

WELLFILE

RESERVOIR FLUID STUDY

FOR

STATOIL

WELL 34/10-1

DST NO.2

BOTTOM HOLE SAMPLE

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SUBJECT: Fluid analysis STATOIL WELL 34/10-1
Bottom hole sample dst no. 2.

This report presents the results from a PVT analysis of a bottom hole sample collected from well 34/10-1 in DST no. 2. Bottle marked BHS 1a 2401/1.

Summary of experimental results.

Bubble point, determined visually and then adjusted via Y function sensitivity : 260.2 BAR 71.67°C
3774 psig (161°F)

Gas/oil ratio from single flash of sample to 15°C, 1 atm : 105.8m³/m³
594.4 SCF/STB

Gas/oil ratio from differential flash liberation, bubblepoint pressure to 1 atm, 15°C. : 104m³/m³
584.4 SCF/STB

Formation volume factor from single flash, saturated liquid/stock tank liquid : 1.284

Formation volume factor from differential vaporization, saturated liquid/stock tank liquid : 1.275

Viscosity of reservoir fluid at bubblepoint : 1.080 cp

Density of stock tank oil at 15°C from single flash : 0.8827 g/cc

Compressibility of saturated reservoir fluid : 12.2 x 10⁻⁵ VOL/VOL/BAR
(8.6 x 10⁻⁶ VOL/VOL/psi)

PROCEDURE

The sample was received in the lab and the opening pressure of the bottle was recorded. 191 BAR (2770 psig). Then a bubble point at ambient temperature was run on sample while still in shipping bottle. 228 BAR (3307 psig).

The sample was then transferred to a visual PVT cell and constant mass pressure-volume relationship was run at reservoir temperature, 71.67°C (161°F). The bubblepoint was visually observed to lie between 258-265 BAR (3748-3847 psig). Y function sensitivity later proved the bubblepoint to be 260.2 BAR (3774 psig.)

See table 3.

A two stage flash was run on this charge, see table 5. See also results from single flash.

The products from the single flash was analysed by gas chromatography. The compositions were recombined by using the GOR determined to yield reservoir fluid composition.

See table 2.

The cell was then recharged and P-V analysis yielded the same bubble point, 260.2 BAR (3774 psig). A differential vaporization was run. See table 4.

Table no. 6 gives the experimentally determined viscosities of reservoir fluid from reservoir pressure to atmospheric pressure, and also calculated gas viscosities.

This whole analysis was witnessed by Mr. G. Pyndus from Exxon Production Research Company, Houston.

NOTE: All gas and oil volumes are at SC. 15°C and 1 atm.

Stavanger, 13.10.78, Per Thomassen



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Table 1. Reservoir and Sample Data

Well and formation Data

Producing zone	BRENT
PERF interval	1814 - 1819 m MSL
Initial static pressure	4100 psig at 1514m MSL
Reservoir temperature	161 °F at 1825 m MSL
Last static pressure	
Date	24/8/78
Well head pressure	2420 psig 166.5 Bar
Rate (oil,water)	B/D
(gas)	Mcf/D
Date	
Tubing size	3½" DP

Sample Data

Date sampled	24/8/78
Type of sample(s)	BOTTOM HOLE
Separator pressure	-
Separator temperature	-
Average flow rates during sampling	
First stage separator gas	Mcf/D
Other separator gases	Mcf/D
Separator oil	B/D
Water	B/D

Remarks

The sample uses in this analysis was marked 2401/1,
Sampled Dst no. 2 RUN 1. The well was flowed at small choke to surge
tank during sampling. Estimated flow rate: 170 B/D.

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TABLE 2. Analysis of separator products from single flash and calculated reservoir fluid composition (FLASH COND. 15°C, atm)

COMPONENT	SEPARATOR GAS [MOLE%]	SEPARATOR LIQUID [MOLE%]	RESERVOIR FLUID [MOLE%]
HYDROGEN SULFID	Nil	Nil	-
CARBONDIOXIDE	1.80	Nil	1.06
NITROGEN	0.60	Nil	0.36
METHANE	85.50	0.19	50.50
ETHANE	7.60	0.23	4.54
PROPANE	1.40	0.18	0.90
ISO-BUTANE	0.73	0.26	0.55
N-BUTANE	0.80	0.30	0.60
ISO-PENTANE	0.57	0.68	0.62
N-PENTANE	0.21	0.35	0.27
HEXANES	0.59	3.03	1.60
HEPTANES	0.21	8.95	3.80
OCTANES		5.73	2.33
NONANES		7.35	3.02
DECANES		7.15	2.95
UN-DECANES +		65.60	26.90
	<u>Σ 100.00</u>	<u>Σ 100.00</u>	<u>Σ 100.00</u>

PROPERTIES OF STOCK TANK LIQUID

Density 15°C : 0.8827 g/cc

Specific gravity

15°C: 0.8835

Molecular weight: 283

CALCULATED PROPERTIES OF UN-DECANE + FRACTION

Density 15°C : 0.918 g/cc

Molecular weight: 371

CALCULATED SEPERATOR GAS PROPERTIES

Real gas spesific gravity : 0.6834 (AIR=1)
Pseudo-critical pressure : 46.3 BAR (671 psia)
Pseudo-critical temperature : 211.6°K (381.2°R)
Avrage molecular weight : 19.743

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TABLE 3. Constant mass pressure volume analysis of sample at 71.67°C (161°F) (EXPERIMENTAL VALUE)

PRESSURE BAR (psig)	RELATIVE VOLUME	Y-FACTOR	COMPRESSIBILITY OF SATURATED OIL
392.7 (5696)	0.9843		
368.2 (5341)	0.9871		average compressibility
343.9 (4988)	0.9900		above bubblepoint
319.2 (4629)	0.9929		:(8.4 x 10 ⁻⁶ cc/cc/psi)
293.9 (4263)	0.9961		12.2 x 10 ⁻⁵ cc/cc/BAR
265.3 (3847)	0.9997		
260.2 (3774)	1.0000		
258.4 (3748)	1.0012	5.84	
254.5 (3691)	1.0044	5.09	
244.7 (3549)	1.0118	5.36	
234.9 (3406)	1.0205	5.26	
224.6 (3257)	1.0310	5.12	
214.3 (3108)	1.0423	5.07	
205.7 (2984)	1.0534	4.96	
191.7 (2781)	1.0746	4.79	
176.5 (2560)	1.1024	4.63	
159.3 (2311)	1.1420	4.46	
128.5 (1863)	1.2523	4.06	
105.9 (1536)	1.3818	3.82	
75.0 (1088)	1.7101	3.48	
56.4 (818)	2.0899	3.32	

CURVEFITTED DATA CAN BE OBTAINED FROM THE FOLLOWING EQUATIONS

RELATIVE VOLUME: $*V_R = 1.0314 - 1.206 \times 10^{-4}xP - 2.06 \times 10^{-12}xP^2$

RELATIVE VOLUME: $*V_R = \frac{260,2 + 1.674xp + 1.099 \times 10^{-2}xp^2}{2.674p + 1.099 \times 10^{-2}xp^2}$ P > 260.2 BAR

Y-FACTOR : $*Y = 2.674 + 1.099 \times 10^{-2}P$ P < 260.2 BAR

*NB! PRESSURES IN BAR

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TABLE 4: Differential vaporization of sample at 71.67°C (161°F)

PRESSURE BAR (psig)	RELATIVE (1) VOLUME	SOLUTION GOR (2) RS (m ³ /m ³) (SCF/BBL)	DENSITY SAT.OIL [g/cc]	SPESIFIC GRAVITY GAS	Z FACTOR GAS
392.7 (5696)	1.2550		0.7685		
368.2 (5341)	1.2586		0.7663		
343.9 (4988)	1.2622		0.7640		
319.2 (4629)	1.2660		0.7618		
293.9 (4263)	1.2700		0.7594		
265.3 (3847)	1.2747		0.7566		
260.2 (3774)	1.2750	104.0 (584.4)	0.7564		
246.1 (3570)	1.2573	96.0 (539.8)	0.7622	0.623	0.8997
214.8 (3115)	1.2371	86.7 (487.0)	0.7690	0.620	0.8850*
184.9 (2681)	1.2130	75.5 (424.0)	0.7773	0.612	0.8806
157.8 (2290)	1.1907	64.4 (361.8)	0.7849	0.611	0.8688
118.7 (1721)	1.1586	48.9 (274.8)	0.7968	0.614	0.8776
89.2 (1294)	1.1347	37.6 (211.2)	0.8060	0.613	0.8884
59.3 (861)	1.1102	25.9 (145.4)	0.8157	0.625	0.9008
30.4 (441)	1.0852	14.3 (80.4)	0.8261	0.649	0.9500*
**atm (0)	1.0482	0 (0)	0.8413	0.833	0.9886*
atm (0)	1.0000	0 (0)	0.8819		
15°C					

1) Cubic meter of oil at indicated pressure and temperature per cubic meter of residual oil at 15°C.

2) m³ cubic meter of gas at atm and 15°C per m³ of residual oil at 15°C

* NB! Values picked off plot. (Z vs p)
No experimental values obtained.

** NB! 1 atm = 1.01325 BAR

TABLE 5

SEPARATOR TEST OF RESERVOIR FLUID. EXPERIMENTAL AND COMPUTED.

SEP. PRESSURE AND TEMPERATURE		GAS OIL RATIO(1)		GAS OIL RATIO(2)		FORM. VOLUME FACTOR (3)		SEP. VOLUME FACTOR (4)		DENSITY OF OIL		GAS GRAVITY	
1.stage (BAR) (°C)	2.stage (BAR) (°C)	Exp. (M ³ /M ³)	Comp. (M ³ /M ³)	Exp. (M ³ /M ³)	Comp. (M ³ /M ³)	Exp. (M ³ /M ³)	Comp. (M ³ /M ³)	Exp. (M ³ /M ³)	Comp. (M ³ /M ³)	Exp. (g/u)	Comp. (g/u)	Exp. (air=1)	Comp.
A) atm,15	-	105.9	106	105.9	106	1.284	1.283	1.284	1.283	0.8827	0.8812	0.6834	0.6995
B) 42.4, 39.44		75.4	76.2	82.0	82.7			1.182				0.6079	0.6147
	atm,15	19.7	19.4	19.7	19.4	1.285*	1.267	1.088	1.085	0.8810	0.8779	0.7788	0.8134

The separator test was run at actual field test conditions.**

K values used in the flash calculation is adopted from work by M.B. STANDING. Emperically calculated from curvefittings of GPSA values and experimental work on Californian oils.

- (1) Gas/oil ratio in cubic meter of gas at 15°C and 1 atm per cubic meter of oil at separator pressure and temperature.
- (2) Gas/oil ratio in cubic meter of gas at 15°C and 1 atm per cubic meter of oil at 15°C.
- (3) Formation volume factor in cubic meter of saturated oil at 260.2 BAR and 71.67°C per cubic meter of oil at 15°C.
- (4) Separator volume factor in cubic meter of oil at separator pressure and temperature per cubic meter of oil at 15°C.

CONVERSION from M³/M³ to SCF/BBL: multiply by 5.615

CONVERSION from BAR to psi: multiply by 14.503

* This value is uncertain due to experimental difficulties in correcting oil volumes at high pressure for temperature.

** See Table No. 7 for comparison with field GOR's.

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TABLE 6. Viscosity of reservoir fluid vs,
pressure at 71.67°C (161°F)

PRESSURE BAR (psig)	OIL VISCOSITY CENTIPOISE	CALCULATED* GAS VISCOSITY CENTIPOISE	OIL/GAS VISCOSITY RATIO
392.7 (5696)	1.256		
368.2 (5341)	1.221		
343.9 (4988)	1.181		
319.2 (4629)	1.162		
293.9 (4263)	1.135		
265.3 (3847)	1.089		
260.2 (3774)	1.080		
246.1 (3570)	1.085	0.0204	53.2
214.6 (3115)	1.169	0.0190	61.5
184.9 (2681)	1.272	0.0177	71.9
157.9 (2290)	1.369	0.0167	82.0
118.7 (1721)	1.613	0.0151	106.8
89.2 (1294)	1.898	0.0141	134.6
59.3 (861)	-	0.0132	-
30.4 (441)	-	0.0125	-
atm (0)	3.85	0.0114	337.7

* gas viscosities are calculated from Carr, Kobayashi and Burrows
Corelations

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TABLE 7. Comparison of field GOR's with
computed GOR's from flash program (DST No. 2)

1st STAGE SEPARATOR (BAR) (PSIG)	1st STAGE SEPARATOR (°C) (°F)	GAS OIL RATIO(1) FIELD MEASURED (M ³ /M ³) (SCF/STB)	GAS OIL RATIO(1) COMPUTED (M ³ /M ³) (SCF/STB)	OIL FLOW RATE (M ³ /D) (STB/D)
(A) 68.3(990)	39.44 (103)	92.4 (519)	72.4 (406)	910 (5724)
(B) 41.4 (600)	39.44 (103)	82.8 (465)	82.7 (464)	1039 (6532)
(C) 31.4 (455)	22.2 (72)	94.7 (532)	85.9 (482)	286 (1796)

(1) NB! Values given here are in standard cubic meter of 1st stage separator gas per cubic meter of oil at 15°C (STO) to be direct comparable with OTIS reported values.

CONVERSION from M³/D to STB/D: multiply by 6.288

- (A) Flow 2. Time: 00.15 25.8.78
- (B) Flow 2. Time: 01.30 25.8.78
- (C) Flow 1. Time: 09.00 24.8.78

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FIG 1: Relative vol vs pressure
Solution GOR vs pressure

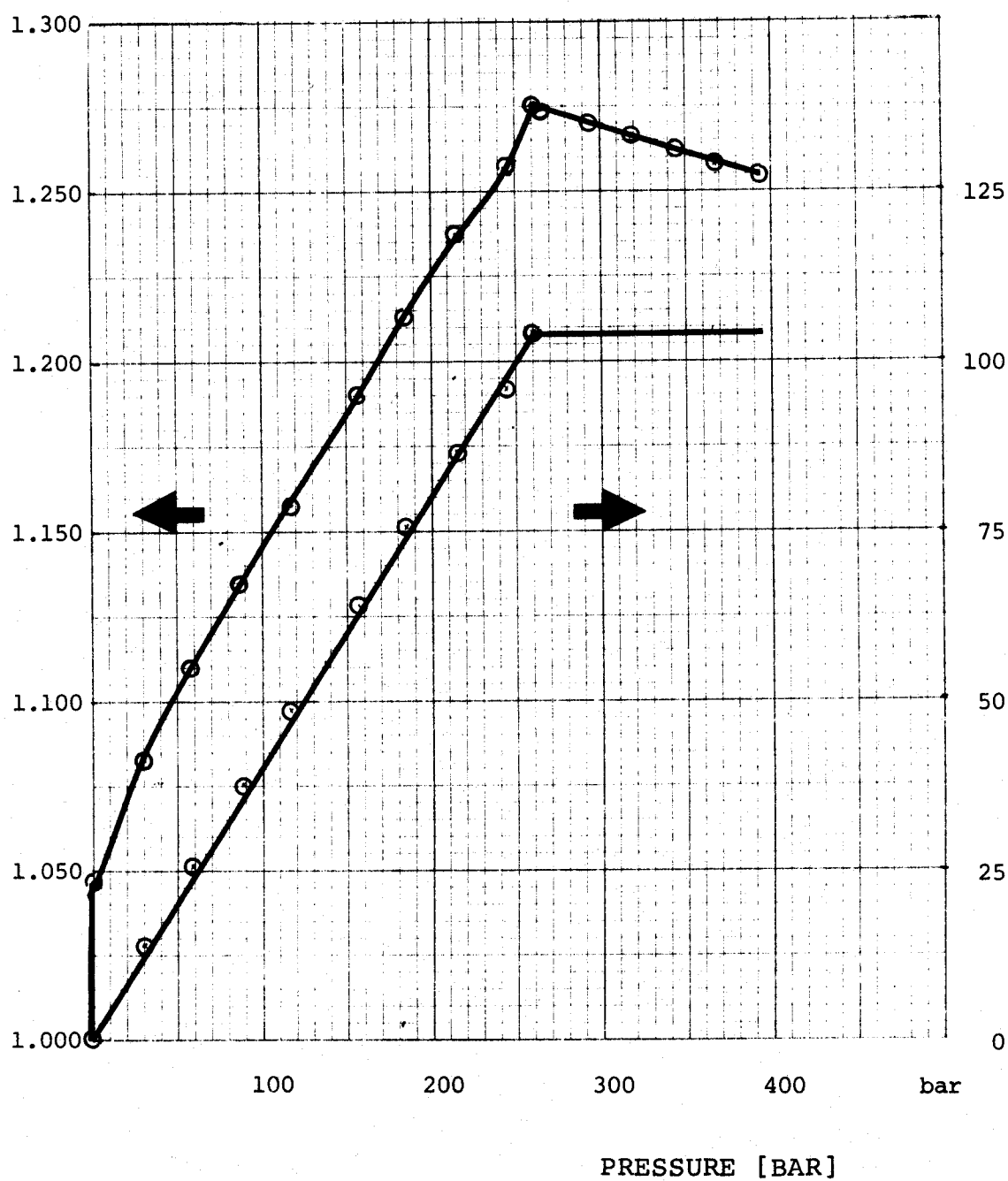
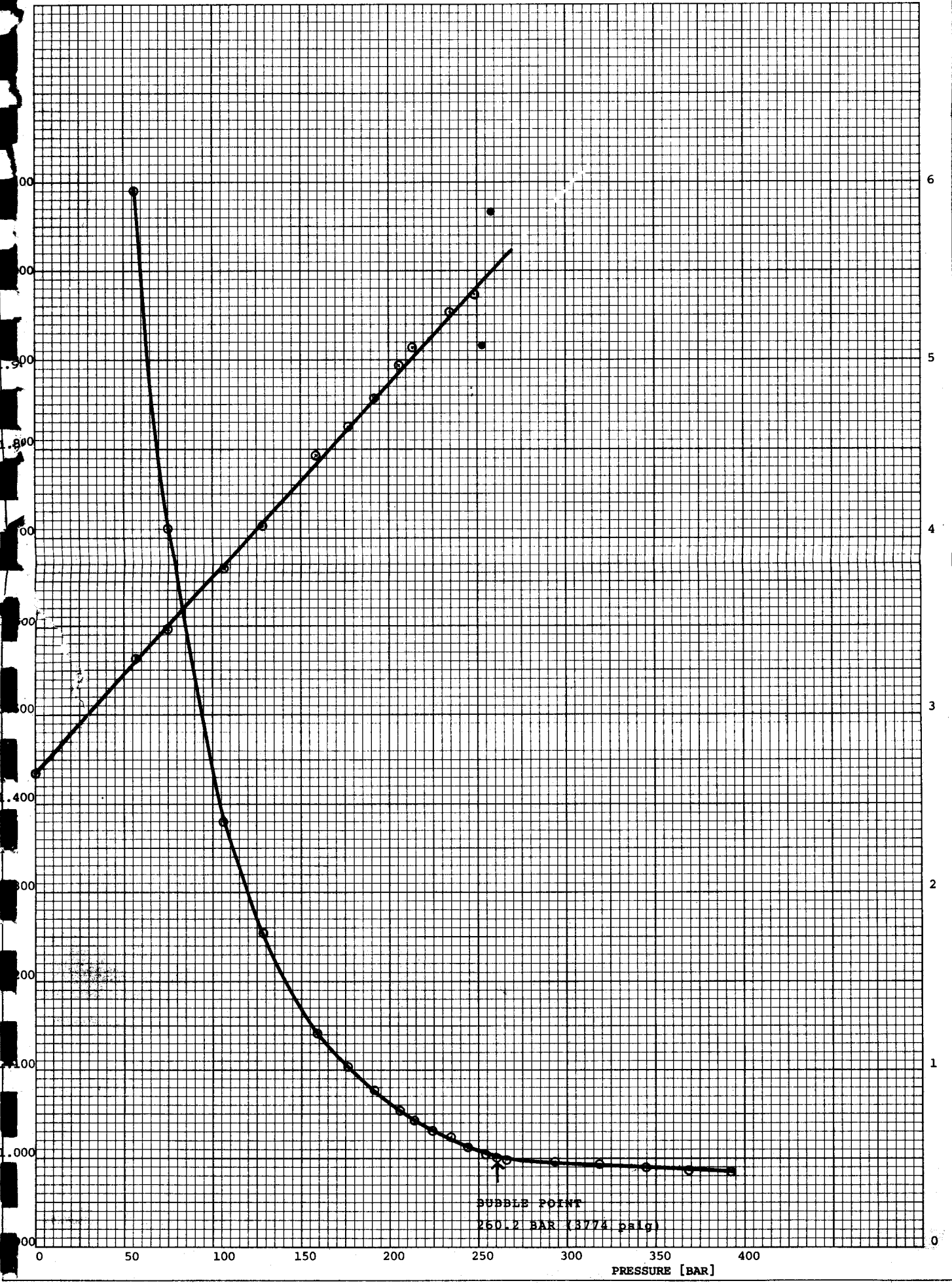


FIG. 2. CONSTANT MASS PRESSURE - VOLUME RELATIONSHIP at 71.67°C. 34/10-1 DST NO. 2



"V"

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FIG. 3
Oil and gas viscosities vs.
Pressure

