEMPERATURE °C	GAS-OIL RATIO R ₁ (1)	GAS-OIL RATIO R ₁ (2)	OIL GRAVITY ° API @ 15.6 °C	FORMATION VOLUME FACTOR B _o (3)	SEPARATOR VOLUME FACTOR (4)	RELATIVE DENSITY OF LIBERATED GAS (5)
1 427							
to							
90	26.0	18.84	19.28			1.029	1.275
to							
0	15.0	1.50	<u>1.50</u>	33.1	1.097	1.000	1.379
		Total	20.78				

- (1) Cubic metres of gas @ 101.325 kPa (absolute) and 15.0°C per cubic metre of oil @ indicated pressure and temperature.
- (2) Cubic metres of gas @ 101.325 kPa (absolute) and 15.0°C per cubic metre of stock tank oil @ 15.0°C.
- (3) Cubic metres of saturated oil @ 1 427 kPa (gauge) and 32.0°C per cubic metre of stock tank oil @ 15.0°C.
- (4) Cubic metres of oil @ indicated pressure and temperature per cubic metre of stock tank oil @ 15.0°C.
- (5) AIR = 1.000.

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FLASH TEST OF SEPARATOR OIL SAMPLE

STOCK TK. PRESSURE kPa (Gauge)	STOCK TK. TEMPERATURE °C	GAS-OIL RATIO R ₁ (1)	GAS-OIL RATIO R ₁ (2)	STOCK TANK OIL ° API @ 15.6 °C	SEPARATOR VOLUME FACTOR B _o (3)	STOCK TK. VOLUME FACTOR (4)	RELATIVE DENSITY OF LIBERATED GAS (5)
90							
to							
0	15.6		<u>1.50</u>	32.9	1.017		1.039
		Total	1.50				

This data was used to develop the recombined reservoir fluid i.e., the separator sample were physically recombined to the specified gas-oil ratio of 21.60 m³/m³ stock tank oil.

- (1) Cubic metres of gas @ 101.325 kPa (absolute) and 15.0°C per cubic metre of oil @ indicated pressure and temperature.
- (2) Cubic metres of gas @ 101.325 kPa (absolute) and 15.0°C per cubic metre of stock tank oil @ 15.0°C.
- (3) Cubic metres of saturated oil @ 90 kPa (gauge) and 26.0°C per cubic metre of stock tank oil @ 15.0°C.
- (4) Cubic metres of oil @ indicated pressure and temperature per cubic metre of stock tank oil @ 15.0°C.
- (5) AIR = 1.000.

CORE LABORATORIES

HYDROCARBON LIQUID ANALYSIS

B277 CONTAINER IDENTITY
 55377-87-383 LABORATORY NUMBER
 Chevron Canada Resources Limited OPERATOR
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 LSD 7-8-9-25 W1M LOCATION
 Chevron Virden 7-8-9-25 WELL OR SAMPLE LOCATION NAME
 Virden, Manitoba FIELD OR AREA
 POOL OR ZONE
 SAMPLER

TEST TYPE & NO. TEST RECOVERY
 Recombined Reservoir Fluid
 POINT OF SAMPLE AMT. & TYPE CUSHION MUD RESISTIVITY @ °C
 PUMPING FLOWING GAS LIFT SWAB
 WATER m³/d OIL m³/d GAS m³/d
 TEST INTERVALS (metres)

SEPARATOR RESERVOIR 1 427 @ °C @ °C
 CONTAINER WHEN SAMPLED CONTAINER WHEN RECEIVED
 SEPARATOR 32.0
 --- PRESSURES, kPa (gauge) ---
 --- TEMPERATURES, °C ---

DATE SAMPLED (Y/M/D) DATE RECEIVED (Y/M/D) 88 01 28 DATE ANALYZED (Y/M/D) DP ANALYST
 REMARKS

COMPONENT	MOLE FRACTION	MASS FRACTION	LIQUID VOLUME FRACTION
N ₂	0.0071	0.0011	0.0012
CO ₂	0.0260	0.0065	0.0066
H ₂ S	0.0094	0.0018	0.0019
C ₁	0.0053	0.0005	0.0014
C ₂	0.0382	0.0066	0.0153
C ₃	0.0753	0.0190	0.0312
iC ₄	0.0230	0.0076	0.0113
C ₄	0.0620	0.0206	0.0294
iC ₅	0.0307	0.0127	0.0169
C ₅	0.0297	0.0123	0.0162
C ₆₊	0.6933	0.9113	0.8686
TOTAL	1.0000	1.0000	1.0000

OBSERVED PROPERTIES OF C₆₊ RESIDUE (15/15°C)

874.3 kg/m³ 0.8751 30.3
 DENSITY RELATIVE DENSITY API @ 15.5° C
 230
 RELATIVE MOLECULAR MASS

CALCULATED PROPERTIES OF TOTAL SAMPLE (15/15°C)

833.4 kg/m³ 0.8342 38.2
 DENSITY RELATIVE DENSITY API @ 15.5° C
 174.96
 RELATIVE MOLECULAR MASS

REMARKS

HYDROCARBON LIQUID ANALYSIS

OPERATOR Chevron Canada Resources Limited
 WELL Chevron Virden 7-8-9-25
 SAMPLE POINT Recombined Reservoir Fluid

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 DATE 88 01 28

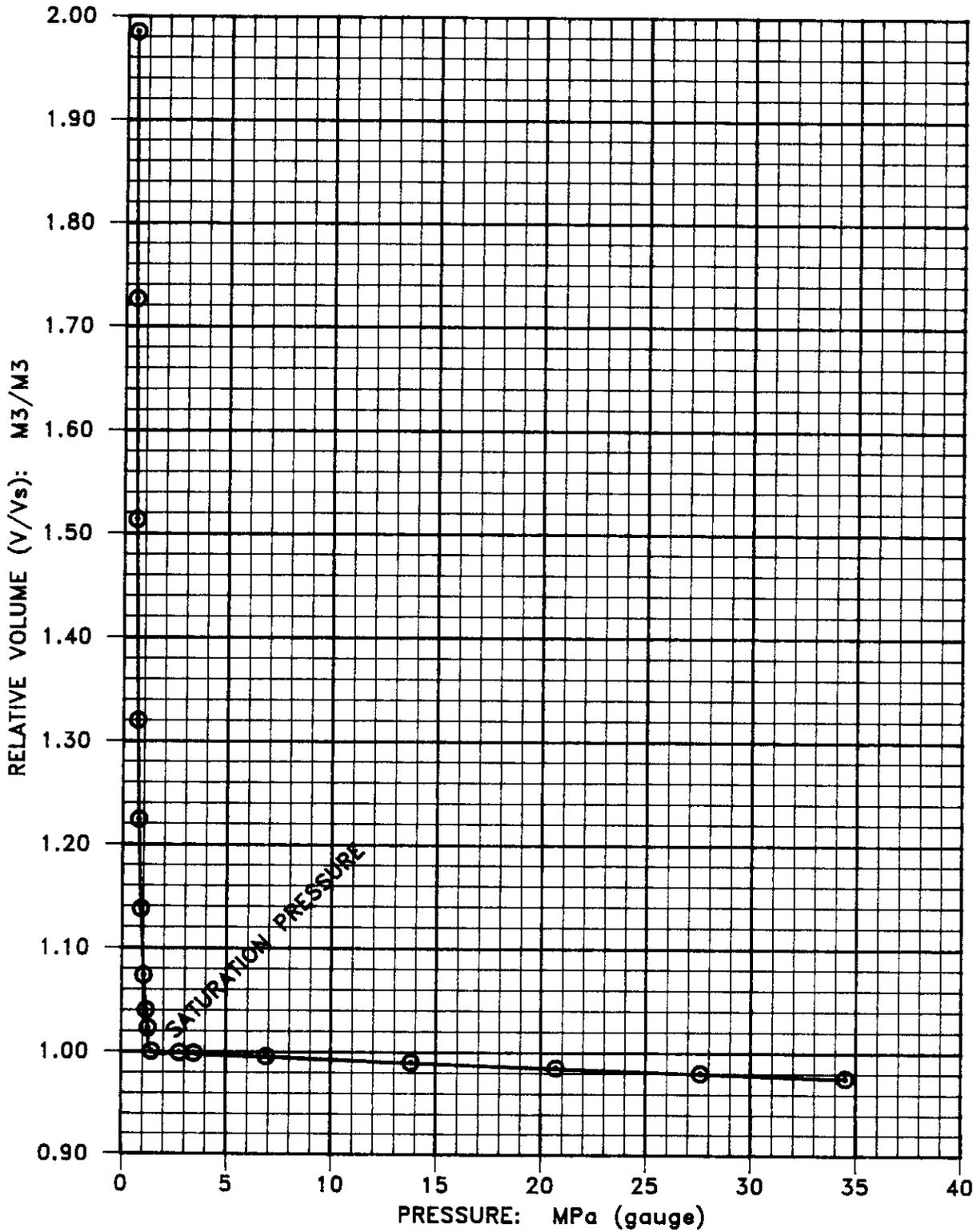
Analysis of C₆+ Fraction

<u>Boiling Point Range (°C)</u>	<u>Component</u>	<u>Carbon Number</u>	<u>Mole Fraction</u>	<u>Mass Fraction</u>
36.1- 68.9	Hexanes	C ₆	0.0415	0.0216
68.9- 98.3	Heptanes	C ₇	0.0449	0.0272
98.3-125.6	Octanes	C ₈	0.0504	0.0347
125.6-150.6	Nonanes	C ₉	0.0371	0.0287
150.6-173.9	Decanes	C ₁₀	0.0416	0.0357
173.9-196.1	Undecanes	C ₁₁	0.0372	0.0351
196.1-215.0	Dodecanes	C ₁₂	0.0320	0.0328
215.0-235.0	Tridecanes	C ₁₃	0.0318	0.0353
235.0-252.2	Tetradecanes	C ₁₄	0.0300	0.0359
252.2-270.6	Pentadecanes	C ₁₅	0.0320	0.0410
270.6-287.8	Hexadecanes	C ₁₆	0.0254	0.0347
287.8-302.8	Heptadecanes	C ₁₇	0.0186	0.0270
302.8-317.2	Octadecanes	C ₁₈	0.0217	0.0333
317.2-330.0	Nonadecanes	C ₁₉	0.0204	0.0330
330.0-344.4	Eicosanes	C ₂₀	0.0153	0.0261
344.4-357.2	Heneicosanes	C ₂₁	0.0133	0.0237
357.2-369.4	Docosanes	C ₂₂	0.0125	0.0235
369.4-380.0	Tricosanes	C ₂₃	0.0109	0.0214
380.0-391.1	Tetracosanes	C ₂₄	0.0106	0.0216
391.1-401.7	Pentacosanes	C ₂₅	0.0097	0.0206
401.7-412.2	Hexacosanes	C ₂₆	0.0082	0.0181
412.2-422.2	Heptacosanes	C ₂₇	0.0076	0.0174
422.2-431.7	Octacosanes	C ₂₈	0.0071	0.0170
431.7-441.1	Nonacosanes	C ₂₉	0.0068	0.0167
441.1 PLUS	Triacontanes Plus	C ₃₀₊	0.0579	0.2106
80.0	Benzene	C ₆ H ₆	0.0007	0.0003
110.6	Toluene	C ₇ H ₈	0.0033	0.0018
136.1-138.9	Ethylbenzene, p + m-Xylene	C ₈ H ₁₀	0.0082	0.0052
144.4	o-Xylene	C ₈ H ₁₀	0.0057	0.0037
168.9	1,2,4 Trimethylbenzene	C ₉ H ₁₂	0.0022	0.0016
48.9	Cyclopentane	C ₅ H ₁₀	0.0020	0.0008
72.2	Methylcyclopentane	C ₆ H ₁₂	0.0120	0.0061
81.1	Cyclohexane	C ₆ H ₁₂	0.0174	0.0088
101.1	Methylcyclohexane	C ₇ H ₁₄	0.0173	0.0103
	TOTAL		0.6933	0.9113
68.9 PLUS	Mole Fraction of C ₇ +			0.6498
68.9 PLUS	Mass Fraction of C ₇ +			0.8889
68.9 PLUS	Calculated Relative Molecular Mass of C ₇ +			240
68.9 PLUS	Calculated Relative Density of C ₇ +			0.8820
68.9 PLUS	Calculated Density of C ₇ + (kg/m ³)			881.2

The above hexanes plus values are based upon a measured mass fraction and a calculated mole fraction, and assume a total hydrocarbon recovery from the chromatographic system.

SECTION II
Illustrations

RELATIVE VOLUME (V/Vs)



OIL VISCOSITY

