9th Biennial International Conference
& Exposition on Petroleum Geophysics

"HYDERABAD 2012"

P-498

Stimulating Tight Sandstone Reservoir for Improved Water Injectivity

B. Ghosh* and Mohamad Yousef Alklih, *The Petroleum Institute*

Summary

The applicability of clay electro-migration in tight clayey sandstone in improving water injectivity is investigated. Electrically non-conductive water injection coreflood experiments are setup and DC electrical power of variable potential is used. The core plugs and produced effluents were analyzed using X-Ray, SEM and ICP-MS methods. Permeability improvement w.r.t pore volume of water injected at various flood velocity and applied voltage differences are recorded and correlated with the amount of pore lining clays released and migrated. The results showed upto 5 times increase in absolute permeability which is dependent both on DC potential difference and flood water velocity.

Keywords: *Water injectivity, electro-migration, tight sandstone reservoir, clay migration.*

Introduction

Application of electro-kinetic phenomena in reservoir stimulation and enhanced recovery from heavy oil reservoir, which has been reported to yield technical and commercial success in some of the North American oil fields. Basic theory behind the stimulation effect is predicted to be the colloidal movement of pore lining clays resulting in widening of pore throats and/or opening new flow tunnels. However, little work is done on its applicability in water injection well. This work explores the possibility of stimulating tight caly laden sandstone reservoir through application of DC electric potential.

Methodology

Brine flow experiments are conducted on 9" long sandstone cores with initial absolute permeability ranging from 5 to 11 mD. A DC power source provided potential difference at the injection and production end of the core plugs. Two sets of experiments were conducted. In the first set, the DC potential is varied and optimized during the water flooding at fixed rate. In the second set, the optimized potential is kept constant and the injection rate is varied to determine the hydrodynamic effect on clay movement. The core plugs and produced clays were characterized through size exclusion micro-filtration, mineralogical analysis using SEM and EDX and ICP-MS analysis. The Joule heating phenomena associated with electro-kinetics is also studied during the entire flooding period.

Conclusions

Part of the results given in Fig 1 show that several folds increase of core permeability could be achieved (Figure 1). Some of the experiments were more efficient in terms of dislodgement of clays and enhanced stimulation which is supported by aize exclusion micro-filtration and produced brines analysis, showing higher concentration of clay and metal elements contained in clays. The results also show larger quantity of clayey elements in the produced brines in the initial period of water flooding, prior to the stabilization of differential pressure and electrical current (Figure 2). Additionally, fluid flow temperature measurements showed an increasing trend with the flooding time and direct proportionality with applied voltage.

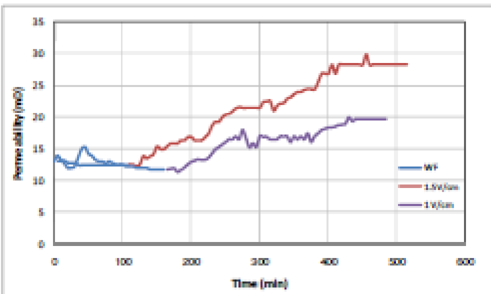

Figure 1: Two curves representing 2 voltages applied leadind to permeability stimulation due to the application of EK. Other curves are shown in the paper

Petroleum Engineering Department, The Petroleum Institute
P.O. Box 2533, Abu Dhabi. UAE.
E-mail: bghosh@pi.ac.ae

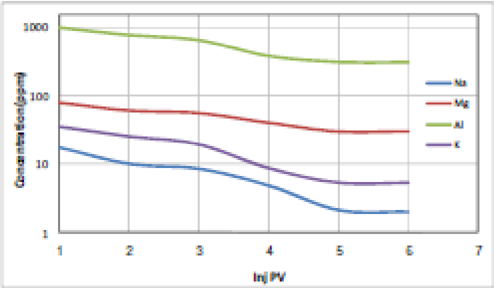

Figure 2: Elemental concentration in produced effluents that were collected per unit pore volume

References

O. P. Das et.al. “Water Injection Monitoring Techniques For Minagish Oolite Reservoir In West Kuwait”, Society of Petroleum Engineers, IPTC 13361, December 2009.

S. A. Amba et. al. “Use of Direct Electrical Current for Increasing the Flow Rate of Reservoir Fluids During Petroleum Recovery” Journal of Canadian Petroleum Technology, vol. 3, No. 1. pp. 8 – 14, 1964.

G. V. Chilingar et.al,“Possible Use of Direct Electrical Current for Augmenting Reservoir Energy During Petroleum Production”, Compass (1968) 45, No. 4, 272-285.

J. K. Wittle, et al. "Direct Current Electrical Enhanced Oil Recovery in Heavy-Oil Reservoirs to Improve Recovery, Reduce Water Cut, and Reduce H2S Production while Increasing API Gravity", SPE 114012,

Acknowledgements

The authors are Thankful to the Petroleum Engineering Department, The Petroleum Institute, Abu Dhabi, for providing the facilities to conduct the laboratory experiments.