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# ASPHALTENE PRECIPITATION DUE TO PRESSURE DEPLETION IN UNDERSEA PIPELINES

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**Key Words:** Asphaltene precipitation, reservoirs, pipelines, solid model, pressure effects, temperature effects.

## Introduction

Crude oil is a complex mixture. It consists of four main hydrocarbon groups: saturated hydrocarbons, aromatics, resins and asphaltenes. Asphaltenes are defined as the crude oil fraction that precipitates upon the addition of an n-alkane (usually n-pentane or n-heptane) but remains soluble in toluene. Asphaltene precipitation and deposition is one of the most important problems in different stages of petroleum production. It causes the plugging of wellbore, pipelines and production equipments. To maintain the production of well and avoid pressure reduction due to asphaltene deposition, so many mechanical and chemical methods have been applied. These methods are expensive and need sufficient time; therefore it is better to find a condition to reduce possibility of asphaltene precipitation. There is a stable condition among asphaltene, resins and maltenes and it disturbs according to various changes in temperature, pressure or composition.

This work studies the asphaltene precipitation due to pressure depletion for a giant Iranian oil reservoir and through undersea pipelines. In this method the solid thermodynamic model presented by Nghiem et al. (1993) was utilized which was then tuned using the PVT data available for this oil reservoir. The model was able to simulate asphaltene precipitation in this reservoir under different production schemes. To study the effect of pressure depletion on asphaltene precipitation, solid molar volume was used as the most important matching parameter. Also, Interaction coefficient between precipitating components and light component was found to influence the amount of asphaltene precipitation especially below the saturation pressure.

## Thermodynamic Solid Model

As described before the solid model divided the oil to two separate phases:

**Solid Phase-** The precipitated asphaltene is introduced as a pure solid phase and the fugacity of this phase is:

$$\ln f_s = ln f_s^* + \frac{v_s(P-P^*)}{RT} \qquad (1)$$

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Where $f_s$ and $f_s^*$ are the fugacities of pure solid, P and $P^*$ are pressure and reference pressure (bar), $v_s$ is molar volume of pure asphaltene (L/mol), R is gas constant ($8.314472\times10^{-2}$) and T is the temperature (°K) respectively.

**Vapor and Liquid Phases**- These phases are modeled with an equation of state (EOS) and volume shift parameters. The fugacity of component i in phase j (j=0, g) is:

$$\ln f_{ij} = \ln f_{ij}^{eos} + \frac{s_i b_i P}{RT} \qquad i=1,\ldots, n_c;\ j=v,1 \qquad (2)$$

Where $f_{ij}$ and $f_{ij}^{eos}$ are the fugacity of component i in phase j with and without translation (bar), $s_i$ is the dimensionless volume shift parameter, $b_i$ is the equation of state parameter for component i respectively. The molar volume of phase j with volume shift is:

$$v_j = v_j^{eos} + \sum_{=1}^{n_c} y_{ij}\, s_i\, b_i \qquad j= v,\ 1 \qquad (3)$$

Where $v_j^{eos}$ is the EOS molar volume without volume shift.

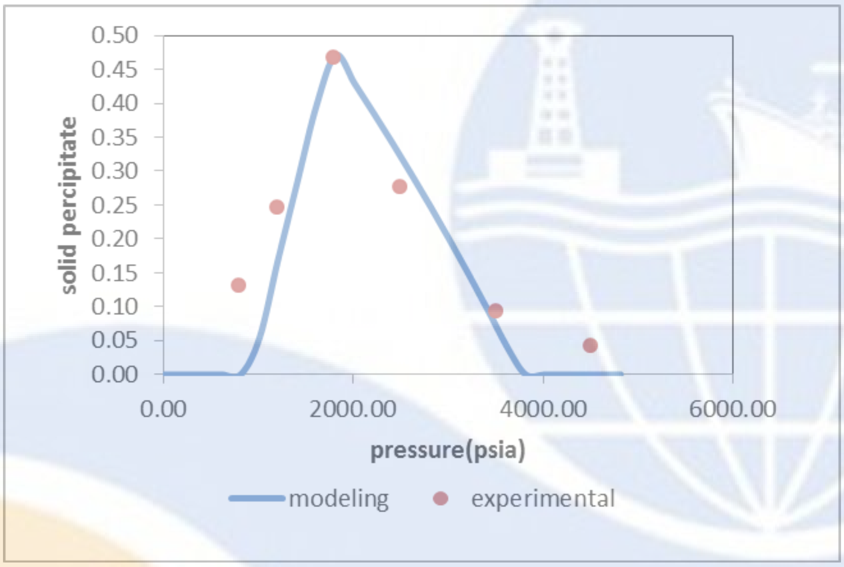


**Fig. 1 )asphaltene precipitation during natural pressure depletion in undersea pipeline.**

## Conclusion

The results showed that in pipelines as the pressure decreases the amount of asphaltene precipitation increases and it reach the maximum amount during the saturation pressure and it would lead to plug the pipeline or reduce the oil production at the end of pipeline.

To study the effect of temperature at 100F and 120F, for pressures below the saturation pressure when the temperature increases, the amount of asphaltene precipitation decreases however, an opposite behavior was observed for pressures above the saturation pressure. For the temperatures above 120F, there is a similar trend above and below saturation pressure and the amount of asphaltene precipitation decreases as the temperature decreases.

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