High-Slurry, High-Temperature Antiscalant for Extreme Ore Processing Conditions

An Article by Solenis
The formation and deposition of scale can present significant challenges for ore processing operators. Use of reclaimed water, processing ore bodies that produce significant amounts of soluble hard water ions and salts, and the challenges of high temperature and high-suspended solids can make scaling especially difficult to control. Excessive scaling causes many mining circuits to experience frequent shut downs and production interruptions. The negative impact on mine revenue and operating profit is significant. Additionally, scale can lead to safety hazards. Traditional commercial antiscalant chemistries are ineffective under extreme process conditions. In some situations, mine operators would not even consider chemical solutions due to the severity of the process conditions. Process re-engineering to minimize the impact of severe scaling often requires a significant capital investment. However, future process changes can render the re-engineering obsolete or ineffective. Clearly, a new solution was needed.

Using a methodical, customer-oriented approach, our Mining R&D, Applications, and Field Service teams worked closely with multiple global mine operators to operationally, financially and environmentally understand and address these harsh scaling issues. As a result, Zalta™ MA11-556 antiscalant product was developed and validated under extreme scaling conditions, including high gypsum supersaturation in water, high temperature and high-suspended solids.

The results of our product design methodology, laboratory evaluation, and successful field validation are summarized in this paper.

**Product Design Methodology**

Antiscalant product development was based on laboratory methodology. See Table 1.

<table>
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<tr>
<th>Problem</th>
<th>Approach</th>
<th>Solution</th>
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<tr>
<td>High gypsum super saturation, via instant water evaporation</td>
<td>1. Analyze process water fed to quench circuit, scale deposit and slurry sample taken directly from process circuit within the scaling section</td>
<td>• Scale inhibition via new deposition inhibition method with substrate of choice (SS, Copper Alloy, HDPE, etc.) and threshold inhibition</td>
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<td>High temp up to 300 °C for a short time, dropping within few mins to about 60 °C</td>
<td>2. Analyze scale and slurry solid phase samples via X-ray diffraction to look directly at scale sample, rather than elements</td>
<td>• T shock inhibitor stability test in water with subsequent scale inhibition testing at lower T</td>
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<td>High ore amount suspended in water, 20 wt% and higher</td>
<td>3. Mimic water is reconstructed with total mass balance of soluble/insoluble fractions and precise type of scale(s) identified</td>
<td>• High suspended solids impact using deposition and threshold inhibition tests in slurry</td>
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<td>Refractory ore high in sulfides, post oxidized + lime water mixed together → ore slurry in quench circuit</td>
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Table 1. Summary of one application example
Laboratory Validation

The laboratory approach proved to be successful while mimicking critical application conditions using harsher laboratory conditions compared to field conditions (i.e., if the product could effectively treat laboratory conditions, it would work in the field.) Using this methodology, extensive laboratory evaluation was conducted that included new test method development, evaluation of more than 60 existing and new antiscalant formulations, and field validation methodologies. Laboratory work was supported by two field trials. The laboratory test results for deposition inhibition, scale quantified by mass and visual appearance, are shown in Figure 1.

![Figure 1. Scale Quantification – Mass & Visual / 316 SS Jar Deposition Test - Top View](image)

Potential product formulations were first screened using the deposition inhibition testing shown in Figure 1. Scale deposit is visually noticeable in those pictures and is maximum for the Blank, minimum for Best Product. Leading candidates were further tested using heat shock conditions to replicate the high process temperature. Top product candidates were then tested in stressed, high-suspended slurry conditions resulting in a single product selection with superior scale inhibition performance, as shown in Figure 2.

![Figure 2. Gypsum scale inhibition in 15% gold ore Slurry: new product vs existing chemistries](image)
Field Validation – Example 1

Field validation with Zalta MA11-556 showed an 80% decrease in cleaning and shutdown frequency that was provided by:

- a 70% reduction in scale formation compared to a 50% reduction target,
- a reduction in scale deposition onto the quench tank and piping surfaces, and
- the formation of a significantly more brittle, easily removable scale that was up to 60% less dense than the scale formed during untreated operation

The following examples from the field validation that illustrate these results are shown below.

![Scale for a blank](image1)
![Scale with inhibitor](image2)

The total weight of the coupon in the untreated blank conditions was 35.2 lb. The total weight of the coupon in the inhibitor treated conditions was 6.3 lb. In addition, the volume of each coupon with adhered scale indicates that the scale for inhibitor treated conditions is 60% less dense than the scale for the untreated blank conditions.

**Figure 3. Coupons – Blank and with inhibitor added.** Note the dramatic difference in coupon scale volume and density.
Seal Tank 1 feed pipe – treated, easy to break apart scale, less total deposit, 5% obstruction of flow after 6 weeks

Seal Tank 3 feed pipe – untreated, hard to break apart scale, more total deposit, 40% obstruction of flow after 6 weeks

Figure 4. Seal Tank Pipe Comparison / 8 times less flow obstruction vs untreated

Field Validation – Example 2
In another mining example, the same methodology and new antiscalant product have been successfully applied to prevent gypsum scaling in a high temperature, very high slurry content process pipelines, resulting in significant total cost savings in metal production and pipe cleaning.

Treated after 5 months
Untreated after 2.5 months

Figure 5. Slurry pipeline comparison

After a trial that lasted more than five months, the inspected pipes showed minimal to no scale deposition as compared to a blank/untreated pipe that was almost completely blocked with scale after only two and a half months.

Summary
Solenis’ Mining R&D and Applications teams combined new methodologies with product development and targeted field validation to launch a new and effective antiscalant for high slurry, high temperature conditions. This product changed mine operators’ perceptions of just how effective antiscalant chemistries can be. Additionally, Zalta MA11-556, has no P and Cl ions that could negatively affect downstream unit operations or the environment.