Field study: Impact of EOR polymer on the effectiveness of produced water treatment

Roland Grillneder, OMV Upstream
Markus Marx, OMV Upstream
Wiston Rodriguez, OMV Upstream
Karl Jamek, OMV Upstream

Agenda

- Research Objectives
- Process & Trial Overview
- Results & Observations
  - Conventional Water
  - Produced water containing back-produced Polymer
  - Produced water containing spiked polymer
  - Water clarifier application
- Conclusion
- Q/A

Research objectives

Water Treatment suitable for EOR polymer

Treating produced water containing polymers is one of the major challenges in EOR

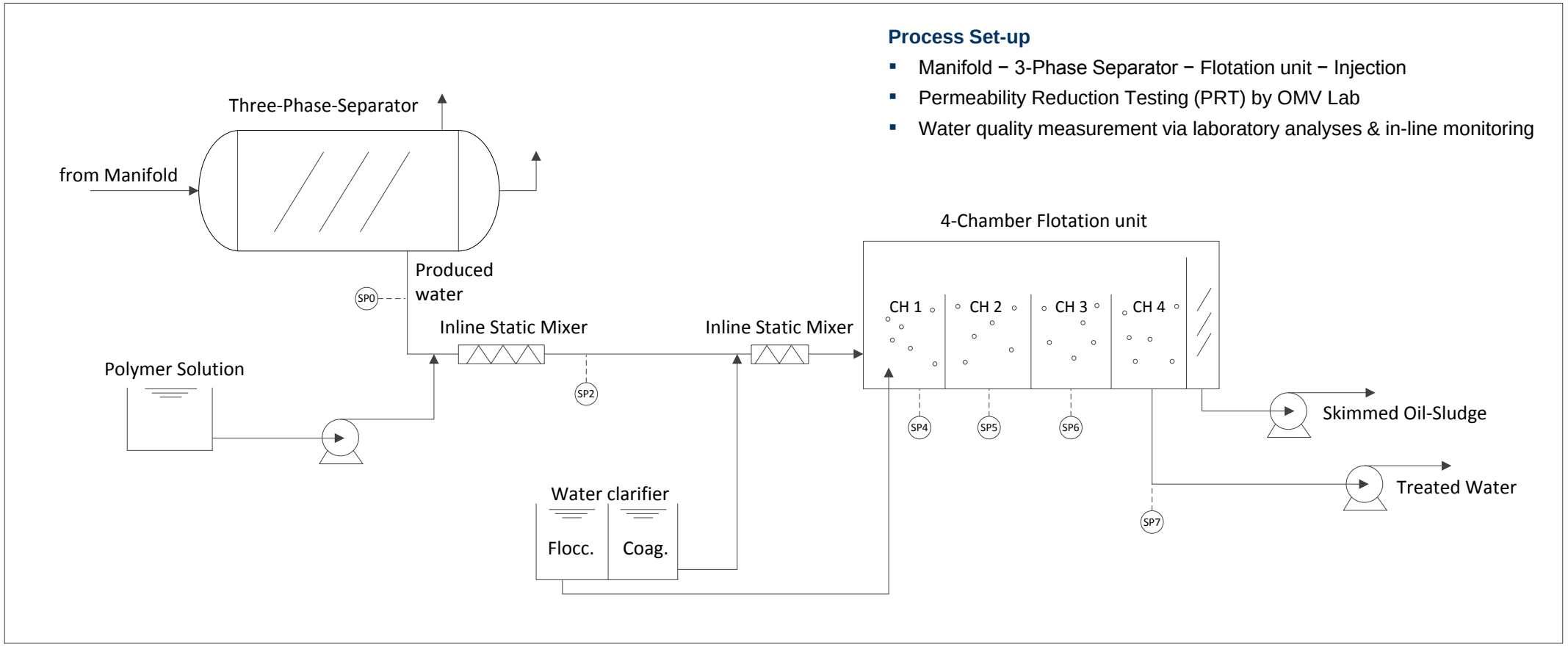
OMV built up a pilot plant for back-produced polymer water activities at Matzen, Austria

Main objective was the evaluation of Micro-Bubble Flotation Technology under actual field conditions

- Effect of varying inlet water characteristics (Retention time, OIW up to 3000ppm)
- Evaluation of various HPAM types & concentrations (Polymer: up to 800ppm)
- Influence of water clarifier

Process & Trial Overview

Process Flow Diagram | Location: Gänserndorf, Austria



Process Set-up

- Manifold − 3-Phase Separator − Flotation unit − Injection
- Permeability Reduction Testing (PRT) by OMV Lab
- Water quality measurement via laboratory analyses & in-line monitoring

Process & Trial Overview

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Trials Overview

Retention time [min] (Flow-rate)

		49 (200bpd)	25 (2000bpd)
Conventional water		■	■
Produced Water containing back-produced polymer			
40ppm Polymer	≙ 1 cp Viscosity	■	
Produced Water containing spiked 3,7 MDa polymer			
40ppm Polymer	≙ 1 cp Viscosity	■	■
150ppm Polymer	≙ 1,14 cp Viscosity	■	■
300ppm Polymer	≙ 1,4 cp Viscosity	■	■
800ppm Polymer	≙ 2,5 cp Viscosity	■	
Produced Water containing spiked 20 MDa polymer			
40ppm Polymer	≙ 1,16 cp Viscosity	■	■
150ppm Polymer	≙ 1,67 cp Viscosity	■	■
300ppm Polymer	≙ 2,65 cp Viscosity	■	■
800ppm Polymer	≙ 8,19 cp Viscosity	■	

■ …w/o chemicals ■ …w/o & with chemicals ■ …with chemicals

Note: Viscosity [cP] @ 7,34s^{-1} share rate and 25°C

- RESEARCH OBJECTIVES
- **PROCESS / TRIAL OVERVIEW**
- RESULTS & OBSERVATIONS
  - Conventional Water
  - Prod. water cont. back-prod. polymer
  - Prod. water cont. spiked polymer
  - Water clarifier application
- CONCLUSION
- Q & A

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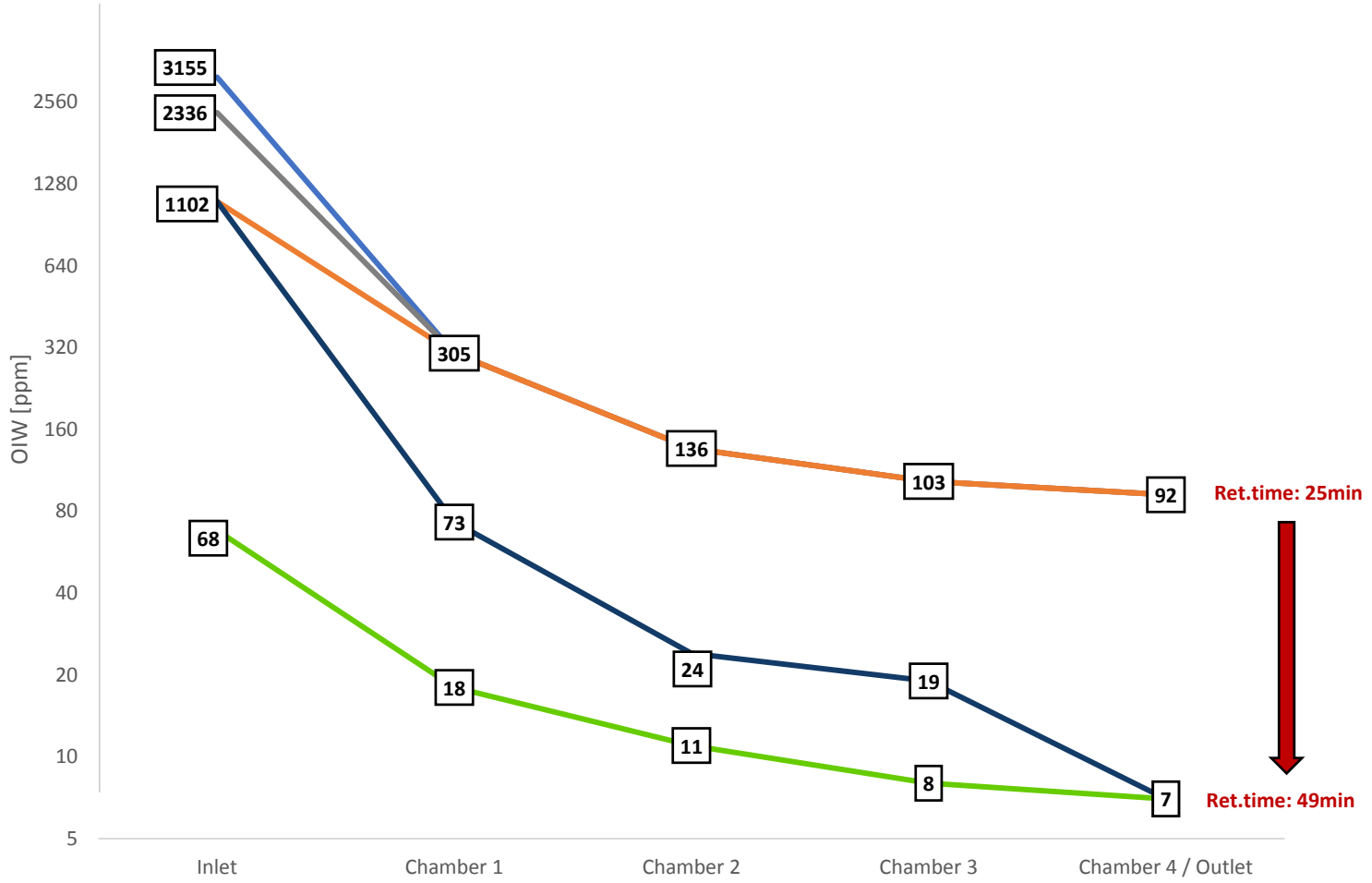
Results and observations

Conventional water with various Oil-in-water Inlet conditions (without water clarifier)



Note: Treatment efficiency relies on the inlet water composition of the tied-in well(s) | The displayed values are the average value of multiple water samples

Observation

(1) High impact of retention time

(2) Minor impact of Inlet OIW fluctuation

(3) Oil droplet converge to similar size distribution in chamber 1 – 4

- Independent of OIW @ Inlet
- Dependent on retention time

(4) Chamber 1 efficiency up to 90%

Results and observations

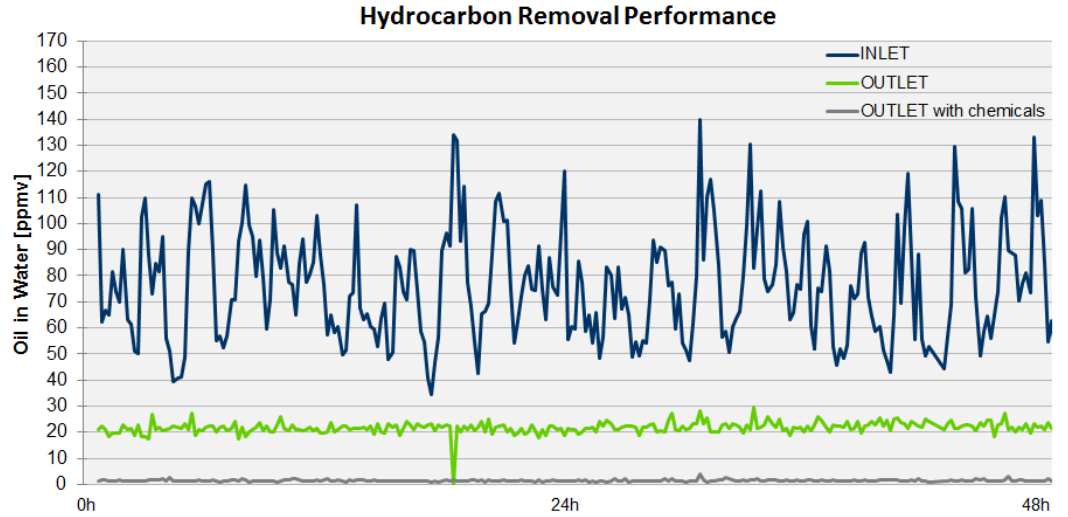
Produced water containing back-produced polymer | Chemicals: with & w/o | Retention time: 49min

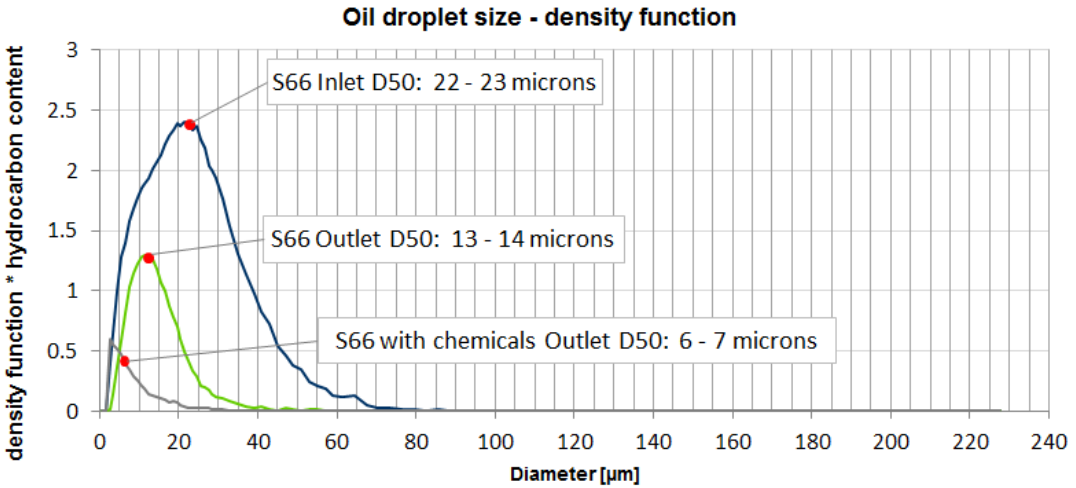
Water Quality Inlet	OIW: ~68 ppm
	TSS: <2ppm
	HPAM: ~40 ppm (~3MDa)
	Oil droplet size (D50): 22-23 micron
Water Quality Outlet	OIW: <5 ppm
(with chemicals)	TSS: <1,5 ppm
	HPAM: ~13 ppm
	Oil droplet size (D50): 6-7 micron
Water Quality Outlet	OIW: ~20 ppm
(without chemicals)	TSS: <1,5 ppm
	HPAM: ~40 ppm
	Oil droplet size (D50): 13-14 micron

Observations

(1) Higher OIW concentrations at outlet compared to conventional water

(2) Oil droplet cut-off towards bigger sizes compared to conventional water





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Results and observations

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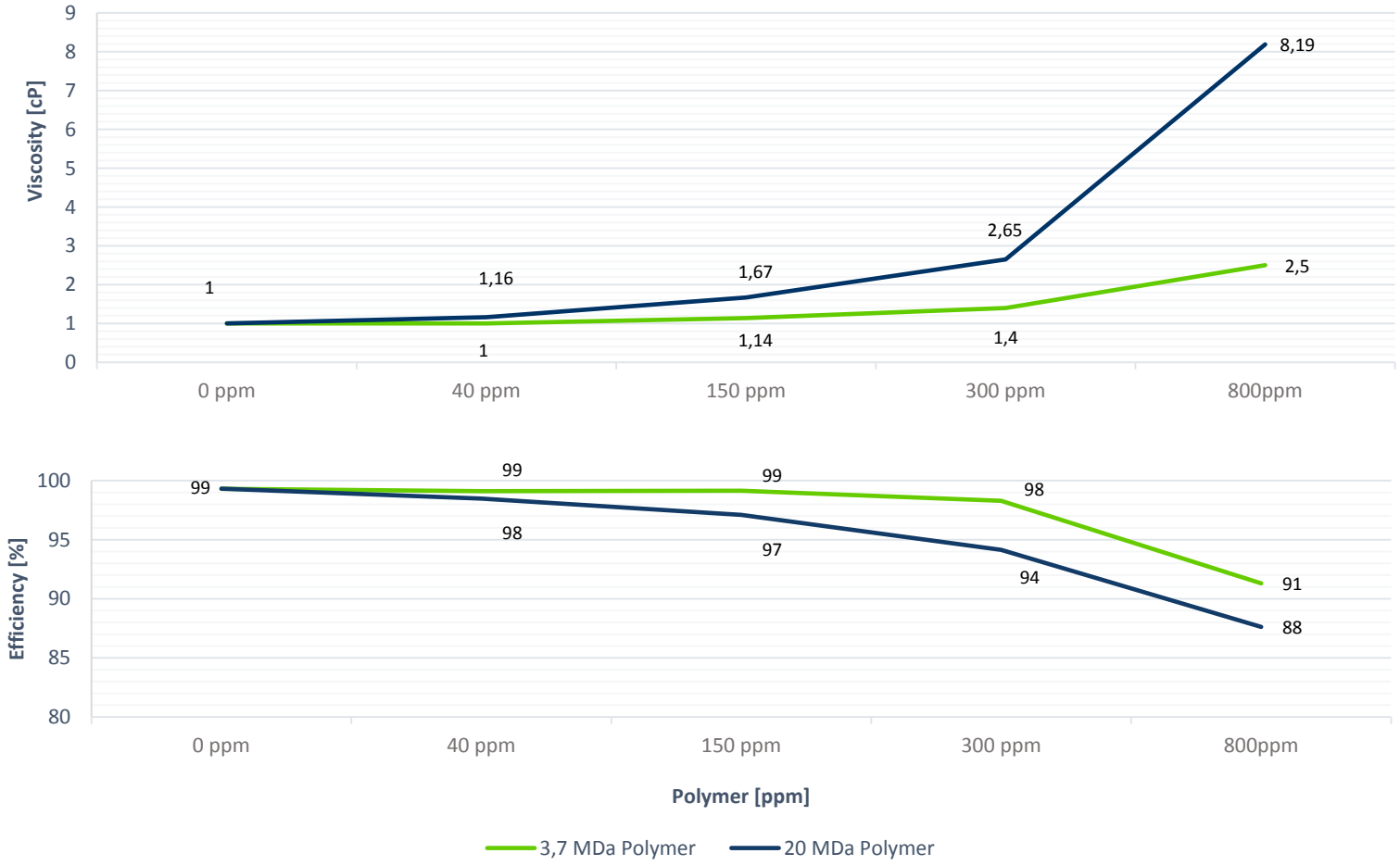
Oil removal efficiency vs. produced water viscosity and polymer concertation | Retention time: 49min



Observation

(1) Visible impact of viscosity on the outlet water quality at 300ppm polymer

(2) Efficient treatment results with high retention time up to 300ppm polymer

(3) Polymer MW differently impacts the outlet quality at same viscosity

Note: Treatment efficiency relies on the inlet water composition of the tied-in well(s) | The displayed values are the average value of multiple water samples

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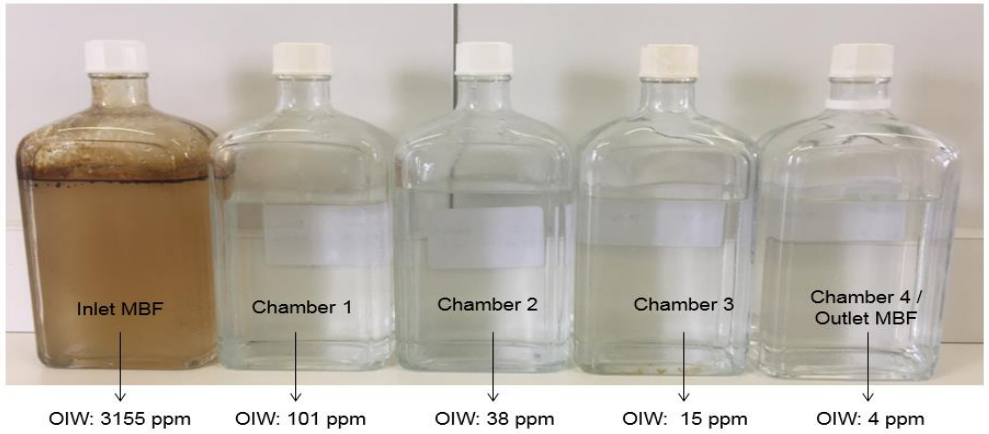
Results and observations

Chemical packages & consumption

Substance / Polymer	Coagulant (Cationic)	Flocculant (Anionic)
0ppm HPAM	< 10 – 20ppm	< 0,5ppm
40ppm HPAM	~ 90 ppm	-
150ppm HPAM	500 – 1000 ppm	-
300ppm HPAM	> 1000 ppm	-



Observation

(1) Water clarifier

60-70% chemical reduction of actual dosing rate for conventional water

(2) Polymer Application

Economic limit for water clarifier application: ~40ppm polymer concentration

(3) Droplet size

Removal of droplets >5-8 microns (with water clarifier)

(4) Sludge

Difficulty of treating sludge containing polymer

Note: Treatment efficiency relies on the inlet water composition of the tied-in well(s) | The displayed values are the average value of multiple water samples

Conclusions of the field study

(1) Combined effect of viscosity, polymer concentration and molecular weight influence the performance of water treatment.

(2) Conv. produced water with spiked polymer is easier to treat in comparison to back-produced polymer water at similar conditions (inlet water specs, polymer concentration, etc.)

(3) Potential alteration of polymer chemistry in reservoir could be affecting oil removal efficiency.

(4) Water clarifier application on produced water containing polymer

a) Chemicals affect injectivity of core-samples

b) Economical limit already exceeded even at low polymer concentrations (due to higher dosage required)

c) Challenge of treating flotation sludge

(5) Preferred treatment approach: Retention time (> 49min) rather than chemical inj. application

Q/A

Roland Grillneder
Facilities Engineer
OMV Exploration & Production

Markus Marx
Fluid Analytics & Production Chemist
OMV Exploration & Production

Wiston Rodriguez
Discipline Support Manager
OMV Exploration & Production