

SPE Short Course: The Formation and Prevention of Oilfield Scale: From the Laboratory to the Field

26 May 2008 • 0900–1700 hrs • 27 May 2008 • 0900–1630 hrs

1.6 CEUs (Continuing Education Units / 16 hours) awarded for this 2-day course.

Presenters

Eric Mackay is a lecturer at the Heriot-Watt University Institute of Petroleum Engineering, where his research interests include the application of reservoir engineering principles and data to better understand production issues. For the past nine years he has worked on oilfield scale, developing and applying flow models to predict scale precipitation and to design squeeze treatments. He has more than 60 publications related to scale management. In 2004, he was invited to make a keynote presentation at the SPE 6th International Symposium on Oilfield Scale, and he was programme committee chairperson for the 2006 symposium. He has prepared and co-presented SPE short courses on oilfield scale and is a technical editor for SPE Production and Facilities. He was invited to be a SPE Distinguished Lecturer for the 2007–2008 lecture series. As well as being responsible for software development, support, and training within the Flow Assurance and Scale joint industry project (JIP) at Heriot-Watt University, Mackay has carried out both theoretical and field applied studies with many of the operating and service companies that support the JIP. In addition to having led more than 20 industrial training sessions in the use of software for oilfield scale management, Mackay has taught practical reservoir simulation to the residential and distance learning MSc classes at the Institute of Petroleum Engineering at Heriot-Watt since 1990. Mackay holds a BSc in physics from the University of Edinburgh and a PhD in petroleum engineering from Heriot-Watt University.

Ken Sorbie is a professor in the Institute of Petroleum Engineering at Heriot-Watt University. He earned his first degree in chemistry from Strathclyde University and a DPhil in theoretical chemistry/applied mathematics from the University of Sussex. Following this, he did a postdoc at Cambridge University working on theoretical aspects of semiclassical molecular quantum theory. He has worked in oil related research for more than 20 years, first with the Department of Energy laboratory at AEE Winfrith, where he led a group working on improved oil recovery, flow through porous media, and reservoir simulation and, since 1988, at Heriot-Watt University. His current research is in oilfield chemistry, and he is principal investigator (along with Professor Anne Neville and Eric Mackay) of the Flow Assurance and Scale Team (FAST) joint industry project (JIP). This 3-year, GBP 2-million FAST project is sponsored by an industrial consortium of 19 companies and was first launched as a JIP by Sorbie in 1989. Sorbie also has three other projects on multiphase flow in porous media and on near well water control treatments, funded by 12 industrial companies. He has published more than 200 technical papers on his research (which are all downloadable in pdf format from www.pet.hw.ac.uk) and a book on polymer flooding. Sorbie has also consulted widely in the oil industry for more than 30 industrial companies and is a regular visitor to companies and research institutes in Brazil, Malaysia, Russia, Italy, Norway, and the US. He has been invited to be a visiting professor at the University of Bergen. He was a SPE Distinguished Lecturer in 2000–2001 and is a member of the Royal Society of Edinburgh. Sorbie has been awarded the Society of Core Analysts 2004 Technical Achievement Award.

Description

This course will be presented by two members of the Heriot-Watt University Flow Assurance and Scale Team (FAST) who have a combined total of 28 years of experience in both research and field applications in the area of oilfield scale prevention. Between them, they have written over 100 technical papers on this subject, and they have both been involved in many field scale prevention studies. This course draws very strongly on that extensive research and field experience and provides both the underlying theory (originally developed by the authors in some cases) in an accessible manner, along with concrete practical examples of how this knowledge is applied in the field.

The two-day, self-contained course serves as both an introduction, and in places as state-of-the-art, in oilfield scale management. It is suitable for production technologists, engineers, oilfield chemists, and anyone involved in flow assurance issues in oil operating companies, the service sector, and scale inhibitor (and sulphate removal) manufacturing industries. The basic science is fully illustrated by field examples, and attendees will have the opportunity to use the Heriot-Watt software to perform scale prediction calculations (SCALEUP) and to carry out field scale inhibitor squeeze designs (using SQUEEZE VI). Course participants are encouraged to bring along their field formation and injection water composition data and other properties of their reservoirs for discussion.

Outline Programme

1. Background to mineral scale formation in oil fields
 - the basic ideas of mineral scale formation
 - oilfield brine compositions and how these lead to different scales
 - calcite scale, mixed Ba/Sr/Ca/SO₄ scales and more exotic scales
 - field examples from around the world
2. Scale prevention using chemical scale inhibitors
 - basics of scale control using scale inhibitors
 - how scale inhibitors work mechanistically
 - topside scale control and downhole squeezing
 - introduction to downhole squeezing of scale inhibitors
3. Thermodynamics of mineral scale prediction
 - thermodynamics and the scale prediction equations
 - sulphate and carbonate scale prediction
 - the fundamental equations for scale formation and their solution
 - scale prediction software
 - examples using field data to illustrate scale prediction
 - use of scale prediction to define experimental conditions for laboratory inhibition efficiency testing
4. Theory of scale inhibitor squeeze treatments
 - basic equations for transport and adsorption of scale inhibitors in flow through porous media
 - the adsorption isotherm, (C)
 - precipitation squeeze treatments
 - field examples of squeeze treatment design
 - demonstration (and hands-on use) of Heriot-Watt SQUEEZE V software
5. The design of field scale management programmes
 - assessing the problem
 - designing a laboratory programme for field scale control
 - screening methods for scale inhibitors for specific field scaling problems
 - bulk jar and tube blocking tests for inhibition efficiency – interpretation of what these tests mean mechanistically
 - the role of core flooding in scale inhibitor selection with field examples
 - assessing and avoiding formation damage when applying scale inhibitors in squeeze processes – field examples
6. Advanced topics in field squeeze design
 - scale inhibitor treatments in horizontal well
 - scale prevention in subsea wells
 - scale inhibitor placement – back to basics on the theory and practice of SI placement in heterogeneous reservoir systems
 - field examples illustrating scale inhibitor placement issues in heterogeneous systems
7. The impact of the reservoir on the field scaling problem
 - where does scale form in the total reservoir/production system
 - reservoir scale predictions of the scaling problem
 - illustration with field examples from the North Sea and offshore West Africa
 - approaching the total system in the context of risk management of the problem
8. Recent developments in scale prevention
 - non-aqueous scale inhibitors – a review of the chemical systems and the mechanisms through which they are thought to work
 - naphthenate “scale” formation – review of current thinking
 - pre-emptive scale protection of wells