Field Life!

Different tools and techniques used to explain why separation processes did not reach expected performances.

Jon Berntsen
MATOR AS

IBC's 9th Annual Conference
Production Separation Systems
London June 2002

Field work -

how to verify and optimise separation performance

This presentation will focus on how to verify:

- Separability of fluids
- Choke valves and how they influence on water quality
- Shear sensitivity of fluids
- Separator malfunction

Some tools, devices and techniques will be shown, however the main message is the methodology used in order to:

- Address and explain separation problems
- Recommend the most efficient modifications

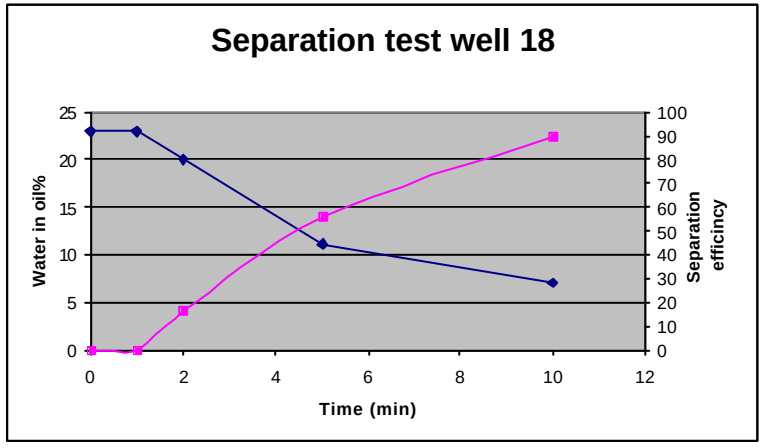
MATOR

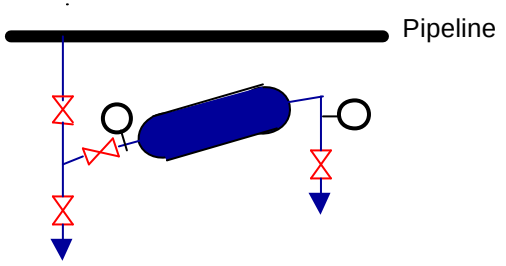
Mini Test Separator

The purpose of the Mini Test Separator (MTS) is to obtain information about the separability of the actual fluids.

- **High pressure sampling and equal separation time in the MTS similar to the actual three-phase separator.**

- **Analysis of the separated fluids to determine concentration and quality of dispersed phases.**





Simplified illustration of the MTS unit

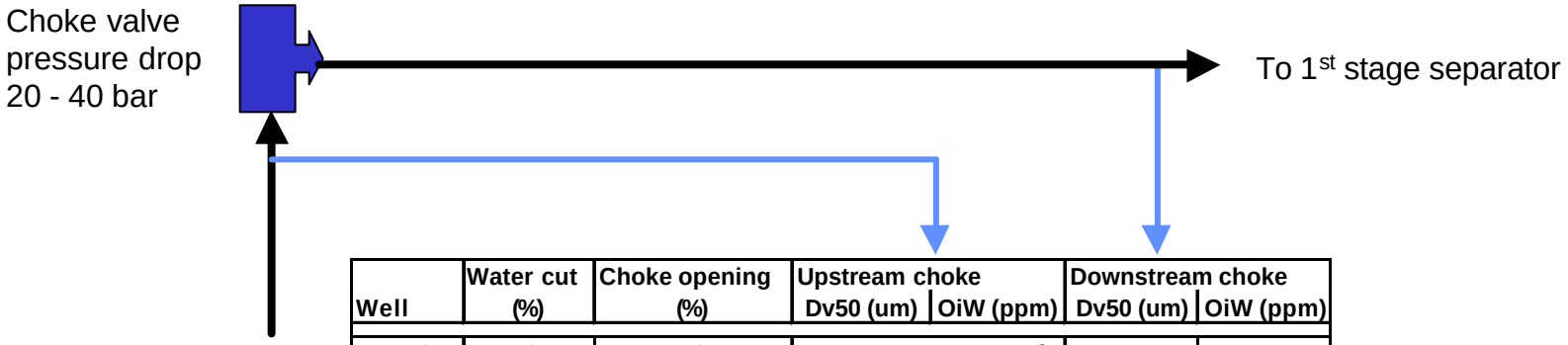
Choke valve and water quality

An example from a field test identifying consequences from choke operation

The test focused on water cut and choke opening, and two wells were identified as problem originators for the produced water treatment:

X-14: Reasonable oil concentration but extremely small oil droplets.

X-20: Good oil droplet sizes but very high oil concentration.



Well	Water cut (%)	Choke opening (%)	Upstream choke Dv50 (um)	Upstream choke OiW (ppm)	Downstream choke Dv50 (um)	Downstream choke OiW (ppm)
X-40	6	40	No water separated		NA	NA
X-48	3,4	34	No water separated		NA	NA
X-09	23	47	10	160	6,9	412
X-52	0,1	12	No water separated		NA	NA
X-14	28	22	6,3	50	1,5	500
X-20	40	11	8,9	43	18	2712
X-33	78	75	-	-	8	326

Shear sensitivity

Shear sensitivity of the fluid is a parameter of great importance prior to selection of process components such as choke valve and inlet devices.

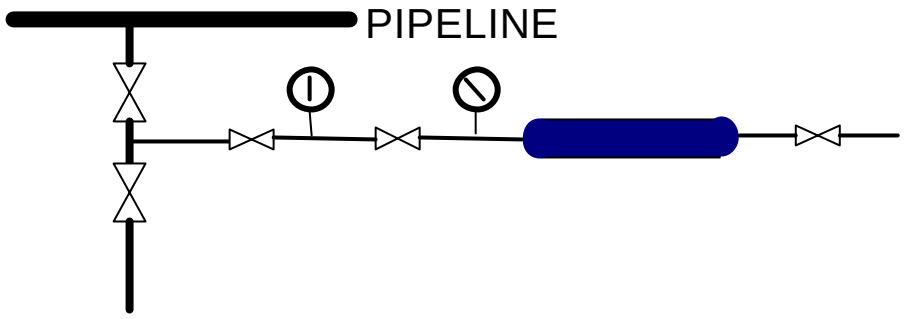
Using Hinze's equation to describe the relationship between energy dissipation and interfacial tension and how they influence on droplet break-up, the significance of shear sensitivity becomes more evident:

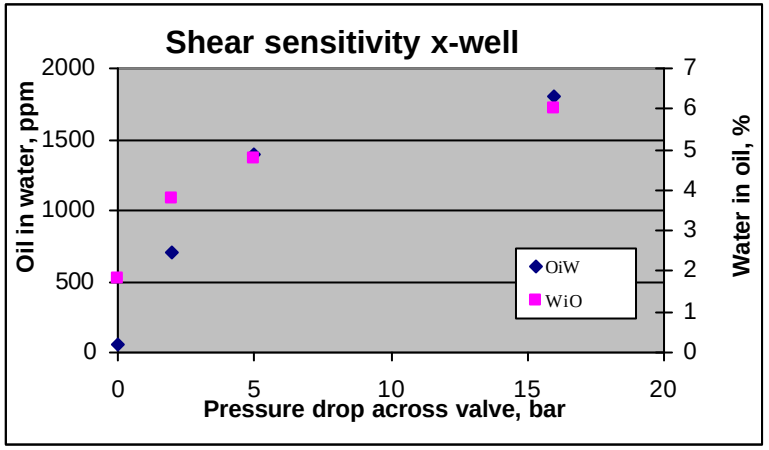
$$D_{max} = C \left(\frac{\sigma^{0.6}}{\varepsilon^{0.4} \cdot \rho^{0.2}} \right)$$

σ = interfacial tension (dynes/cm)
ε = energy dissipation (1/s)

- Fluids with lower interfacial tension results in smaller droplets.
- Fluids exposed to higher energy dissipation results in smaller droplets.
- Fluids with low interfacial tension and at the same time exposed to high shear, you have a problem!

Principle of testing:





Separator malfunction

High effort from oil companies is put into troubleshooting of separators that are not performing as expected.

The cause of the malfunction can be multiple, and the most frequently methodology used to solve the malfunction is:

- **Chemical treatment**

To some extent this might be good enough, however since the process is in more or less constant changes, this “stimulation” usually is a short-term solution.

We have been involved in several projects in order to assist in troubleshooting of separators and our experience and focus are more directed towards:

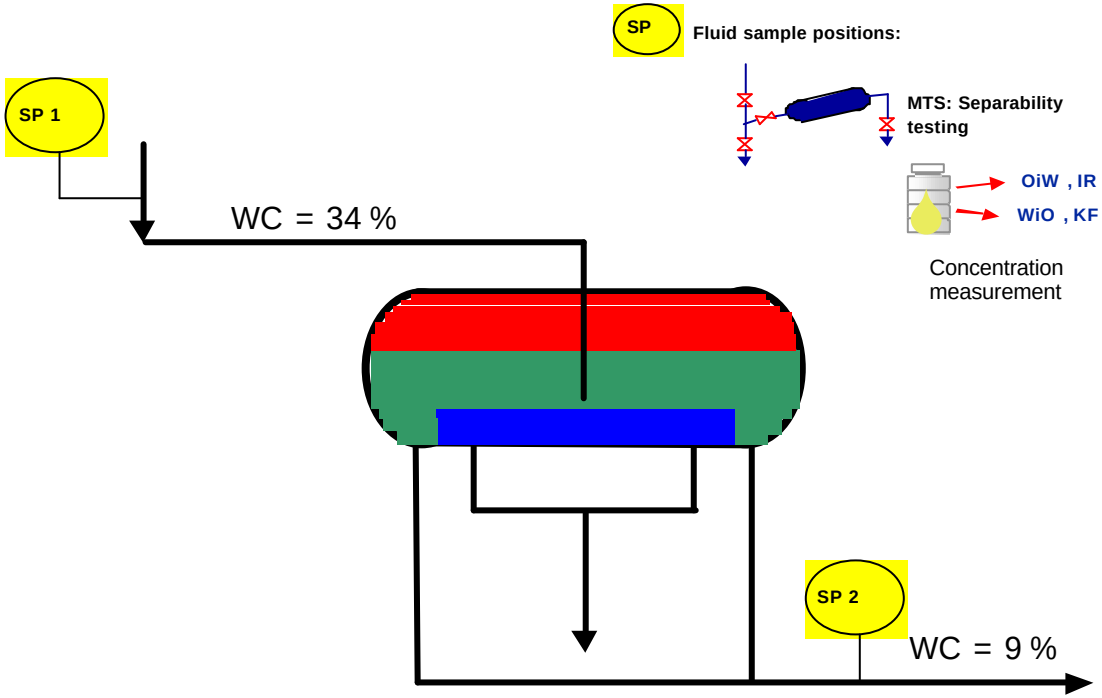
- **Fluids behaviour and separability**

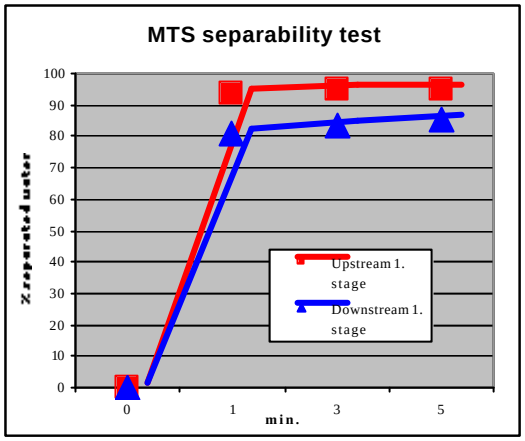
If the fluids separate easily prior to the inlet separator, but experience poor separability in the separator, it is our understanding that the problem could be assossiated with the devices in the separator, for instance inlet cyclones or internals.

Let’s have a look !

Inlet separator with too high water carry-over

The 1. stage separator lacked performance after modification and extensive chemical treatment did not solve the problem. In order to address the problem separability tests were performed.





Test programme:

- **Baseline fluid characterisation**
- **Separability test by use of MTS**

- **Fluids u/s and d/s separated easily indicating retention time problem and/or emulsifying effects within the separator.**

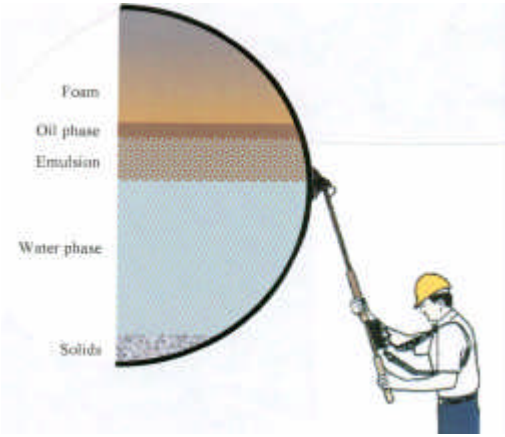
- **Optimizing of the inlet cyclones.**
- **Tuning of both g/o and o/w interfaces.**

MATOR

Inlet separator troubleshooting

Neutron backscatter to detect gas/foam/oil/emulsion/water layers in the separator

We have implemented Neutron Backscatter technology as a supplemental tool in order to understand separation phenomena inside the separator. The backscatter basically emits fast neutrons through the wall of the separator which interact with the hydrogen atoms in the liquid (or gas), thereby loosing energy. During this process some of the neutrons are reflected back (backscattered) as slow (low energy) neutrons. The degree of backscattering is proportional to the hydrogen density of the phases inside the separator.



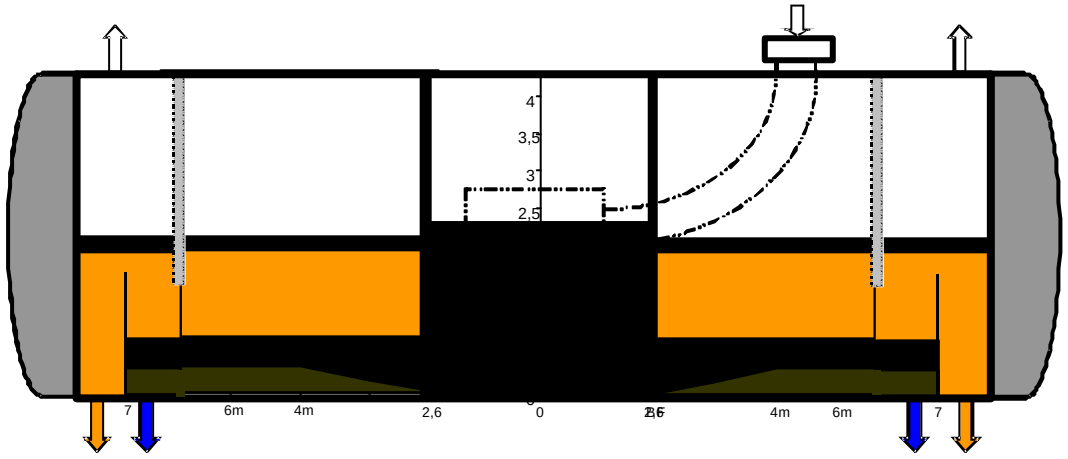
Detection of different layers in the separator

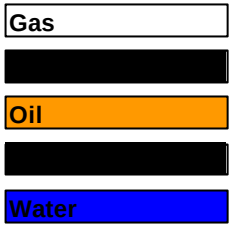
Moving this detector along the separator wall it is possible to detect foam layer, emulsion thickness, sediment built-up or naphthenate layer. Influence of varying process parameters can be visualised instantly.

MATOR

Inlet separator with too high oil in produced water

Neutron Backscatter scan to obtain emulsion characteristics and phase behaviour inside the separator:





- Inlet fluid is easy separated by MTS.
- Water outlet contains up to 2-3% oil, mostly free and easy separated, but also higher portion of dispersed oil compared to inlet during MTS-testing.

RESULTS FROM SCAN:

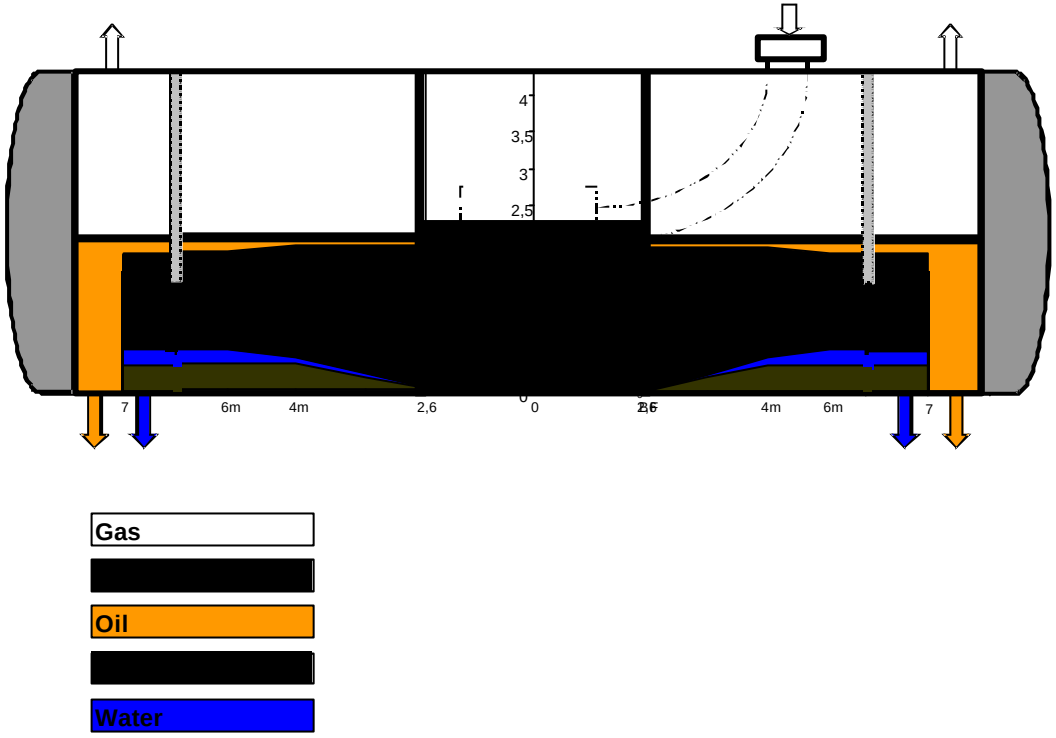
- No separate water phase present

POSSIBLE REASON:

- Fluid exposed to shear in the inlet section, and turbulence created by the outlet of the cyclones to disturb the foundation of a water phase.
- Worse with increased gas flow rate.

MATOR

Inlet separator with too high oil in produced water (cont'd)



RESULTS FROM SCANNING WITHOUT SLUGGING WELLS:

- Distinct water phase established.

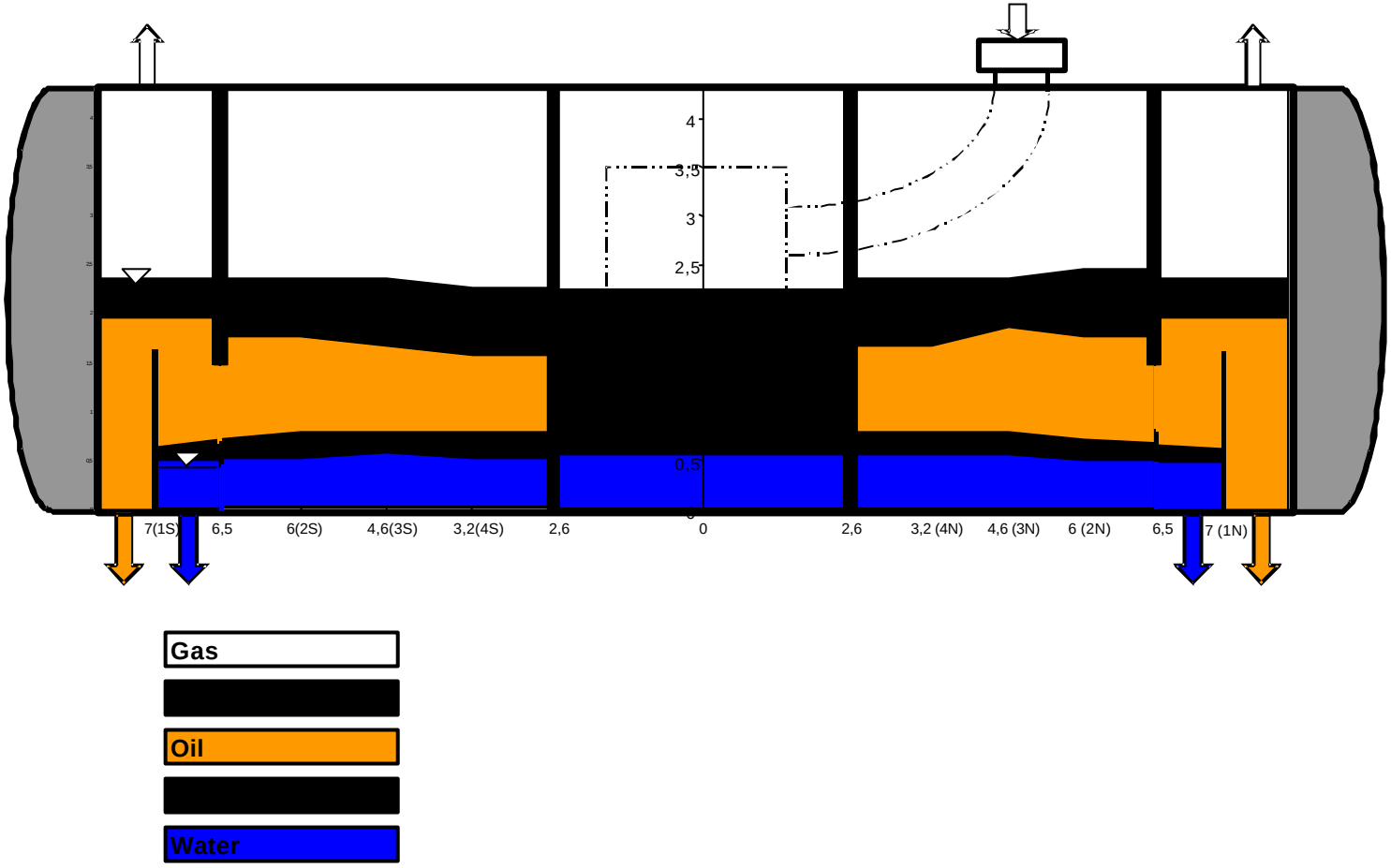
CONCLUSION:

- Slugging from specific wells is the cause to the problem. Instabilities from slugging do not allow for a proper water phase to be established and separate adequately.
- The inlet cyclones expose the fluid to shear forces and create a considerable concentration of dispersed oil limiting to separation performance. The shear rate and concentration of dispersed oil in water increases with increasing gas rate.
- The inlet cyclones are also indirectly responsible for the unstable conditions in that they are not very capable of handling the slugging.

MATOR

Verification of conditions after modification

After modification, in this case a new inlet cyclone package, the performance has improved. Note that even in the inlet section chamber free water phase was established.



MATOR

Summary

- The separability is governed by the fluids behaviour!
- It is recommended to address the problem rather than treat the symptom.
- By a comprehensive and systematic survey, along with different methods to access information, almost all the problems related to separation can be addressed.
- The result is a more accurate and cost effective action to eliminate the problem!

MATOR