Study on Existence of Asphaltene Deposition in Deepwater Crude Oil Pipeline

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ABSTRACT

As the development of investigation on the deepwater oil-gas resources, it has become a controversial issue whether asphaltene deposition exists in deepwater oil pipelines. Based on the related researches, this paper studies on the main factors such as temperature, pressure and oil composition, causing asphaltene deposition, and theoretically infers the possibility of asphaltene deposition in deepwater oil pipelines; meanwhile, the subsequent deposition in pipelines is analyzed. The results indicate that it’s entirely possible for the considered deepwater pipeline system to meet the conditions of asphaltene deposition which is hardly controlled by fluid’s own flow.

KEY WORDS: deepwater submarine pipeline; analysis of cases; asphaltene deposition; study of existence; flow assurance.

NOMENCLATURE

$\delta_i$: the solubility parameter of the i component
$\delta_{mixture}$: the solubility parameter of the oil mixture system
$\delta_{asphaltene}$: the solubility parameter of the oil mixture system when the asphaltene deposition occurs
$\phi_i$: the volume fraction of the i component
$P_{M}$: the pressure at point M
LPM: the line pressure at manifold
PD: the pressure difference
WHD: the well head pressure

INTRODUCTION

Deepwater oilfields have become the leading potential regions among the newly developed oil and gas reservoirs all over the world, the development and utilization of the deepwater oil-gas resources are considered as an important strategy to implement the sustainable economic development and ensure the energy security by many countries. Malfunction occurs anywhere in the submarine oil pipeline can cause paralysis of the whole system due to its closed pipeline system. The asphaltene deposition in the wellbore has greatly influenced the oil production of onshore oilfield and will endanger the safe operation if it occurs in the submarine pipeline. Therefore, the existence of asphaltene deposition in the submarine pipeline system should be proved before any effective measure can be taken to prevent the damage by asphaltene deposition so as to ensure the normal operation of the submarine pipeline system.

Asphaltenes are known as insoluble in low molecular weight n-alkanes such as n-pentane and n-heptane, but soluble in benzene or toluene (Kawanaka et al., 1991). During the process of crude oil producing and transportation, asphaltene deposition has great effects on onshore oilfield, which mainly include wettability alteration, pipe flow area reduction, friction loss increase, pipeline blockage and efficiency of production equipment undermining (Andrew et al., 2001; Thou et al., 2002; Sunil et al., 1995; Maria and Chiaravallo, 2001; Hasket and Tarter, 1963; Guo et al., 2007). For example, an offshore oilfield in Alaska with an API of 32.5, had experienced serious asphaltene deposition problem that was found out at a depth of 6,000 meters using a gauge ring by the engineer during the wellbore examination in December 1998. Some oil wells from Prinos oilfield in North Aegean were blocked completely with asphaltene and then were forced to stop production within only a few days after production. The asphaltene content in crude oil of Venezuela Maria-Acem oilfield was between 0.4wt%~9.8wt%, which caused some of the wells to be blocked partially or completely by asphaltene deposition and the deposition problem was even exacerbated after acidizing the crude oil with a certain concentration of acid. The oil and gas output in Venezuela Lake Maracaibo oilfield was accounting for half of the nation’s total output, however, the crude’s API decreased from 40 to 30 due to the asphaltene aggregation, and the asphaltene content in crude was up to 10wt%, leading to a serious asphaltene deposition during production. More than 400 wells in Algeria Hassi Messaoud oilfield, whose crude oil had an API of 42.3, were found solid deposition containing 83.4wt% asphaltene in the wellbore at initial period of oil production from 1960~1963, which caused a wellhead pressure loss of 20%~25% and a great increase of oil output.

In order to reduce the influence of the asphaltene deposition on oil production, researchers have investigated the major factors of asphaltene deposition (Thou et al., 2002; Barker et al., 2007), which could be mainly divided into the internal and external factors. The internal factors consist of crude oil composition, miscible flooding, mixed transportation and etc. while the external factors include pressure, temperature, electric effect and etc. Thus, it is necessary to make an