Novel Application of SPI-2400 in Miscible Floods as a Preventative Measure for Asphaltenes Precipitation

The nature of asphaltenes and their role in the production and processing of crude oils has been the topic of numerous studies. This is due to the fact that the economics of oil production can be seriously affected by the asphaltene deposition problem. This paper presents a novel method to minimize or eliminate the problem of in situ asphaltene precipitation.

It was found that when small amounts (l%-3% by volume of solvent) of non-ionic surfactant with a C_{18} structure having the characteristic dimethylamide of an unsaturated fatty acid group as an active ingredient (SPI 2400) were added under reservoir conditions to rich solvent containing C_3, C_4 and to CO_2 the incipient precipitation was significantly shifted, so it will not occur under normal reservoir conditions.

Introduction

Miscible and immiscible flooding of crude oil reservoirs by light hydrocarbon gases, carbon dioxide and other injection gases has become a popular method for enhanced oil recovery. The flooding process, however, causes a number of changes in the flow and phase behavior of the reservoir fluids and can significantly alter rock flow properties. Such changes include the precipitation of asphaltenes and wettability reversal, which can alter recovery efficiencies. The existence of asphaltenes in crude oils and their deposition in the reservoir and well bores can cause severe problems and affect the efficiency and cost of petroleum production.

The important parameters that affect asphaltene precipitation during gas injection are the compositions of the crude oil and solvent gas, and the pressure and temperature of the reservoir. Precipitation of asphaltenes is a complex process and it is generally followed by flocculation, which produces an insoluble material in the oil. Asphaltenes are believed to be stabilized in solution by resins and aromatics and the asphaltene/resin ratio plays a key role in their precipitation. This ratio is more important than the absolute asphaltene content in determining which crude will be subject to precipitation.

Problems arising from asphaltene deposition have been reported in the literature for many field projects. Some examples of these are the Ventura field in California, the Massi Messaoud field in Algeria, heavy oil fields in Venezuela and the Mitsu and Rainbow Lake fields in Canada.

Deposition of asphaltenes in the well bore can be a serious production problem and may require frequent solvent washing and scraping to maintain oil production. Significant damage can be caused during well acidizing because the acid can cause the asphaltenes to precipitate and form rigid films. Other problems associated with asphaltenes precipitation are the seizure of downhole safety valves, submersible pumps, hinderance in wireline operations and production restrictions.

Presently asphaltenes are removed either by mechanical cleaning, chemical cleaning, or by manipulating reservoir conditions (for example: pressure, production rates, etc.). The approach taken by the oil industries has been a remedial one. The development of a more desirable alternative of preventing the problem has lagged due in part to a lack of understanding of the mechanisms involved in the asphaltene deposition process.

There are two different schools of thought as to the nature of asphaltenes in solution. One school of research considers the asphaltenes to be dissolved in the oil in a true liquid state, and may precipitate depending on the thermodynamic conditions of temperature, pressure and composition. Thus, asphaltene precipitation is considered to be a thermodynamically reversible process. Experimental results, however, have not categorically supported this point of view. The second school of research considers that the asphaltenes are solid particles, which are suspended colloidally in the crude oil and stabilized by large resin molecules. This makes the deposition process irreversible and theories used for colloids are utilized to describe the phenomenon.

The second theory has wider acceptance.

Claims

An economical and useful method of SPI-2400 addition (non-ionic surfactant with a C_{18} structure and a characteristic dimethylamide group) l%-3% by volume of solvent was investigated to prevent or reduce incipient solids precipitation.

The following are the findings of this investigation:

l. The addition of SPI-2400 to the solvent or CO_2 will suppress or negate asphaltene precipitation under reservoir conditions (depending on conditions, temperature and pressure).

2. The addition of SPI-2400 to the solvent or CO_2 will greatly reduce operating costs by eliminating or reducing the amount of money spent on work-overs and a production loss due to asphaltene plugging. For example, current operating expenses for one company due to asphaltene plugging in Rainbow Lake, Alberta are about $2,500,000 a year. The chemical cost to prevent the above problems will be about $700,000 a year.

3. The SPI-2400 (diamethylamide) was found to be much more effective and more economical in preventing asphaltene precipitation than Xylene.

4. A small addition of SPI-2400 to CO_2 improves the viscosity of CO_2. In homogeneous reservoirs increased viscosity will improve mobility and reduce fingering, which will result in better overall recovery.

A one per cent increase in the recovery of oil from Alberta reservoirs will add half a billion

barrels of proven recoverable reserves.