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Volatile Corrosion Inhibition Mechanisms for Top of The Line Mitigation – A Guideline for Volatile Corrosion Inhibitor Selection

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Abstract

Top of the line corrosion (TLC) is one of the main corrosion issues in hot & wet gas pipeline i.e. in Gulf of Thailand. Volatile Corrosion Inhibitors (VCI) have been developed to mitigate TLC instead of corrosion inhibitor batch treatment. They are available in different forms of chemical formulations, leading to different TLC protection mechanisms. This work aims to compare the efficiency of VCIs with different TLC protection mechanisms. In addition, secondary properties of VCIs have been tested to support the selection of appropriate VCIs based on limitations of each field.

Literature reviews on possible mechanisms of corrosion mitigation through various VCI agents were initially performed. Then, four different VCI formulations denoted as VCI formulation A, B, C and D were characterized thoroughly to understand their inhibitor mechanism(s) and secondary properties (i.e. TAN, volatility) followed by TLC efficiency test in simulated gas-pipeline conditions. The screening test on volatility of the VCIs was undertaken by weight loss measurement. pH and TAN were assessed by a universal pH paper and an automated TAN analyzer according to ASTM D 664, respectively. Bottom of the line corrosion (BLC) rate was determined by an LPR test.

Four VCIs were selected based on their major compositions which could be divided into two different groups based on the dominant inhibition mechanism for TLC mitigation. Group I of VCI A and B relies on one or more chemical substance(s) that can easily vaporize, transport and form a protective inhibitor film onto the metal surface in the space, enabling the corrosion mitigation by absorption, dissolution and hydrophobic effects on the metal surface. Group II of VCI C and D can reduce the corrosion rate by a combination of carbon dioxide scavenger(s) and a colligative property related to vapor pressure lowering. The experimental results obviously exhibited the differences in volatility and TAN value between those two VCI groups. The VCI Group I had a % weight loss in 3-day experiment almost double compared to the VCI Group II. While the TAN of Group II was almost nil, Group I was approximately 40-70 mg KOH/g. Nevertheless, the TOL corrosion protection efficiency of both groups was similar i.e. in the range of 95-99% while BLC corrosion protection for Group II was slightly higher i.e. 80-90% Vs > 90%.

Different approaches for TLC mechanisms are presented as a guideline to select and/or development of a promising VCI most suitable for different field conditions. VCI group I with very high volatility by nature, there are some concerns on low thermal stability and low inhibition efficiency when using with high operating temperature. Especially when TAN is strictly controlled, VCI Group II would be more applicable to minimize operational issues.