

Solution To Scale Control In The Tinggi Offshore Oil Field

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Abstract

This paper describes the successful application of newly developed magnetic fluid conditioners (MFC's) in the elimination of scale build up problems on one of PCSB's Tinggi Field offshore oil platforms located in the South China Sea. This platform had the worst scale problem of all the PCSB platforms in Malaysia and the MFC's were installed on the most severe scale problem on that platform.

Also included is a brief comparison of the performance of various scale control mechanisms trialed in the Malaysian oil fields in the search for an effective control mechanism of scale build up.

Case History of Scale Problems in the Tinggi Field

The Tinggi Field has a long history of particularly severe scale problems. Various scale control mechanisms have been trialed over many years in the Tinggi field and other fields in Malaysia with minor success until 2001. Both chemical scale inhibitors and magnetic fluid conditioners (MFC's) had been trialed.

Comparison of Scale Control Mechanisms Trialed

A brief comparison of the effectiveness of the various mechanisms trialed in the Malaysian oil fields is included in Appendix A. Most mechanisms trialed had minor or no effect and in some cases actually increased the rate of scale build up. Only one was totally successful, that being the Scale-X™ MFC's.

PCSB Approach

PCSB's engineers realized early on in their trials of the various scale control mechanisms and from a review of technical literature ⁽¹⁾⁽²⁾⁽³⁾ that magnetic fluid conditioning had the best potential to solve the severe scale problems provided it was engineered properly to co-

ordinate with the plant design and fluid process conditions. The challenge was to find a company that applied a multi-disciplined total engineering approach to the design of the MFC's and who would work with PCSB engineers in "controlled" trials taking into consideration the entire platform fluid process conditions and plant design.

In 1999, PCSB approached Magnetic Technology of Australia (MTA), a company that applies a multi-disciplined approach, and supplied extensive data on the platform scale problems, plant design and fluid process. The oil-water separation systems on offshore platforms are a once through system and cannot be treated with the commonly available "off the shelf" MFC's which are only suitable for re-circulating systems where the fluid has multiple passes through the MFC. MTA developed a new approach to MFC design and two MFC's were installed in August 2001 in a separation vessel on the oil and water outlet stand pipes which was identified as having the most severe scale problems.

Also, MTA at the request of the PCSB engineers took into consideration the ease of retrofit so that no time consuming and costly modifications were required to the platform plant.

The trial extended until May 2002, that is, 8 months. PCSB closely monitored the outcomes in the following categories:

1. Flow control valve operational performance
2. Production output levels
3. Separation vessel fluid levels
4. Separation vessel operating pressure
5. Ability to reduce and/or stop scale build up
6. Ability to remove existing scale build up
7. Ability to reduce de-scaling maintenance shutdowns from 4 per year to 1 per year.

The Problem

This separation vessel has 3 phase separation, gas/oil/water, and presented the worst situation for scale formation because of the large amount of gas liberated. Also, the pressure drop through the water flow control valve was a massive 1300kPa. The type of scale was 95% calcite, 3% dolomite and 2% barite. The stand pipes were scaled almost closed in 3 to 6 months and the flow control valves became inoperative in 15 days when chemical scale inhibitors were not used and within 28 days when the chemical scale inhibitors were used. The platform had to be shutdown every 3 months for de-scaling. Appendix B graphically shows the scale problem in the standpipes and valves.

The scale build ups progressively reduced **the production output level by 18% over 3 months** between de-scaling maintenance shutdowns.

The Solution

Specially designed Scale-X™ MFC's were installed in the separation vessel on the standpipes replacing the vortex breakers. These MFC's were designed to treat the scale build ups in the standpipes and the flow control valves and incorporated vortex breaker duties. A photograph of the MFC on the water outlet standpipe is shown in Appendix C

This new approach to the application of MFC's is a world first and took 2-1/2 years to develop specially for this application.

The Outcomes

The outcomes resulting from the installation of the Scale-X™ MFC's exceeded the PCSB specification in all categories and:

1. completely stopped the scale build up in the standpipes and the control valves
2. removed pre-existing scale build up
3. showed that chemical scale inhibitors can be eliminated.
4. the production output has remained at 100% on a continuous basis, that is, there is no drop off in production levels.
5. operational performance of the platform has remained steady with no requirement to ramp up the vessel fluid levels and pressures to maintain production output
6. control valves remain 100% operational without chemical scale inhibitors or twice daily stroking of control valves and.
7. de-scaling maintenance shutdowns can be reduced from 4 per year to less than 1 per year.
8. production output has been significantly increased due to no drop off in production and reduction in de-scaling maintenance shutdowns.
9. flow control valve life has been lengthened.
10. an economic evaluation of the Scale-X™ MFC's has a return on investment within a matter of weeks and it is a once off investment.
11. significant benefits have been achieved in HSE issues.

Appendix D shows the scale build ups after 3 months without the MFC's and at 8 months with the MFC's installed. Appendices E and F show the improved operational performance of the platform system in maintaining full production output with the control valves remaining fully operational.

References

- (1) "Study of Paraffin Crystallisation Process Under the Influence of Magnetic Fields and Chemicals" – SPE38990, Society of Petroleum Engineers – September 1997 by L C C Marques, N O Rocha, A L C Machado, G B M Neves, L C Vieira and C H Ditz – Petrobras Research Center, RJ.
- (2) Federal Technologies Alerts – "Non-Chemical Technologies for Scale and Hardness Control" by the United States Department of Energy – January 1998
- (3) "Lifting the Scale from Our Pipes" – New Scientist 18 February 1988 – Professor John Donaldson and Dr Sue Grimes – Chemistry Department, City University London

Acknowledgements

These new magnetic fluid conditioners (MFC's) were developed by Magnetic Technology of Australia and are marketed under the name Scale-X™ Magnetic Fluid Conditioners. Further information can be obtained from www.scale-x.com or forward your email enquiries to info@scale-x.com .

Appendix A

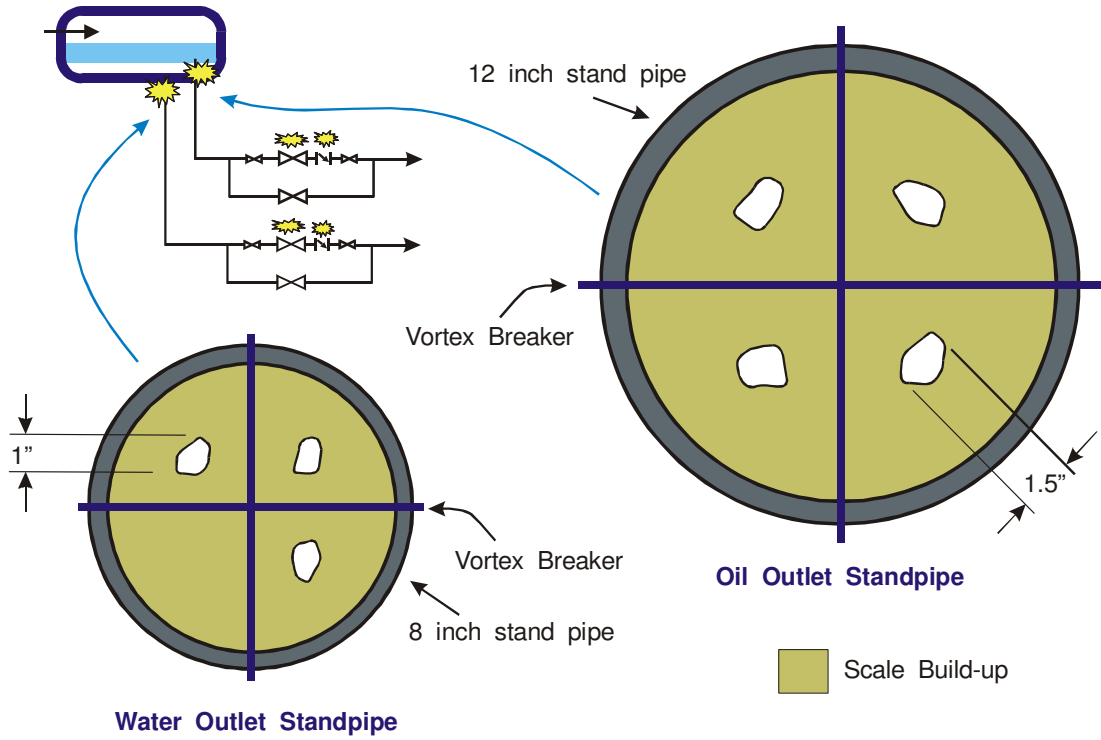
Evaluation of scale control mechanisms trialed and/or applied on Tinggi & Other Offshore Oil Fields in Malaysia			
Shell Fluid Chemistry Forum held at Miri, Sarawak, Malaysia on 7 & 8 October 2002			
Control Mechanism	Product Name	Effectiveness (scale 1 to 10)	Comments
Magnetic Fluid Conditioner	MFC "A" (see Note A)	6	Cleans reduced from 2 per year to 1 per year
Magnetic Fluid Conditioner	MFC "B" (see Note B)	5	Cleans reduced from 3 monthly to 5 monthly. MFC units suffered from front end fouling.
Magnetic Fluid Conditioner	Scale-X™	10	Eliminated scale build up. (Reduced calcite by 100%, barite by 100% and dolomite by 100%). Removed existing scale build ups. Exceeded PCSB specification.
Chemical scale inhibitor	Surflo SI 2750	0	Increased scale problem - barite by 480%, calcite by 100% and dolomite by 8%
Chemical scale inhibitor	Surflo SI 3007	1	Reduced calcite by 33%. Increased barite by 500% and dolomite by 8%
Chemical scale inhibitor	Scaletrol-5	1	Reduced calcite by 19% and dolomite by 0.4%. Increased barite by 109%
Chemical scale inhibitor	Techni-Hib 764	6	Reduced calcite by 63% and dolomite by 14%, increased barite by 100%
Chemical scale inhibitor	Techni-Hib 767W	3	Reduced calcite by 47% and dolomite by 3% and increased barite by 103%
Chemical scale inhibitor	Techni-Hib 7576	2	Reduced calcite by 27% and dolomite by 7%, increased barite by 100%

Note A: Supplied by Magniflo

Note B: Supplied by MagWell

Appendix B (1)

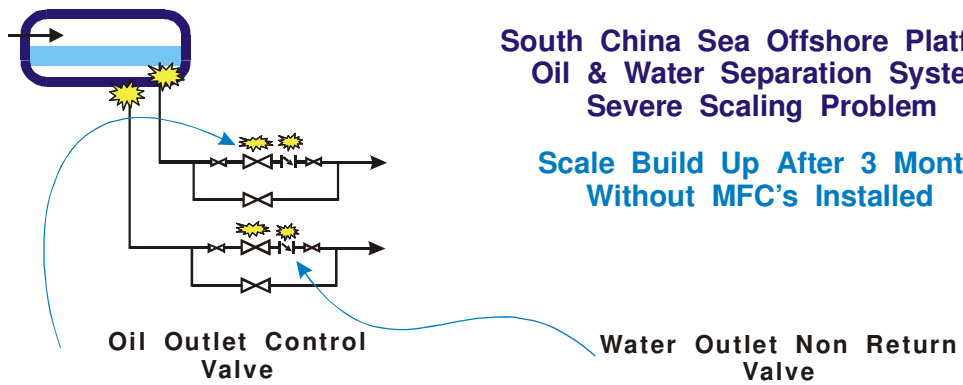
**Oil/Water/Gas Separation Vessel
Oil and Water Standpipes
Scale Build Up Before De-scaling
Without MFC's Installed**



Appendix B (2)

**South China Sea Offshore Platform
Oil & Water Separation System
Severe Scaling Problem**

**Scale Build Up After 3 Months
Without MFC's Installed**



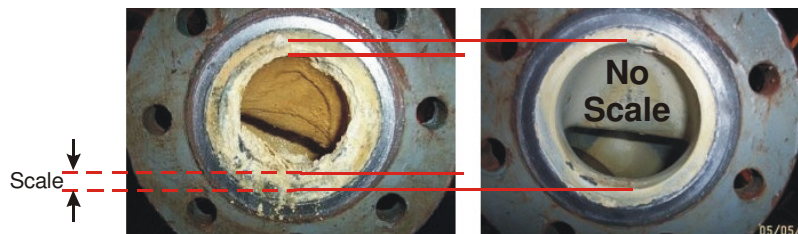
Appendix C



Scale-X™ MFC mounted on the water outlet standpipe

Appendix D

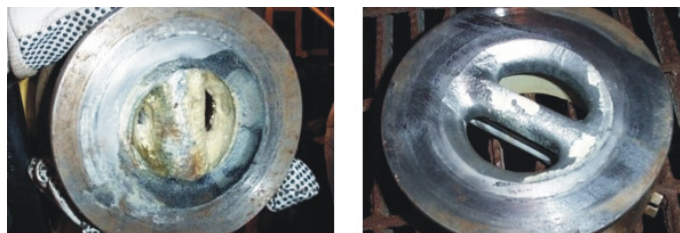
Oil Control Valve



Thick Scale Build Up
After 3 Months
Without MFC's Installed

No Scale Build Up
After 8 Months
With MFC's Installed

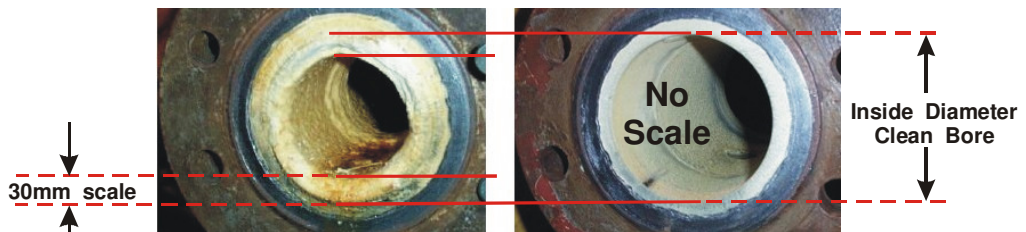
Non-Return Valve



Heavy Scale Build Up
After 3 Months
Without MFC's Installed

No Scale Build Up
After 8 Months
With MFC's Installed

Block Valve Reducer Downstream of Oil Control Valve



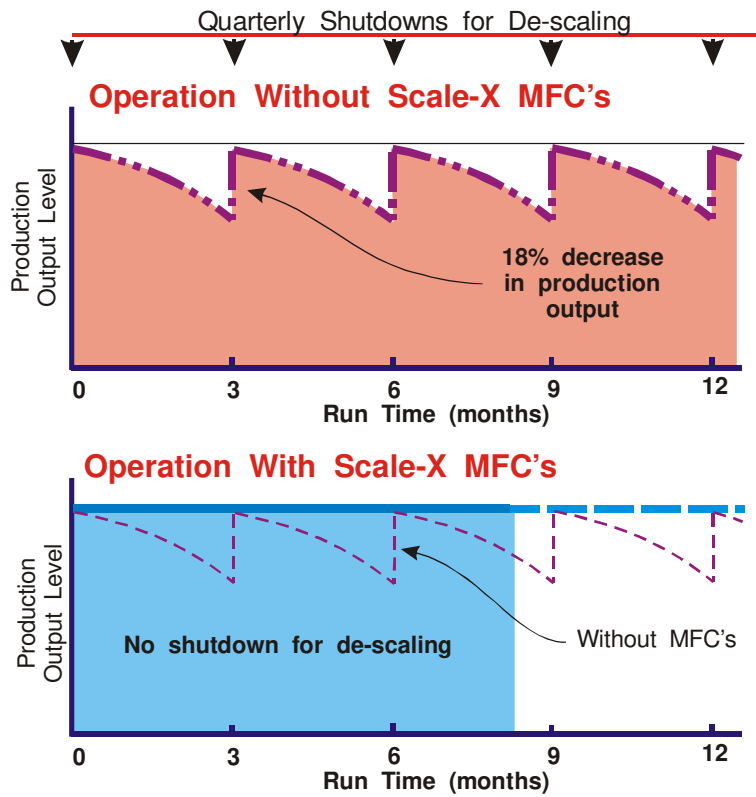
Thick Scale Build Up
After 3 Months
Without MFC's Installed
Thickness of Scale is 30mm

No Scale Build Up
After 8 Months
With MFC's Installed
Scale is eliminated

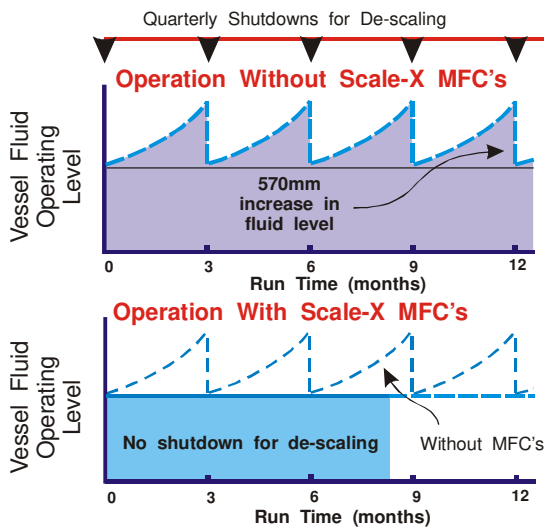
NOTE: The liquid through these valves and reducer is 3 parts crude oil and 1 part formation water.

Appendix E

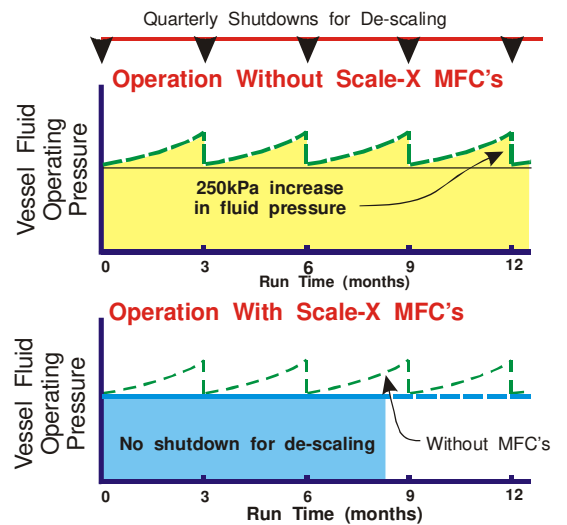
**Production Output Level
Operation of South China Sea Offshore Oil Platform
Without and With Scale-X MFC's**



**Vessel Operating Liquid Level
Operation of South China Sea Offshore Oil Platform
Oil & Water Separation Vessel
Without and With Scale-X MFC's**



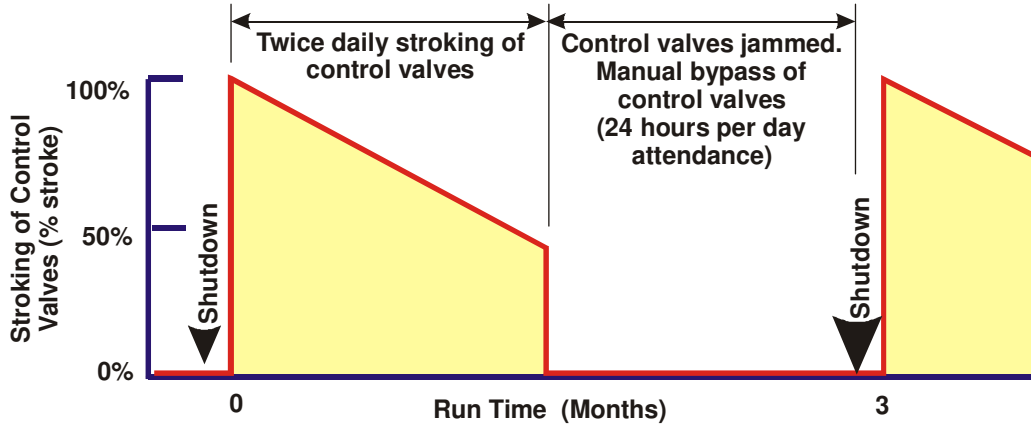
**Vessel Operating Pressure
Operation of South China Sea Offshore Oil Platform
Oil & Water Separation Vessel
Without and With Scale-X MFC's**



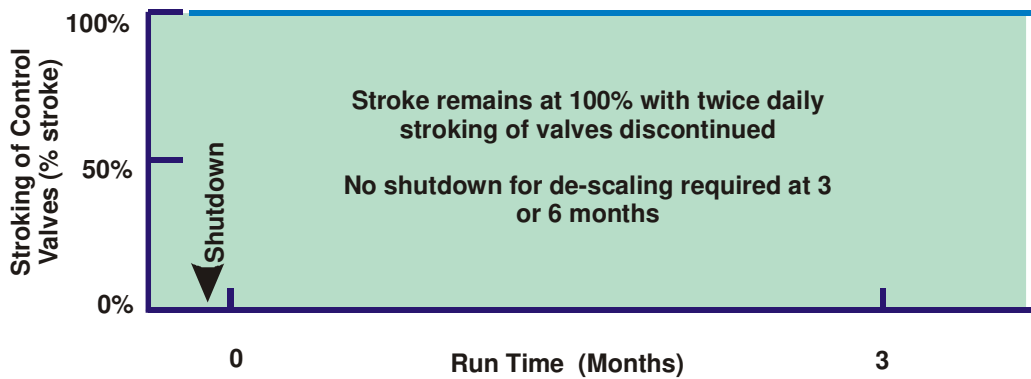
Appendix F

**Stroking of Flow Control Valves
Oil & Water Separation Vessel Control Valves
Without and With Scale-X MFC's**

Operation Without Scale-X MFC's (Valves stroked twice daily)

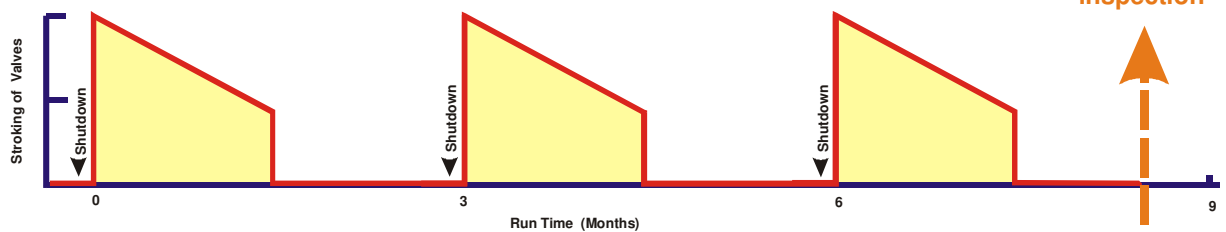


Operation With Scale-X MFC's (No stroking of valves)



Eight Month Overview

Operation Without Scale-X MFC's (Valves stroked twice daily)



Operation With Scale-X MFC's (No stroking of valves)

