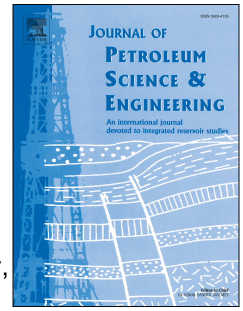
Accepted Manuscript



Physical modeling of the composite solvent injection to improve the ultra-viscous oil recovery efficiency steam-assisted gravity drainage

D.N. Borisov, D.I. Tazeev, D.V. Milordov, N.A. Mironov, Y.Y. Borisova, M.R. Yakubov, A.N. Beregovoy, M.I. Amerkhanov, R.S. Khisamov

PII: S0920-4105(18)30374-7

DOI: 10.1016/j.petrol.2018.04.077

Reference: PETROL 4957

To appear in: *Journal of Petroleum Science and Engineering*

Received Date: 25 October 2017

Revised Date: 7 March 2018

Accepted Date: 29 April 2018

Physical modeling of the composite solvent injection to improve the ultra-viscous oil recovery efficiency steam-assisted gravity drainage

D.N. Borisov [a,]*, D.I. Tazeev[a], D.V. Milordov[a], N.A. Mironov[a], Y.Y. Borisova[a], M.R. Yakubov[a], A.N. Beregovoy[b], M.I. Amerkhanov[c], R.S. Khisamov[c]

[a] *A.E. Arbuzov Institute of Organic and Physical Chemistry of Kazan Scientific Center of Russian Academy of Sciences, Kazan, Russian Federation*

[b] *TatNIPIneft R&D Institute of PJSC «TATNEFT», Bugulma, Russian Federation*

[c] *PJSC «TATNEFT», Almetyevsk, Russian Federation*

Correspondence to: A.E. Arbuzov Institute of Organic and Physical Chemistry of Kazan Scientific Center of Russian Academy of Sciences, Arbuzov st., 8, Kazan, Russian Federation, 420088

E-mail address: boriku@gmail.com

ABSTRACT

The experiments carried out on a physical model of reservoir of ultra-viscous oil have revealed features of oil displacement in various variants of the composite solvent and steam injection. In order to avoid precipitation of asphaltenes, the employment of inhibitors has been rationalized and their minimum fraction in displacement fluid has been determined. The effect of the sequence of solvent and vapor injection on the dynamics of ultra-viscous oil recovery has been investigated. The effect of clay and water in the rock on the rate of oil displacement and the ultimate oil recovery factor has been evaluated.

Keywords: ultra-viscous oil; heavy oil; solvent; reservoir modelling; thermal enhanced oil recovery techniques; steam-assisted gravity drainage.

1. Introduction

The global oil recovery from conventional oil fields decreases. More attention is devoted to hard-to-recover oil reserves including those of heavy and ultra-viscous oils (UVO) (Attanasi and Meyer, 2010; Meyer and Attanasi, 2007). Transition to the recovery of ultra-viscous oils is more significant in Canada, which possesses a large fraction of these global oil reserves. One example is that, in Western Canada (the Province of Saskatchewan), where nearly 2/3 of heavy oil of Canada are localized (5.4 milliards of tons of proved and possible reserves), 55 % of reserves are in reservoir that are less than 5 m in thickness (Dong et al., 2006; Srivastava et al., 1999). There are significant reserves of ultra-viscous oils in the Republic of Tatarstan, Russia (more than 1.4 milliards of tons), major part of which is related to the deposits of the Permian system. Ultra-viscous oil of the Ashal’chinskoe field (Tatarstan, Russia) is recovered using steam-assisted gravity drainage (SAGD) since 2006 (Ibatullin et al, 2009). The field possesses a complex structure represented by water-filled strata in uppermost and oil-saturated parts, clay strata, as well as the zones with the net oil pay of less than 10 m (Ibatullin et al, 2012). As reserves are recovered, the viscosity of Ashal’chinskoe oil increases, because more movable oil is firstly recovered followed by the oil with the higher viscosity with an increase in temperature