H_2S Scavenger Laboratory Methodology, Performance Data, and the Development of Combination Products

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INTRODUCTION

Offshore sour gas can be highly toxic and contain sulfur-containing impurities that reduce natural gas quality. Hydrogen sulfide (H_2S) is generally the constituent that is the main cause of these issues along with leading to fouling due to corrosion. The reduction or elimination of H_2S via chemical scavengers has long been a relatively low-capital means of effectively treating oil and gas production. Laboratory tests were designed to incorporate the major influences and allow the screening of scavenger products for field implementation. A test method was used to compare the performance of standard commercial products with the goal of developing a stand-alone product and then a combination of products varying in functionality.

METHODOLOGY

Measured by mass flow meters, sour gas is dispersed through a metal tube immersed in the test fluid. The apparatus is primarily made of Hastelloy construction with a temperature and pressure rating of 260 ^oC and 11 MPa. 70 % of the vessel capacity is a liquid phase, with the fluid comprised of organic phase and/or brine. Gas constantly flows under pressure and temperature and the liquid phase is mixed at 1,000 rpm. The outlet concentration of H_2S is continuously measured by gas chromatography coupled with a thermal conductivity detector (TCD). The system is to reach a steady-state condition before an aliquot of the product to be tested is introduced into the vessel via an injection pump. The concentration of H_2S is then measured until it reaches the baseline saturation. The decline in H_2S from the input concentration measures the product´s ability to scavenge and is represented in a graph of H_2S mol% versus time. This method was based on work conducted by A. Bonfim and A. Magalhães[1,2].

The test conditions for the method were as per Table 1, with a gas flow of 600 mL/min of 3.2 % H_2S in CO_2. All of the products were tested at 1,000 ppmv.

Table 1 - Test Parameters

Test Condition	1	2	3
Water (%)	70	30	0
Temperature (^oC)	70	100	100
Pressure (psig)	150	150	150

RESULTS

The preferred H_2S scavenger chemistry was a non-nitrogen, glycol hemi-formal named ethylenedioxydimethanol (EDDM). A formulated product, A, was tested under all three conditions and the graphical results are presented in Figure 1.

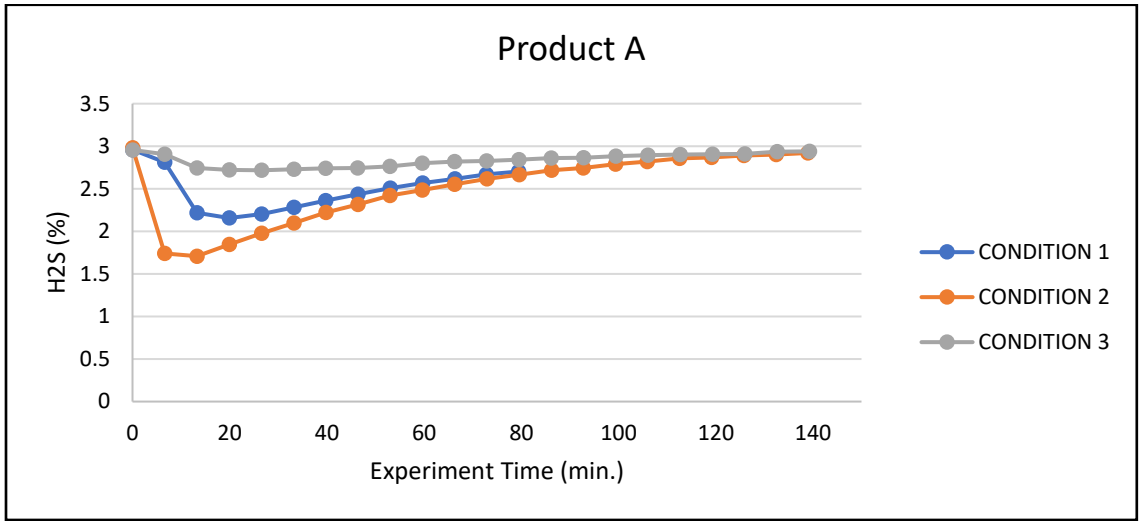

Figure 1 - Graph of Outlet H_2S Concentration Versus Experimental Time for Product A

The results show that the combined increase in the composition of the organic phase and temperature provides the most effective scavenging performance, as evidenced by the lowest drop in the H_2S concentration of the three test conditions. It was determined that test condition 3 was the most challenging and, thus, was used as the qualifying condition for the development work. Figure 2 illustrates the performance of blends of EDDM with different solvents and in a combination product with 3,3'-methylenebis[5-methyloxazolidine] (MBO).

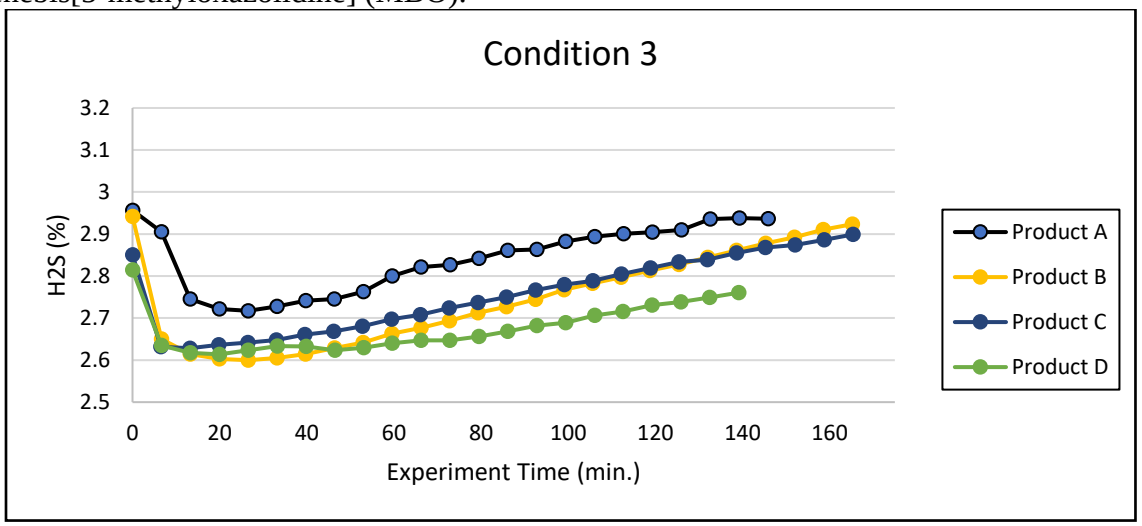

Figure 2 - Graph of H_2S Concentration under Condition 3 for Various Formulations

Table 2 provides the product chemistries. The idea was to incorporate acceptable solvent chemistries and compare the performance of a combined scavenger blend. In all cases, the total scavenger concentration was the same.

Table 2 - Product Chemistry Composition

Product	EDDM	Simple Alcohols	Heavy Glycols	MBO	Ethylene Glycol
A	✓	✓	×	×	×
B	✓	×	✓	×	×
C	✓	×	✓	✓	×
D	✓	×	×	×	✓

CONCLUSIONS

Based on the evaluation of the base scavenger chemistry, EDDM, test condition 3 was used for the product development phase. Under this test condition, ethylene glycol shows the greatest potential to scavenge in the organic phase. Adding MBO to the heavy glycol formulation did not provide a marked change in scavenging performance compared to EDDM alone with heavy glycols.

REFERENCES

[1] Bonfim, A., "Avaliação de desempenho de sequestrantes de H2S em petróleo", Dissertação (Mestrado em Ciências em Engenharia Metalúrgica e de Materiais), Instituto Alberto Luiz Coimbra de Pós-Graduação e Pesquisa de Engenharia (COPPE), UFRJ, Rio de Janeiro, 2013.

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