

Denne rapport
tilhører

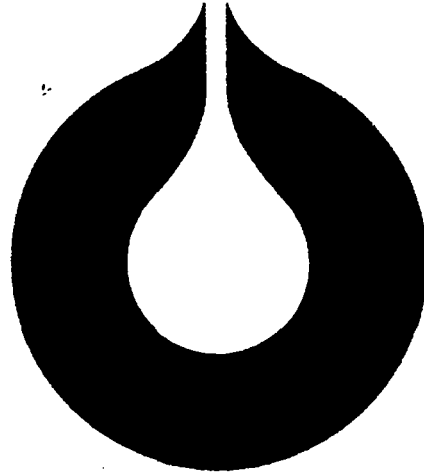


L&U DOK.SENTER

L.NR. 200 89 04 00 35

KODE well 31/2-11 NT22

Returneres etter bruk



statoil

31/2-11

Emulsions of TROLL crude oil/
formation water

STATOIL
EXPLORATION & PRODUCTION
LABORATORY

by
Torgeir Lund

Måling			
Kontroll	Dato	Sign.	Måling
TL			

Sept.-83

LAB 83

Den norske stats oljeselskap a.s




Classification _____

Requested by
 Alan Baker, T&U

Subtitle

Co-workers
 D.Malthe-Sørenssen, LAB
 Helga Baardsen, LAB

L.nr.	Statoil		
Avd.	LAB	Generallarkiv	
S.bh.	TL		
Mott.	21 SEPT. 1983		
Kode			
Oppr.			
M. nr.			
Kont.	Dato	Sign.	Dato
TL			

Title
 Emulsions of TROLL crude oil/
 formation water
 STATOIL
 EXPLORATION & PRODUCTION
 LABORATORY
 by
 Torgeir Lund
 Sept.-83
 LAB 83.45

Prepared
 16/9-83 | Torgeir Lund

Approved
 16/9-83 | D.Malthe-Sørenssen

EMULSIONS OF TROLL CRUDE OIL/FORMATION WATER

On request from T&U we performed a study on the formation of emulsions of mixtures of crude oil and formation water from well 31/2-11.

The scope of the experiment was to obtain some information of the possibility of TROLL oil/formation water to emulsify and the stability of the emulsions.

The study was undertaken to get some background information for the planning of transport of high water-cuts through sub-sea flowlines.

Water and oil samples

The water samples were from DST 1, 17.3.83 and delivered in two plastic bottles no. 15 and no. 16. The perforated depth was 1681 - 85 m.

The crude oil was delivered in two cans dated 27.4.83.

Water analysis

The emulsifying tendency will depend on the water quality. Especially, contamination of surface active mud components will influence the results. Salinity and physical constants were determined to check the water quality.

The water samples contained some fine sand, which was removed by filtration before analysis. The ion concentrations and physical properties of the water are given in Table 1. Special attention was given to the Ca-value, as any contamination of drilling or completion fluids would give high Ca-concentrations. An acidic slurry of the sand after filtration gave a negative Ca-test. Artificial formation water was prepared and the viscosity was measured and compared with the viscosity of the formation water. No significant difference could be found. From these analysis and analysis from other samples from the same DST we decided to use the filtrated formation water in the emulsion study.

Emulsion studies

The main parameters to be varied were % watercut and temperature. The temperature interval of interest was 20-50°C, and we measured in that interval the formation of emulsions (mixtures) with 20-80 Vol % water. The stability of the emulsion formed will be strongly dependent on the mixing conditions. Two methods were used to form emulsions.

Method A) Water was slowly added to the oil through a capillary. The mixture was stirred with a rotor at 250 RPM for 15 minutes. This method was chosen to simulate laminar flow and expected flow time in the flow line.

Method B) Water and oil was mixed with a rotor speed of 20000 RPM (without load) for 2 minutes. The condition will exemplify the consequences of any extreme shear stress during production/transport.

RESULTS

Method A.

Optically the adding of water to the oil gave a one phase mixture for watercuts up to 50 % at 20°C. We believe this due to the relative low density difference between the two phases and the relative high oil viscosity. After mixing (250 RPM/15 min) the samples were transferred to a Ubbelohde viscometer. The samples were throughout the experiment taken from the upper layer of the mixture. The samples were equilibrated for 10 min at the measuring temperature in a water bath before measurement of viscosity.

At the highest temperatures this equilibration time was long enough for a partial up to total phase separation, to occur. The results of the measurements of kinematic viscosities are given in Table 2, and plotted in Figs. 1 and 2. At 20°C all watercuts up to 60 % give emulsions stable enough to survive the 10 min equilibration time between mixing and measurement. We note the extreme increase of emulsion viscosity from 40 to 60 % watercuts.

For all emulsions of watercuts below 60 %, samples taken 35 - 45 minutes after mixing have the same viscosity as the crude oil, showing a natural break out of water.

At the higher temperature, 40°C, qualitatively the same observations are made i.e. for the watercuts 40 - 50 % the kinematic viscosity is substantially higher than for lower watercuts. At this temperature the break out of water is somewhat faster than at 20°C. As an example, the 60 % watercut emulsion breaks within 10 minutes. Watercuts > 70 % do not give emulsions at any temperature examined.

As expected the absolute values for kinematic viscosity are strongly temperature dependent. We note that watercuts up to 50 % build emulsions with retention time longer than 10 min at temperatures up to 40°C. At 50°C (and above) no emulsions can be created under these mixing conditions.

Method B

These experiments were done at mixing temperatures of 40-50°C. Any lower temperatures should favor the emulsifying tendency.

At the rotor speed of 20000 RPM all watercuts up to 80 % build creamy, highly viscous emulsions. The 80 % watercut emulsion started to decompose immediately after end of mixing.

The break out of water was somewhat slower for the watercuts 70 % and 60 %. For the watercuts 50 % and lower no water break out was observed.

All emulsions were allowed to stand overnight cooling down to room temperature. The final condition gave from all original mixtures: One water phase and one water in oil (WiO) emulsion phase with a water content of 50 - 60 %. The 50 % and 40 % WiO emulsions were found to be stable after long-time treatment at 70°C. The results are summarized in Table 3.

CO₂-influence on pH of formation water.

A simple test was made to check the final pH of formation water by bubbling CO₂-gas through at atmospheric pressure. The result is compared with the effect on distilled water under the same conditions. Results are plotted in Fig. 3 and indicate a moderate buffer effect in the formation water and a pH at saturation of 4.9.

Table 1 Water Samples. Well 31/2-11
DST 1, 17.3.83, 1681 - 85 m

Ion	Sample 15	Sample 16	Artifical water
	Conc (mg/l)	Conc (mg/l)	Conc (mg/l)
Na	14200	18100	14000
K	200	465	200
Mg	480	470	500
Ca	2000	1945	2000
Ba	215	—	
Cl	29450	29590	30000
SO ₄	<5	<5	0
HCO ₃	220	220	200
CO ₃	0	0	0
pH	7.66	7.66	
Density 20°C (g/cm ³)	1.034	1.034	
Resistivity 20°C (Ω m)	0.168	0.168	
Kin. viscosity (mm ² /s)	1.083		1.075

Table 2 Kinematic viscosity (mm^2/s) of emulsions produced by Method A.

Water, oil ratio	Temp. ($^{\circ}\text{C}$)			
	20	30	40	50
0/100	19.0	12.7	8.97	6.93
20/80	20.6	—	—	—
40/60	38.9	26.2	21.2	a)
50/50	117.1	75.2	45.7	a)
60/40	153.2	—	b)	a)
70/30	a)	—	a)	a)
80/20	a)	—	a)	a)

a) No emulsion

b) Decompose < 10 min

Table 3 Stability of emulsions produced by Method B

Mixing water/oil ratio	Mixing Temp (°C)	Final condition Water/WiO-emulsion ratio	Water content* in WiO emulsion (%)	Comments
40/60	30	0/100	40	WiO-emulsion treated at 30-70°C for 4 hours +at 70°C for 70 h. Stable
50/50	40	0/100	50	WiO-emulsion treated at 70°C for 15th. Stable
60/40	40	15/85	50	
70/30	40	25/75	60	
80/20	40	60/40	50	
40/60	50	0/100	40	
50/50	50	0/100	50	
60/40	50	5/95	60	
70/30	50	30/40	60	
80/20	50	60/40	50	

* Emulsions (WiO) with up to 50 % water stable for T < 70°C.

Figure Captions

- Fig. 1 Kinematic viscosity of emulsions as function of % water at 20°C and 40°C.
- Fig. 2 Kinematic viscosity of oil and emulsions as function of temperature.
- Fig. 3 Time dependence of pH by bubbling 3l/min CO₂ through 1l water at 1 atmosphere and room temperature.

Fig. 1

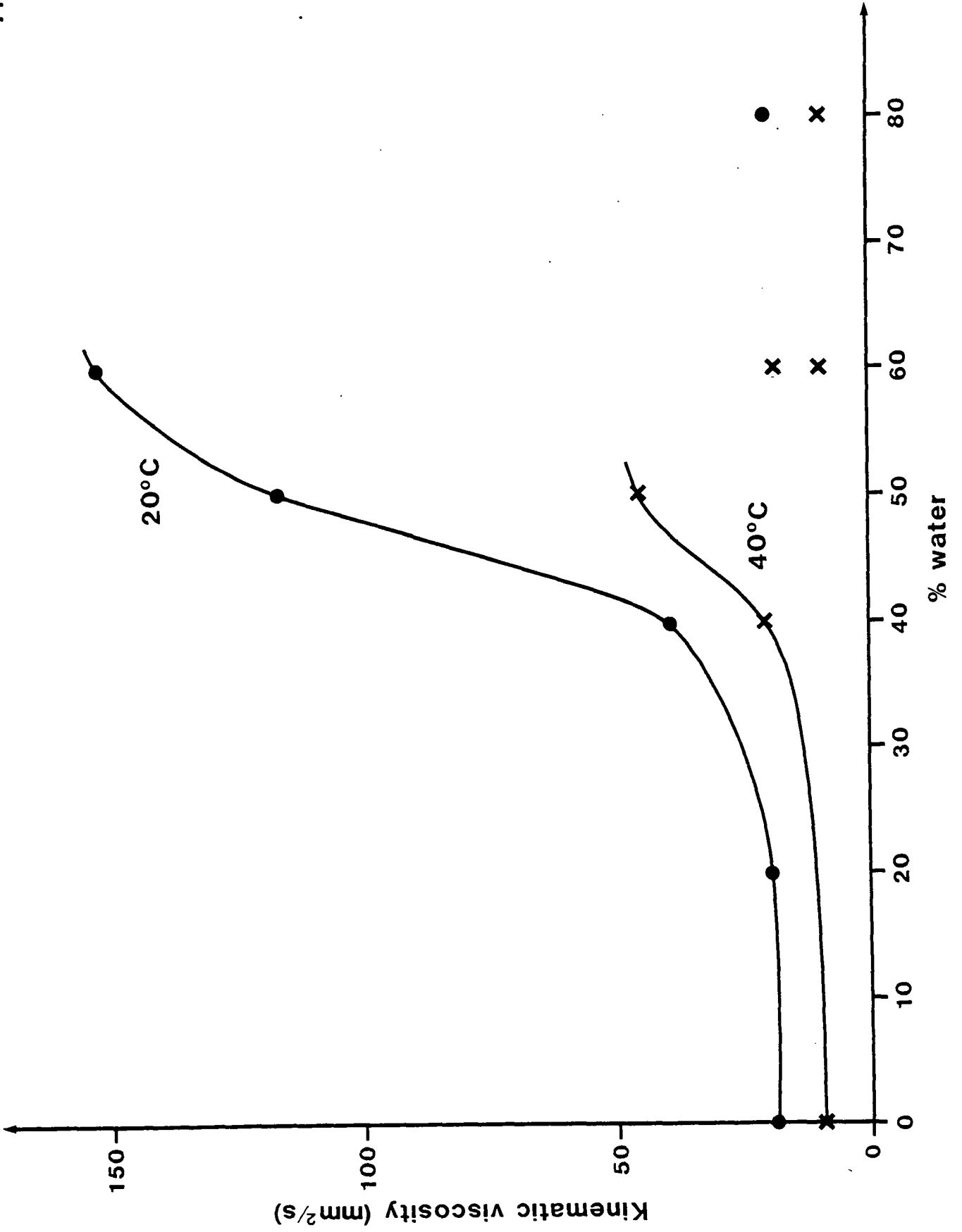


Fig. 2

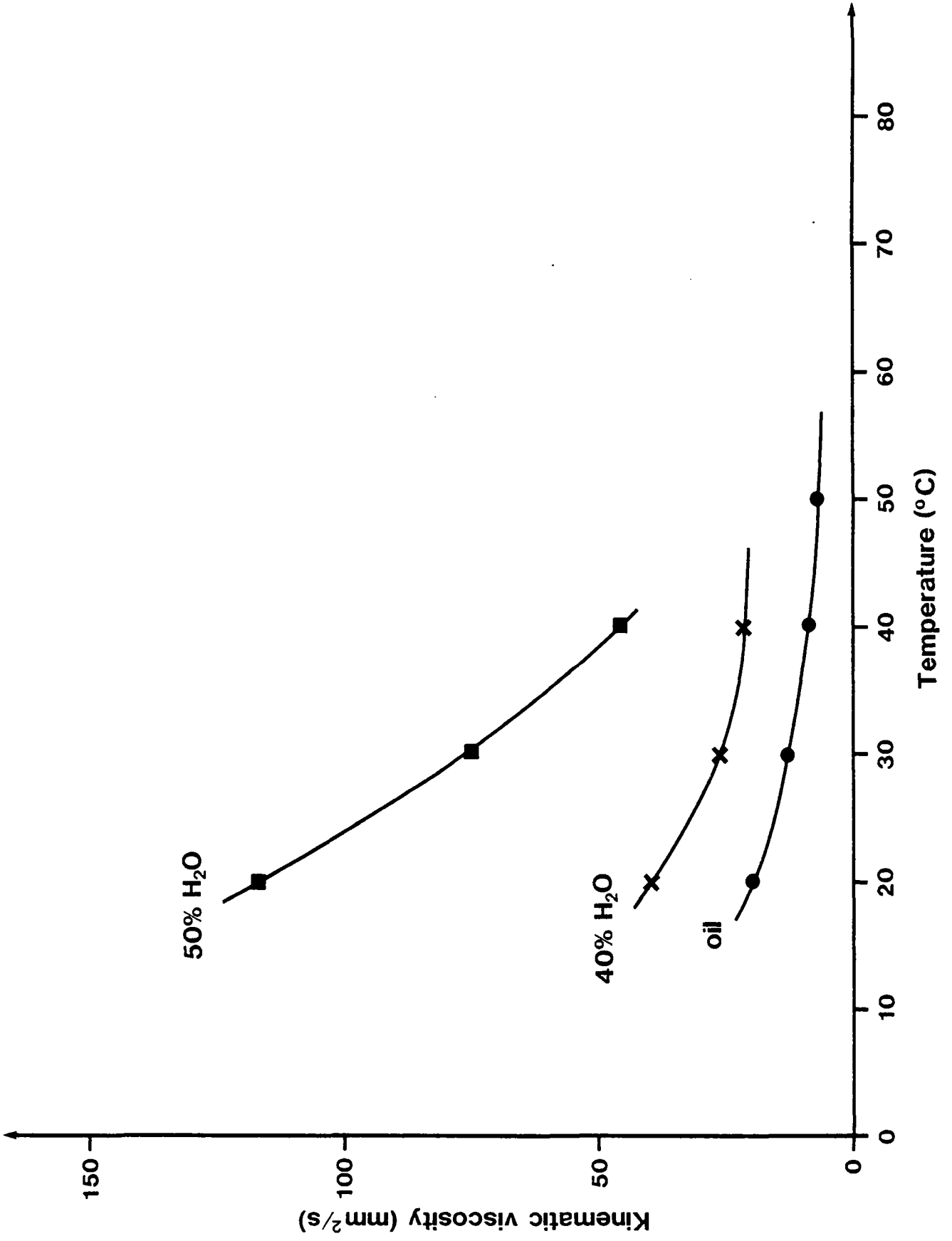


Fig. 3

