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Hydrate Management: Parameters to consider for a progressive replacement of MEG by antiagglomerant

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Abstract

Hydrate management is a critical challenge in the oil and gas industry, where the formation of hydrate deposits can disrupt production and transportation systems. Monoethylene Glycol (MEG) has traditionally been used as a hydrate thermodynamic inhibitor, but its high operational costs and environmental impact have prompted the exploration of alternative solutions. This study investigates the use of antiagglomerants (Low Dosage Hydrate Inhibitors) as potential replacements for MEG. Laboratory tests were conducted to assess the hydrate inhibition performance of these LDHIs under varying conditions in a transition phase (from MEG to LDHI). Loop tests were performed to validate the slurry viscosity when LDHI is injected. The impact on process equipment (including separation units and MEG regeneration units (MRUs)) and water treatment (separation, biotreatment), was evaluated through lab tests. Notably, the results do not indicate any show stoppers for the transition from MEG to LDHIs. The economic benefits and reduced energy consumption, with LDHIs make them a promising solution for progressive MEG replacement in hydrate management strategies.

Keywords

Hydrate, MEG loop, Antiagglomerant

Introduction

In the oil and gas industry, hydrate management is a critical concern. Hydrates, also known as gas hydrates or clathrates, are ice-like crystalline structures formed when water molecules combine with natural gas components (such as methane, ethane, or propane) at low temperatures and high pressures. These solid deposits can accumulate in pipelines, flowlines, and equipment, leading to flow restrictions, increased pressure drops, and potential blockages. Another impact if this hydrate crystallization is the increase of the fluid viscosity.

Monoethylene glycol (MEG) has long been the go-to solution for hydrate inhibition. It effectively prevents the formation of hydrates by lowering the hydrate formation temperature. When injected into pipelines, MEG acts as a thermodynamic inhibitor, shifting the hydrate equilibrium conditions toward higher pressures and lower temperatures. However, MEG comes with a significant drawback: energy consumption, liquid loading in flowline cost. Recent field experiences have also highlighted hydrate formation on MEG lines [1]. In recent times, low-dosage hydrate inhibitors (LDHIs) have gained prominence. These inhibitors work differently from traditional thermodynamic inhibitors like MEG. A Low-Dosage Hydrate Inhibitors antiagglomerant (LDHI-AA) aims to limit the hydrates agglomeration. As a result, hydrate particles remain small, well-dispersed, and non-adherent. The transition from MEG to LDHI-AA represents a paradigm shift in hydrate inhibition strategies. However, these transitions phases are poorly documented. The objective of this paper is to assess the performances of 2 antiagglomerant, regarding the impact on subsea flowing (viscosity) and surface installations. Indeed, oil/water separation efficiency is a critical parameter during this transition, especially due to the possible impact of LDHI-AA on the emulsion [2].

The impact of LDHI-AA on MEG regeneration units is a key consideration. MEG regeneration units recover MEG from produced water, and LDHI-AA may affect their performance and the fouling of the heat exchanger. Water treatment becomes more complex during the transition since the antiagglomerant can bring additional organic pollution to the water. This become more important when the water is discharged to environment after treatment. The aim of this study is this to assess the interest of switching from MEG to antiagglomerant to mitigate hydrate, focusing on subsea impact (viscosity) and surface installations (separation, MRU, water treatment), during the transition phase.

Methodology

The methodology aims to assess the performances of the antiagglomerant and their impact on the surface installations of an existing gas field where replacement the substitution of the MEG loop per an antiagglomerant is envisaged (separation, MRU and water treatment).

Experimental Procedure

Antiagglomerant performances were assessed with a loop test where operational conditions were reproduced to mimic subsea conditions.

Loop tests were conducted on a loop with the following characteristics: 35 m long, 1" diameter. Flow and temperature were controlled, whereas pressure drops were measured along the flow loop to assess the viscoqity variation. Gas consumption (C1/C3 (98%/2%)) was measured to assess the hydrate formation.
100mL bottle tests were conducted at 2 water-cuts (30% and 70%) at XX°C. 100ppm demsulsifier was added to optimize the separation.
Water treatment tests were performed to mimic the treatment used to treat the produced water. Coagulation/separation step was reproduced at the lab scale, using the chemicals injected upstream each treatment step. Biodegradability of the fluid was assessed by measuring Chemical Oxygen Demand (COD) and Biological Oxygen Demand after 5 days (BOD5).

Chemicals & Fluids

2 antiagglomerants from 2 different suppliers were used to assess the performances and the impact. A demulsifier was specifically selected to improve the separation step.
Actual production chemicals were used in the lab to assess the impact on the surface installations (corrosion inhibitor, water treatment chemicals).

Results and Discussion

Antiagglomerant performances

Table 1 presents the relative viscosity as function of the water-cut and the concentration of antiagglomerant A.

Table 1. Flow loop viscosity – LDHI-AA-A

Antiagglomerant dosage	WC (%)	Relative Viscosity	Blockage
0%	5%	-	YES
1%	30%	<6	NO
3%	30%	<6	NO
1%	70%	<6	NO

Results point out that without an antiagglomerant, the flux is blocked due to hydrate formation. Flow loop results point out an important and rapid increase of the slurry viscosity inducing a blockage of the flow loop (high pressure trip). Adding antiagglomerant show that the relative viscosity of the slurry remains below 6 whatever the water-cut and the concentration of LDHI-AA-A. Same results were obtained with LDHI-AA-B. these results show that the LDHI-AA allow a dispersion of hydrate in the organic fluid.

Impact of antiagglomerant on MRU

Tests point out there is no reverse effect of the antiagglomerant in the water phase. Indeed heating and evaporating water/MEG solution containing LDHI-AA does not lead to the formation of deposit or any gunk.

Impact of antiagglomerant on separation

Figures 1 to 3 present the evolution of several phases water (blue), emulsion (red) and condensate (green) as function of the time, without AA) (Fig.1), with 1% AA-A (Fig.2) and 1% AA-B(Fig.3). All tests were performed with a demulsifier injection.

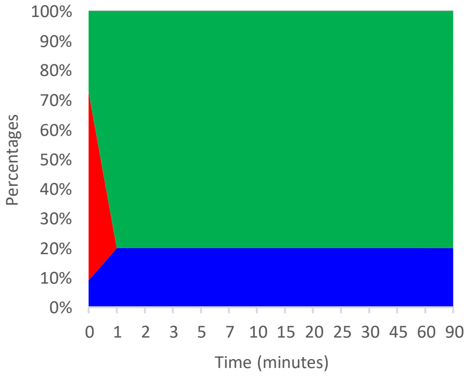

Figure 1. Separation Blank test (30% WC)

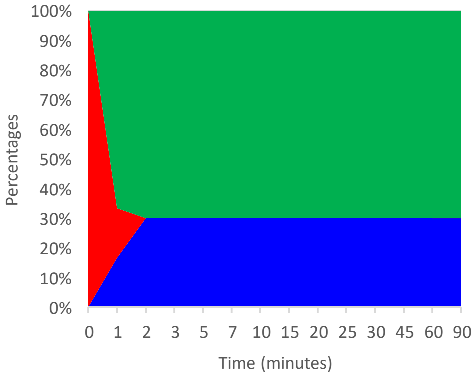

Figure 2. Separation with LDHI-AA-A @1% (30% WC)

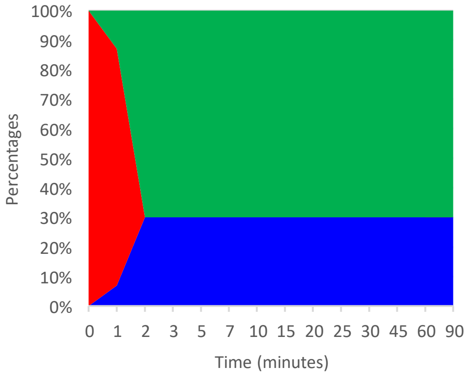

Figure 3. Separation with LDHI-AA-B @1% (30% WC)

When adding an antiagglomerant, separation efficiency is decreased. However, water and condensate phases are recovered after less than 3 minutes. Without antiagglomerant, emulsion was not stable and very difficult to maintain 30% water-cut. Tests performed without demulsifier show longer time to obtain the same separation efficiency. Results point out the necessity to add a proper demulsifier to ensure condensate/water separation.

Impact of antiagglomerant on water treatment

Table 2 presents the water characterization after coagulation / flocculation and settling for a flux containing 30% water-cut (standard methos were used to determine Chemical Oxygen Demand (COD), Biological Oxygen Demand after 5 days (BOD5)).

Table 2. Water characterization (30% water cut)

AA	COD mg O2/L	BOD5 mgO2/L	BOD5/COD
0%	365	189	0,52
A-1%	1990	540	0,27
A-3%	3590	740	0,21
B-1%	4112	1270	0,31
B-3%	11500	3290	0,29

Results indicate that adding an antiagglomerant is impacting the COD and the BOD5. LDHI-AA-B has a greater impact on the COD and BOD. For both AA, increasing the concentration from 1% to 3% is increasing the COD and BOD. BOD5/COD ratio is characterizing the biodegradability of the water. Results indicate that without antiagglomerant BOD5/COD = 0,52, representing a readily biodegradable water (BOD5/COD >0,3 = readily biodegradable; 0,3 > BOD5/COD > 0,2 = medium biodegradable; 0,2 > BOD5/COD = non-biodegradable). Adding antiagglomerant is reducing the water biodegradability. Even if COD and BOD are higher with antiagglomerant, analysis point out that the water is more biodegradable and could be accepted by the biological water treatment. Results at 70% water-cut confirm the conclusions obtained at 30% water-cut.

Conclusions

In this study, the effects of anti-agglomerants on slurry viscosity and surface installations were investigated (focusing on separation, MEG Regeneration Unit and water treatment). Despite the challenges posed by their implementation, the results are promising since no showstopper were pointed out. However, a demulsifier shall be selected and injected upstream the separation. Furthermore, the organic load on the biotreatment will increase with a slight decrease of the biodegradability. Thus a particular attention shall be paid to the water treatment system.

Moving forward, field trials will provide valuable insights into the practical implications of anti-agglomerant usage, allowing for informed decision-making during process optimization and scale-up.

Responsibility Notice

The authors are the only responsible for the paper content.

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