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HYDRATE MITIGATION FOR DEEP WATER AND LONG DISTANCE PIPELINE – FLOW ASSURANCE APPROACH

MITIGASI HIDRAT UNTUK JALUR PIPA LAUT DALAM DAN JARAK JAUH – PENDEKATAN *FLOW ASSURANCE*

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ABSTRAK

Keberadaan gas hidrat dalam industry produksi minyak dan gas bumi telah dikenal dengan baik, komponen dari gas hidrat didominasi oleh gas methan dan umumnya terdapat di sedimen laut dalam. Walaupun gas hidrat dapat dikategorikan sebagai potensial sumber hidrokarbon yang baik dan juga sebagai sarana penyimpanan gas alam, secara umum keberadaan hidrat dianggap sebagai masalah bagi operasional dan keamanan produksi. Hidrat dapat terbentuk dalam kondisi tekanan dan temperature yang dapat ditemukan pada gas alam dan pipa minyak serta dapat memyebabkan sumbatan khususnya ketika temperature turun dengan signifikan seperti ketika menutup sumur atau aliran gas yang melewati katup. Hal ini dapat menyebabkan potensi bahaya yang serius untuk peralatan ataupun pekerja di industry produksi minyak dan gas bumi. Selain dari variasi dari gas rate untuk menghindari pembentukan hidrat, saat ini terdapat dua metode yang telah banyak digunakan untuk pencegahan terbentuknya hidrat pada pipa produksi yaitu menggunakan insulasi thermal dan juga chemical inhibitor. Setiap metode memiliki keuntungannya masing-masing. Perangkat lunak PIPESIM adalah aplikasi yang dapat digunakan untuk mengevaluasi kedua metode tersebut lalu digunakan untuk menentukan skenario terbaik manakah yang dapat digunakan berdasarkan pengeluaran paling rendah, waktu tersingkat dan kesulitan yang minimum.
Kata Kunci: *gas hidrat, mitigasi, inhibitor, pipa, lepas pantai*

ABSTRACT

The existence of gas hydrates is well known in the oil and gas production industry. The components are dominated by methane and naturally occur in deep marine sediment along continental margins. Although hydrates may be of potential benefit both as a hydrocarbon resource and as a mean of storing and transmitting natural gas, traditionally their presence is considered to be an operational and a safety problem. They can form at the pressures and temperatures found in natural gas and oil pipelines causing blockages, especially when temperature falls significantly, such as when closing in a well or flowing gas through a choke. This could deliver a serious potential problem for oil and gas offshore production either for its equipment or personnel. Besides the variation of gas rate to avoid hydrates forming, currently there are two methods that have been used widely to prevent hydrates formation in production pipelines - thermal insulation and chemical inhibitor. Each method has its own benefits. PIPESIM software application can be used to evaluate both mitigation methods and to then find which is the best scenario based on lowest cost, shortest period of application and less adversity.

Keywords: gas hydrate, mitigation, inhibitor, pipeline, offshore.

I. INTRODUCTION

Gas hydrates are one of the serious economic and safety problems in the petroleum industry during exploration, production, processing and transportation of natural gas and liquid. Pipelines and processing equipment can be blocked by their formation. These blockages reduce and stop flow potential leading to production loss or operational shut down. Formation of gas hydrates can take place during operation and shut in periods. Normally appearances of gas hydrates are under high pressure and low temperature conditions. The fluid compositions also affect its formation. These are the normal situation for seabed or cold climate wet gas or multiphase flow lines. Currently we are moving the exploration and production of petroleum into more extreme conditions. Hence, the problem of gas hydrates formation is more challenging. Many attempts have been made to solve this problem, including to protect against gas hydrates plugging.

II. BRIEF OVERVIEW

This part of this paper will discuss the subsea tieback design and the Figure 1 below which is the design arrangement for a single branch, subsea flowline system from the seabed through to the top side. The flowline has multiphase fluid from the wellhead to the process facility.

As we can see from the curve in Figure 2 the gas rate variation doesn't have any effect on avoiding operation condition for entering the hydrate region. Another possibility is to change the piping diameter in order to change the operating condition curve, as a drop in pressure along the pipeline could help to avoid hydrates.

Insulation for piping could make a difference in operating conditions, although this option should be implemented at the first stage of design and could increase CAPEX but will not make any additional cost during production. This option can only be applied to the environment that has a stable condition. Insulation works by maintaining fluid temperature above the hydrate zone

Table 1
Input Variable Summary

		Gas Rate (mmscf/d)	Insulation Thickness	Methanol (%bbl/bbl)	MEG (%bbl/bbl)	TEG (%bbl/bbl)
Initial Condition		60	0	0	0	0
Gas Rate Variation	*Case 1*	100	0	0	0	0
	Case 2	150	0	0	0	0
	Case3	200	0	0	0	0
Insulation Thickness Variation	*Case 4*	60	0.25	0	0	0
	Case 5	60	1.75	0	0	0
	Case 6	60	2.50	0	0	0
Methanol Variation	*Case 7*	60	0	1	0	0
	Case 8	60	0	3	0	0
	Case 9	60	0	5	0	0
MEG Variation	*Case 10*	60	0	0	1-4	0
	Case 11	60	0	0	5-10	0
	Case 12	60	0	0	11-14	0
TEG Variation	*Case 13*	60	0	0	0	3
	Case 14	60	0	0	0	5-20
	Case 15	60	0	0	0	22

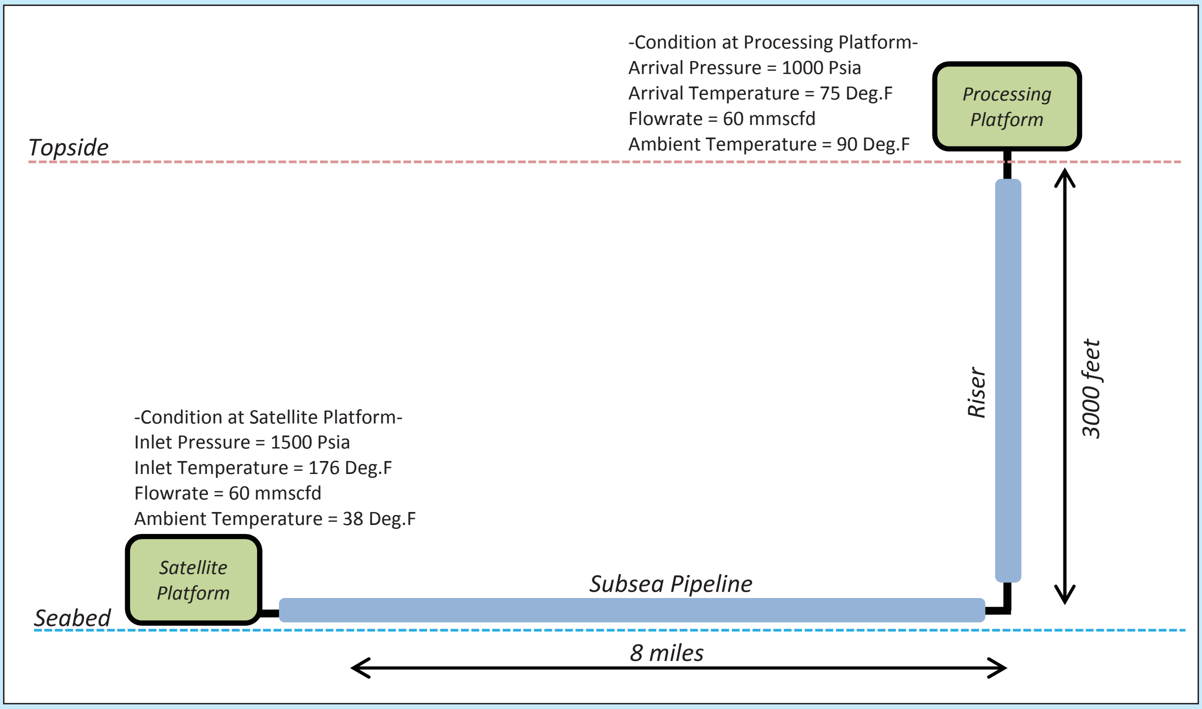

Figure 1
Subsea Tieback Design.

Effect of Insulation Thickness

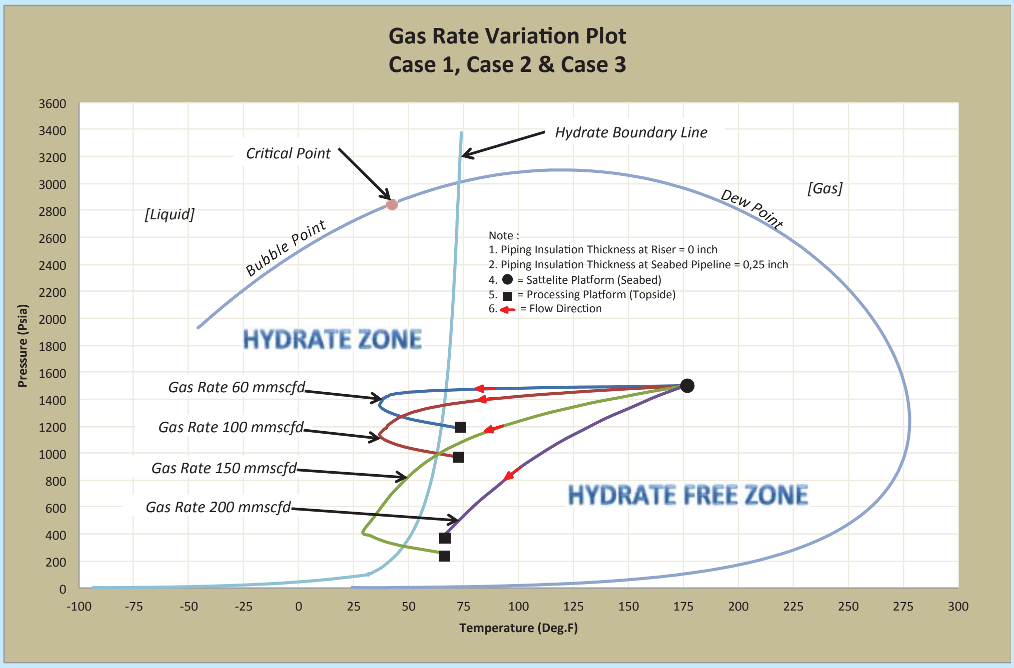

Figure 2
Gas Rate Variation Plot.

Effect of Gas Rate

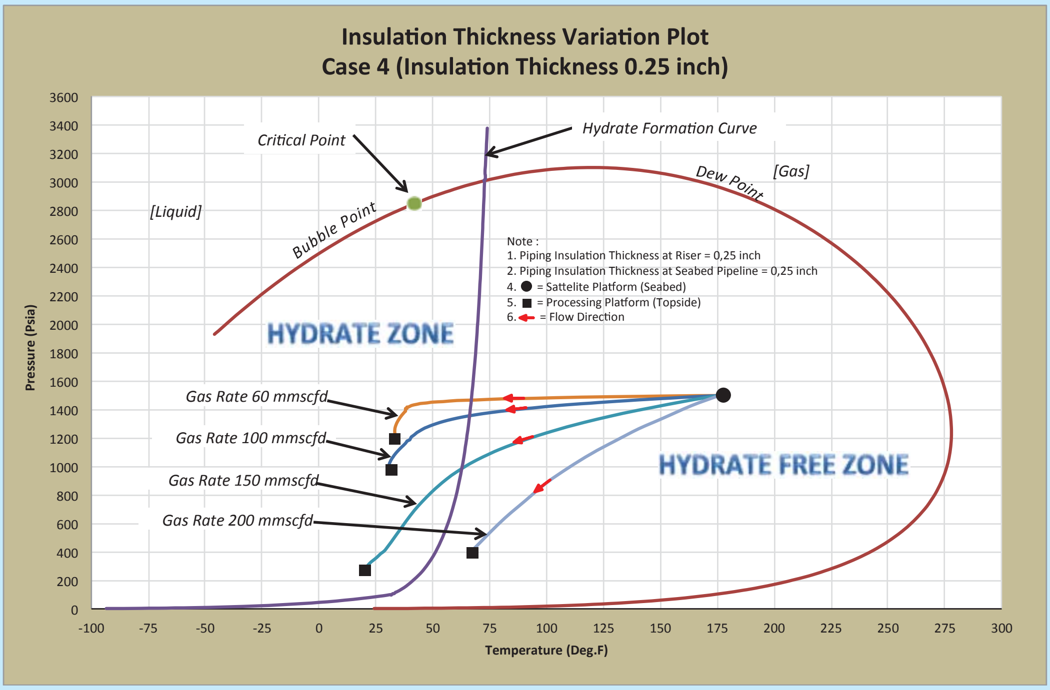

Figure 3
Insulation Thickness Variation Plot.

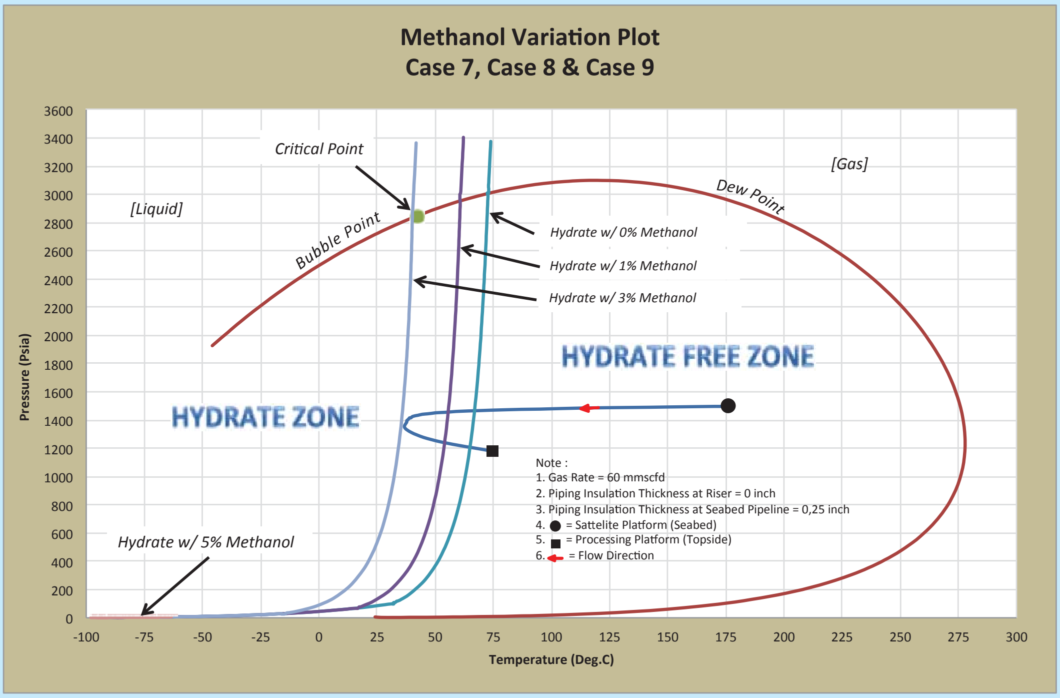

Figure 4
Methanol Variation Plot.

Effect of Mono Ethylene Glycol (MEG)

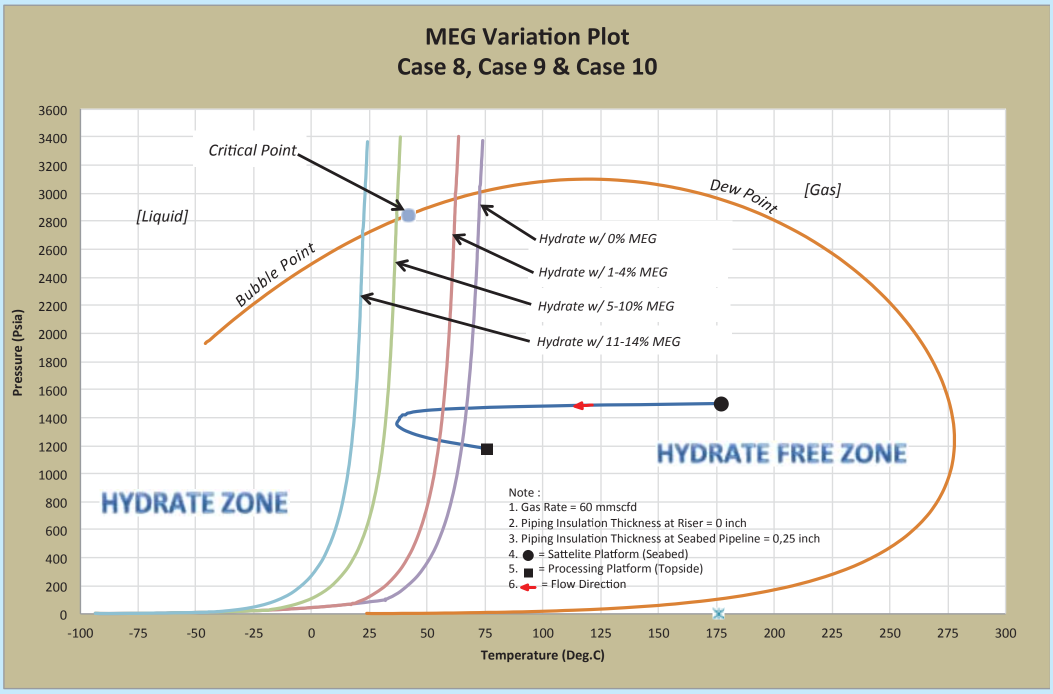

Figure 5
MEG Variation Plot.

Effect of Tri Ethylene Glycol (TEG)

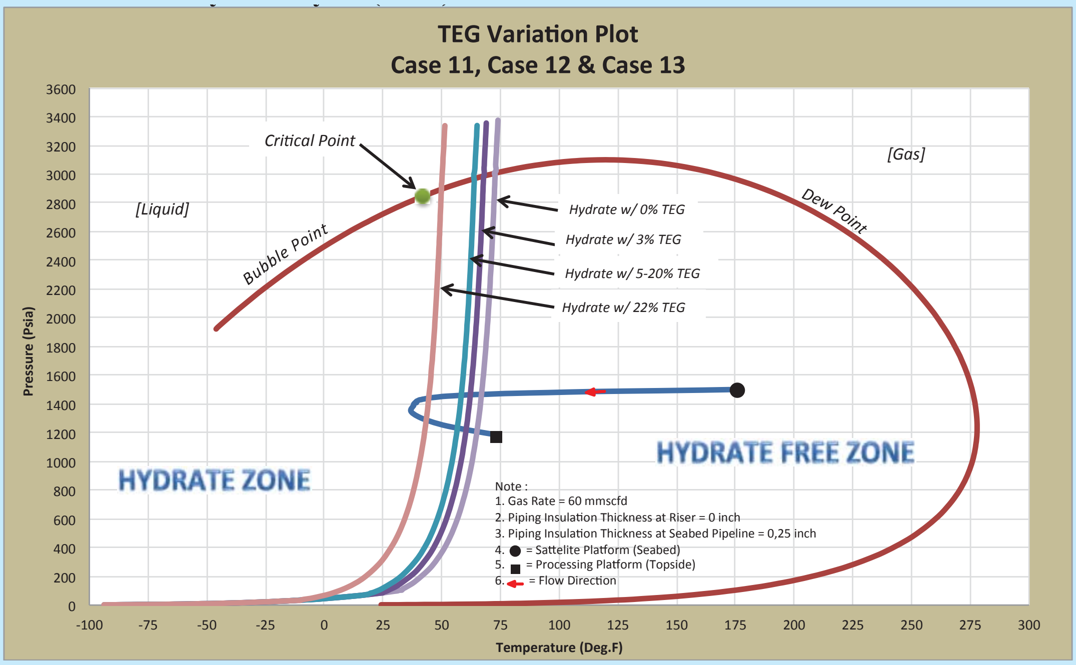

Figure 6
TEG Variation Plot.

Effect of Methanol

Methanol has a significant effect on hydrate. Using 5% can eliminate hydrate within this curve, but this 5% level would represent over use because 3% of methanol is enough to move the hydrate curve line away from operating condition.

The use of MEG has a better effect on the elimination of hydrate. The use of MEG composition

Comparison of Simulation Result

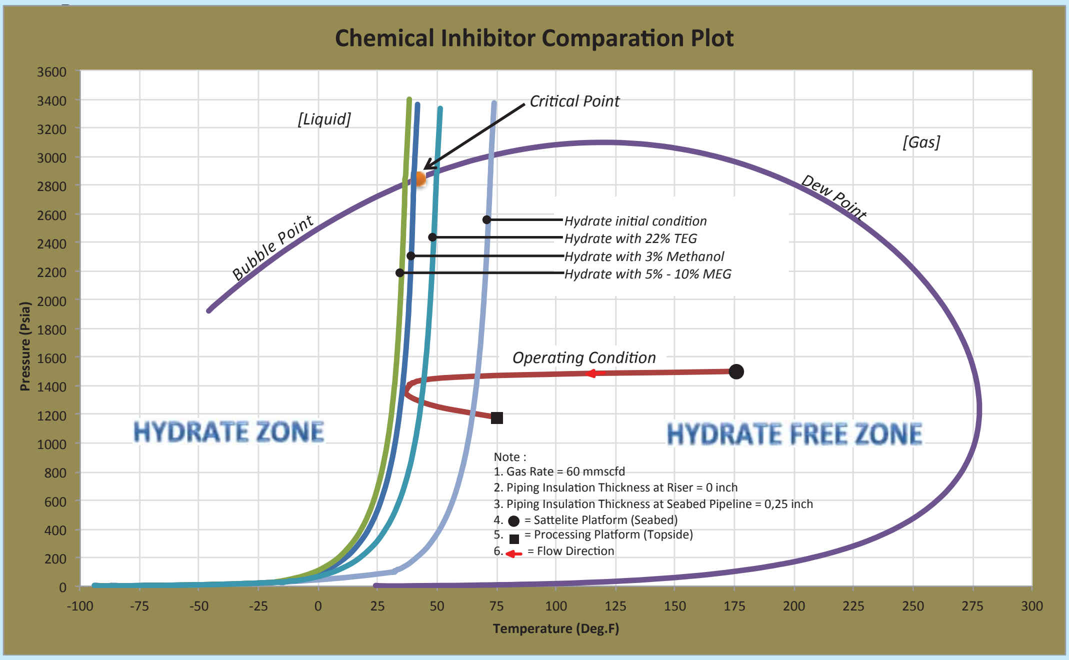

Figure 7
Chemical Inhibitor Comparison Plot.

Ambient Temperature Degradation

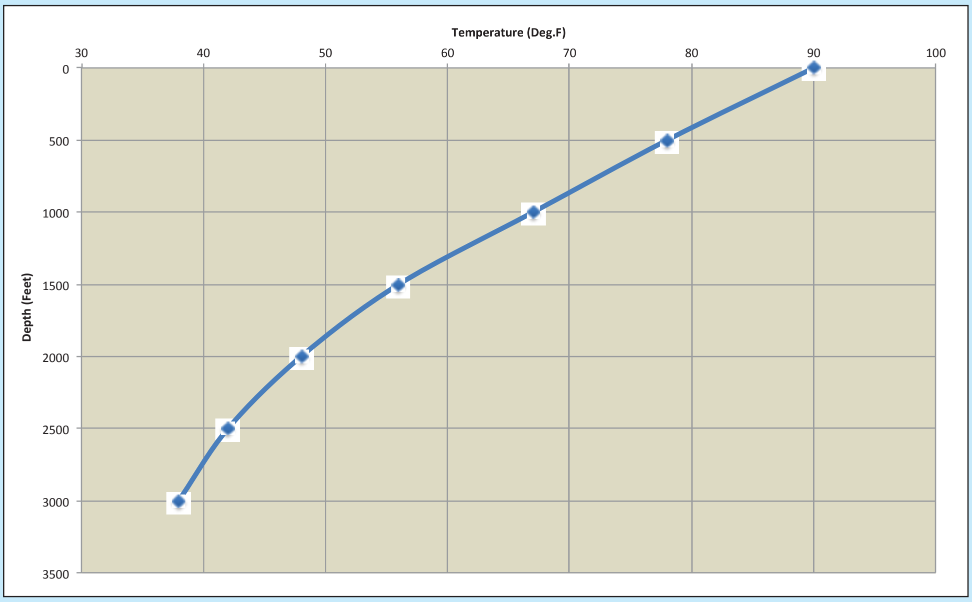

Figure 8
Temperature drop vs depth

of 3 - 10% has been shown to have a significant result in term of moving the hydrate curve. As we can see from the curve, MEG 11-14% move the hydrate curve further away from operating condition, but this percentage will not be considered to be used because the percentage 3-10% already is enough to move the hydrate curve away from operating condition.

TEG has less significant effect on hydrate compared to Methanol or MEG, and the use of 22% TEG is the maximum percentage that can be applied to the software. An experiment has already been done with 22.1% TEG but the curve output result has shown no hydrate being formed, this issue being suspected as the limitation function of this software.

Comparison plot has shown that MEG and Methanol has delivered a solution for hydrate mitigation. The hydrate effect from the use of 3% Methanol has slight difference with 5-10% MEG, it has show that the quantity use of Methanol and MEG to prevent hydrate almost equal, but the big difference will be coming from the cost and also the effect to the environment. The hazard of hydrate plug can be avoided by the use of chemical inhibitor without changing the gas rate.

The smooth line of temperature degradation against depth shown the temperature decreases at the deeper locations, this gradation is used at the riser pipeline from seabed to topside.

Cost Analysis

In order to analyze cost expenses for each method, below is the price rate;

a. Insulation price = $500,000 USD / Kilometer (Cameron, 2011)
b. Methanol Price = $375 USD / Metric Ton (ChemEXPO, July, 2015)
c. MEG Price = $1100 USD / Metric Ton (ChemEXPO, April, 2015)
d. TEG Price = $1450 USD / Metric Ton (ChemEXPO, July, 2015)

The overall piping length for this study is 8 miles, equal to 12.9 kilometers; therefore the piping insulation cost becomes $6,450,000 USD. The consideration of equal composition percentag volume being used for this case, therefore the price level per chemical price have already represent the use of chemical inhibitor.

III. CONCLUSION

Thermal insulation has a high CAPEX in advance; even though it's not affecting OPEX at the early operating but the environmental and well condition change during production can be the cause of additional OPEX.

Variations of gas rate could be more effective depending on natural gas composition. For this hypothetical data, the rate for deep-water condition should be kept at high level to prevent the hydrate plugging.

Of the three chemical inhibitors, the most effective method and lower cost is Methanol, but the hazard to the environment makes this chemical not easy to use and consequently it is the second option for hydrate mitigation.

MEG is the second best option for hydrate mitigation based on the experiment, even though MEG has a higher price and needs more percentage to prevent hydrate. But this option has a better solution to reduce cost and that is by using a reclamation process. The reclamation of MEG can reduce cost and the environmental impact compared to Methanol.

Recommendations

MEG reclamation is used to recover the MEG and water components from a MEG-water-salt mixture by contacting the mixture stream with a heated recycle stream of MEG. Both components are vaporized and subsequently separated by distillation. Salt accumulates in the concentrated recycle stream, crystallizes and is discharged from the process. MEG reclamation is unusual compared to other equipment used in gas processing. The use of MEG and MEG reclamation process is a better solution to prevent hydrate formation.

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