OILFIELD TECHNOLOGY

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HIGH PERFORMANCE CHEMISTRY

Shahnoz Hamidi, BWA Water Additives, USA, explores new scale inhibition chemistry that gives operators better options for difficult-to-treat, HPHT environments.

In the business of recovering oil and gas and keeping wells producing at high yield, scale is a dreaded and unwanted obstacle. Speciality chemicals such as polymeric scale inhibitors play an important role in removing such obstacles and prolonging the producing life of an oilfield. Choosing the right speciality polymer to prevent the build-up of topside scale and to inhibit the formation of scales downhole can mean all the difference between uninterrupted well production and prolonging the need for squeeze treatment.

As more wells are being drilled at greater depths, higher temperatures and higher pressures are being encountered. In these harsh environments, typical low cost scale control agents such as phosphonates functionally fail, as they cannot withstand such high temperatures and high pressures. Additionally, in a HPHT environment, the rate of inorganic scale formation increases greatly, thus exceeding the typical performance profile of phosphonates and requiring high performance scale inhibitors that can control not only common scale species like barium sulfate and calcium carbonate, but also iron and difficult to remove scales such as lead sulfide and zinc sulfide.

Further complicating the choice of scale inhibitor options is that some operators now practice corporate sustainability and seek to use more products that have less of an environmental impact. Still, those operators which are not routinely practicing corporate sustainability may in fact be driven by regulations that have developed limiting the use of certain chemistries based on their profile of environmental persistence, bioaccumulation and toxicity. In the North Sea, for example, UK and EU operators tend to adopt the requirements of the Convention for the Protection of the Marine Environment of the North-East Atlantic, also known as the OSPAR Convention. The result is that operators in the North Sea are often concerned about the environmental profile of chemical treatments, particularly biodegradability. Many traditionally used phosphonates fail to exhibit the improved biodegradation, bioaccumulation and toxicity profile sought by the OSPAR Convention, and the typical alternative biodegradable polymers, such as polyasparate (PASP), fail in HPHT environments, leaving operators without a good high performance, biodegradable scale inhibitor option.

A new antiscalant

In response to these regulations and the general industry need for high performance scale inhibitors that work under HPHT conditions, BWA Water Additives has developed Bellasol® S65, a biodegradable antiscalant effective for both barium sulfate and calcium carbonate scale inhibition and hydrothermally stable to 180 ˚C at pH 12. The biodegradable maleic polymer (BMP) chemistry of the antiscalant meets the highest OSPAR standards ('Gold' in the UK/Netherlands and 'Yellow' in Norway). As per the Organization of Economic Cooperation and Development (OECD) Test 306 standard, BMP biodegrades to 70.2% in 28 days. This antiscalant is also compatible with other oilfield additives and is not weakened by the presence of oxidisers used at normal biocide dosages.

Although this antiscalant was developed with the goal of achieving high levels of biodegradability, it has been found that oil and gas companies are choosing it purely for its performance profile. As an example, Figure 1, which depicts dynamic tube blocking tests that simulate actual oilfield conditions that are more severe than typical static jar tests, shows that the antiscalant outperforms PASP for calcium carbonate inhibition even at lower dosages than PASP. When dosed at 4.0 ppm and 2.5 ppm, PASP fails in under 30 and 60 min. respectively, as evidenced by a change in pressure of ≥1 psi. This new antiscalant, however, continues to inhibit calcium carbonate even after two hours.

Likewise, it also outperforms traditionally used phosphonates such as deta-phosphonate (DETAP). Figure 2 depicts dynamic tube block tests for barium sulfate inhibition based on synthetic brine waters described in Table 1. In such dynamic tests, a tube is pre-scaled for a given period, then each scale inhibitor applied is tested for its ability to further inhibit scale.

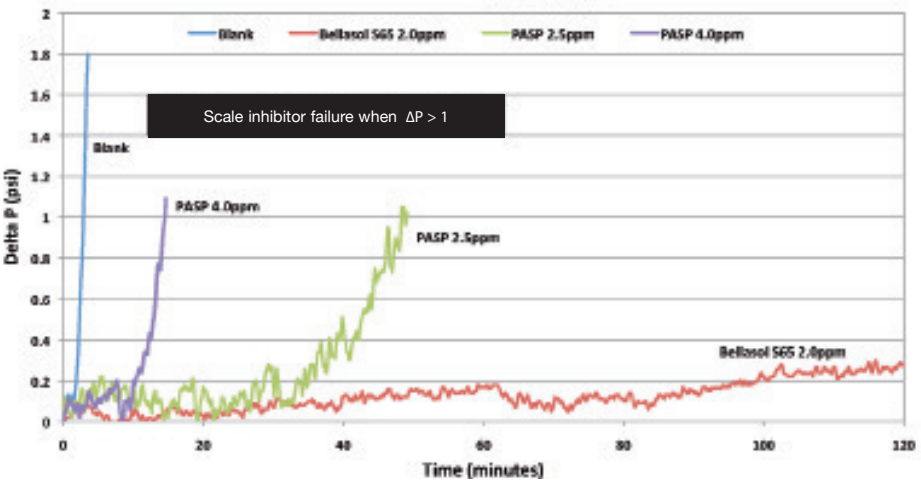

Figure 1. Brent water $CaCO_3$ dynamic tube blocking test: dosed as solids.

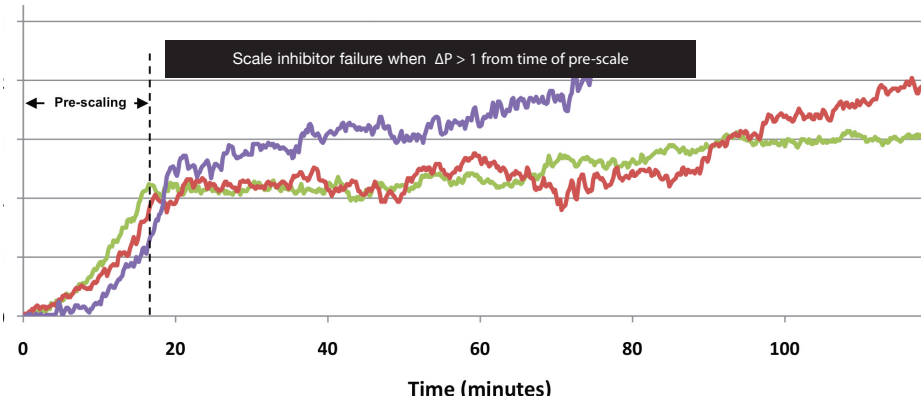

Figure 2. $BaSO_4$ dynamic tube blocking test: dosed as solids.

Table 1. Synthetic brine for $BaSO_4$ test.

Ion	mg/l
Ba^{2+}	120
SO_4^{2-}	530
Ca^{2+}	636
Mg^{2+}	634
Na^{+}	15 004
Cl^{-}	26 338
K^{+}	446
Sr^{2+}	190
$CH_3CO_2^{-}$	1015
TDS	43 898
pH	5.5

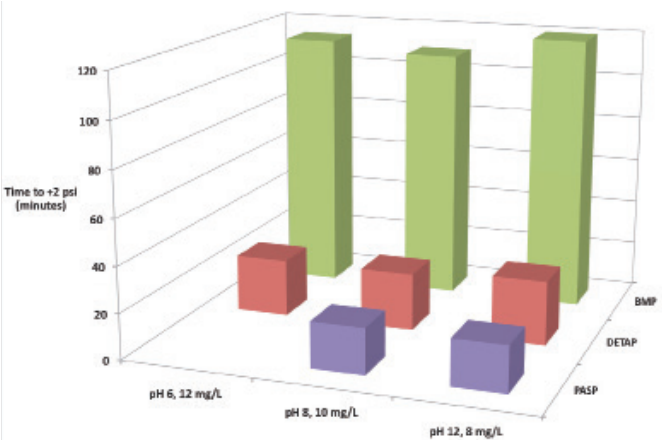

Figure 3. Hydrothermal stability profiles after seven days ageing at 200 ˚C.

Scale inhibitor failure is determined by a change of pressure equal to 1 psi in the dynamic system. Figure 2 shows that at the same dosages, PASP fails in under two hours, DETAP fails at two hours, yet Bellasol S65 continues to inhibit barium sulfate scale well beyond two hours.

Equally impressive as its ability to outperform typical phosphonates and other biodegradable scale inhibitors is the ability of Bellasol S65 to withstand extreme high temperatures. This is important because scale inhibitors used in squeeze treatments must withstand reservoir conditions for extended periods of time, typically 12 to 18 months or longer. If a polymer is not hydrothermally stable, its scale inhibition performance will start to fail. In Figure 3, the hydrothermal stability profiles of BMP (Bellasol S65) are compared to PASP and DETAP when held for extended period at 200 ˚C in a worst case scenario of a solution phase rather than the typical field scenario of adsorbed onto rock. While PASP and DETAP fail hydrothermal stability in 40 min or less, Bellasol S65 remains hydrothermally stable for nearly two hours.

Conclusion

Oil and gas operators continue to face more extreme environments of higher temperature and higher pressures which make for difficult-to-treat scale conditions. The typical scale inhibitors that could solve such problems are not always fit for such extreme environments. Additionally, traditional scale inhibitors may not meet certain environmental standards, thus limiting the operator's options.

The new all-organic, phosphorus-free BMP addresses the operator's dual requirements of both high performance chemistry and reduced environmental impact. Specifically, BMP has been designed to offer:

- Improved carbonate and sulfate scale inhibition compared to existing phosphonate and polyaspartate based scale inhibitors.
- Resistance to thermal ageing compared to existing phosphonate and polyaspartate based scale inhibitors.
- Detectability in brine solutions to the 1 ppm level.
- Biodegradability meeting the highest tier of OECD/OSPAR standards.