Evaluation Of Corrosion Inhibitor Properties Of Partially Hydrolyzed Polyacrylamide Solutions

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ABSTRACT

Partially hydrolyzed polyacrylamide (HPAM) is the most common range of viscosifying polymer used in chemical Enhanced Oil Recovery (EOR) applications. The scope of the study, developed in this paper, was to evaluate the change in uniform and/or localized corrosion behavior of carbon steel linked with the use of polymer. The different results made it clear that the use of viscosifying polymer always led to a significant decrease in corrosion rate, irrespective of the other parameters. This is a very positive point for application of polymer flooding, as it will not implicate any changes of material in the fields where this technology will be applied.

KEYWORDS

EOR, Polymer flooding, Polyacrylamide, Corrosion, Carbon steel.

INTRODUCTION

Fossil fuels currently supply more than 85% of world’s energy, and global energy demand and consumption is forecasted to go up rapidly over the next 20 years (Jamaloei B.Y, Kharrat R, Torabi F, 2011). Such demand can only be satisfied by sustaining the production of energy in existing fields. Therefore, Enhanced Oil Recovery from existing fields has become increasingly important. Polymer flooding is one of the most efficient EOR technologies that started as early as the late 1950s (Standnes D.C, Skjevrak I, 2014). Adding polymers increases the viscosity of the injected fluid downhole, which helps to push out viscous crude oil for better oil recovery (up to 10-15% over water flooding) (Standnes D.C, Skjevrak I, 2014; Taylor K.C, Nasr-El-Din H.A, 1998). Among them, Hydrolyzed polyacrylamide (HPAM) is gaining popularity in EOR: inexpensive, it can also withstand high mechanical forces during water flooding (Li C.Y, Zhang D, Li X.X, Mbadinga S.M, Yang S.Z, Liu J.F, Gu J.D, Mu B.Z, 2016; Wever D.A.Z, Picchioni F, Broekhuis A.A, 2011).

In the meantime, oil / water pipelines and flowlines are usually made of seamless carbon steel capable of transporting fluids at high temperatures and pressures. As regards the inside surface, although injection fluid is deoxygenated upstream, produced water or seawater used in EOR processes bring oxidants and nutrients (most notably carbon dioxide, hydrogen sulfide and sulfate) to a reservoir (G. Voordouw, 2011). This can lead respectively to conventional uniform corrosion as well as Microbiologically Influenced Corrosion (MIC) of steel pipes, and consequently degradation of their properties like mechanical strength or structural integrity. More broadly, seawater or produced water injection raise several issues. That is why this water is generally mixed with various additives: corrosion inhibitor, oxygen scavenger, biocide, and so on. It should be noted that MIC has not been investigated in this study.

THEORY

Literature Survey

Two lines of research have been investigated, namely:
- Polymer effects which were observed on corrosion phenomena,
- Testing methods of corrosion inhibitors, to validate the techniques and tests performed.

It appeared that the literature on polymer along with corrosion topics is rather rare. Most of the articles do not even tackle corrosion issues. Most of them refer to promising chemical flooding technology which shows better performance according to certain criteria – often physico-chemical criteria. In a similar way, quite a few publications focus on corrosion inhibitors or develop a list of criteria to help select the best corrosion inhibitor, but they have no relevance to viscosifying polymers.

However, as regards the appropriate papers, it seems that WL (Weight Loss) coupon method, LPR (Linear Polarization Resistance) technique, PP (Potentio-dynamic Polarization) curves plotting and Electrochemical Impedance Spectroscopy (EIS) are commonly used to assess the inhibiting behavior of an EOR polymer (Martin R.L and Braga T.G, 1986; Hilliard H.M, 1984; Jia R et al, 2017). Thus, the decision to perform these techniques in order to measure corrosion has been substantiated.

Thermodynamics of corrosion