ICOSET UIR International Conference
Conference on Science, Engineering, and Technology
ISBN : 978-979-3793-74-0

Laboratory Studies of Nanosilica Additive Application in Surfactant Injection Process to Increase Recovery Factor

Novia Rita, S.T., M.T [1], Dr. Mursyidah, M.Sc [1], Tri Yudha Putra[1], Dr. Nguyen Xuan Huy[2]

[1]*Petroleum Engineering Department of Universitas Islam Riau*
Jalan Kaharuddin Nst No 113 Marpoyan, Pekanbaru, Indonesia

University of Technology Vietnam
Ho Chi Minh City, Vietnam

noviarita@eng.uir.ac.id
mursyidahumar@eng.uir.ac.id
yudhatri48@student.uir.ac.id

Abstract

When natural flow is not able to produce more fluids, it needs further processing such as waterflooding process, which basically this process uses the water formation who was produced will be injected back into formation. In this study, the results of the research to find the largest recovery factor (RF) value from the injection of surfactant solution, which will be added with nanosilica (SiO_2) solution into the synthetic core. The instrument used for the injection is injection meter from the reservoir laboratory of petroleum engineering islamic university of riau, with compressor as additional tool for a pressure that's going to injection meter. The concentration of surfactant solution tested were 0,5%, 2,5% and 5%. With a porosity value of 10,2% categorized as fair porosity and permeability on synthetic cores has a value of 21,3mD which is categorized as a good permeability. From the injection of surfactant solution with the highest recovery factor result will be added of nanosilika concentration. The nanosilic concentrations used were 0,05wt%, 0,1wt% and 0,2wt%. Based on the research, the highest recovery factor value at 5% of concentration surfactant solution which have 21,2% of oil recovery result, then recovery factor will increase when the addition of nanosilika with 0,05 wt% concentration that makes recovery factor increase to 40,1%. Where the results are increased by 2 times from the surfactant injection itself.

Keywords: waterflooding, recovery factor, surfactant, and nanosilica

1. INTRODUCTION

This year's oil and gas industry is still full of challenges even though it is more attractive compared to previous years. This condition is considered to provide encouragement related to industrial development in the coming years, including later supporting the pace of the economy.

In recent years, ideas and applications to use of nanoparticles the upstream of petroleum industry such as exploration, drilling, production, reservoir management and enhanced oil recovery. Two important characteristics that cause nanoparticles are suitable to be applied in the upstream of petroleum industry, namely by particle size and it can manipulated the properties of these nanoparticles. Nanoparticles have a very small size (1-100 nm), with these sizes very easily flowing in rock pores. On the other hand, by manipulating the properties of the nanoparticles will be able to change the properties of the injection fluid and reservoir fluid such as viscosity, interfacial tension, reservoir rock wettability and others.

ISBN: 978-979-3793-74-0

Surfactant injection is used to reduce the interfacial tension of oil that makes oil recovery increases. So the injection efficiency increases according to the decreased of interfacial tension. This surfactant injection is intended to produce residual oil that left by the water drive, where's oil trapped by capillary pressure so it cannot move out to production. The solution to increased production (recovery factor) was to injected a surfactant solution.

Mixed of surfactants with oil will forms as emulsion that will reduce capillary pressure. After that the oil can move to the surface, it is hoped that there will be no oil left behind. Therefore, the researchers will try to use nanosilica type (SiO^2) nanomaterials which are added with surfactant solution to improve Recovery Factor.

2. METHODOLOGY

In this reasearch, researchers used coreflooding methods with compressor as the pressure that pushed the injection fluid, the pressure was 30 psi. here is the schematic of the coreflooding method with injection meter.

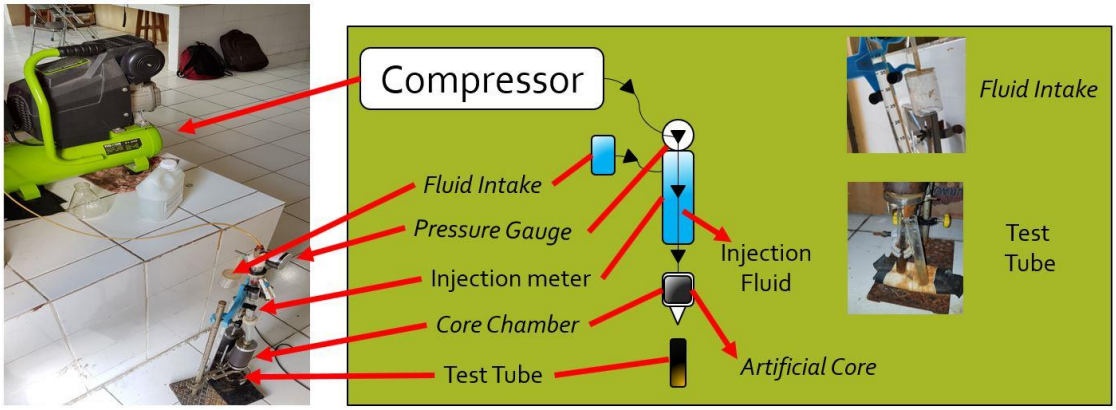

Figure 1 schematic of Ijection meter

First thing to do on this research was prepared the equipments and materials that will be needed, such as injection meter, core chamber, sandstone sample, brine (NaCl mixed with distilled water), surfactant and nanosilica. After that researchers make atificial core from sandstone sample and for the epoxy was cement. Artificial core will be used for aging with crude oil and made it oil wet.

Next thing was selected the surfactant concentration for injection fluid by used phase behavio test. Researchers use 10 concentration test, from 0,5% to 5% of surfactant, the result is seen by the ammount of oil that increased by the surfactant concentration. And researchers found that 5% of surfactant concentration was have more oil than the other concentration. To do this research, we chose 3 concentration, 0,5%, 2,5% and 5%. But before the surfactant injection, researchers use brine as base cased for this studies.

After the surfactant injection completed. The concentration that have the most recovery factor will be added nanosilica, with the concentration was 0,05 wt%, 0,1 wt% and 0,2 wt%, and hope the recovery factor will be increased from the surfactant injection it self.

3. RESULT AND DISCUSSION

The result of the surfactant injection was great, researchers used PV (per-volume) as the injection meter can accommodated only 50 ml of injection fluid, we used 4 steps of PV for searched the recovery factor, like 50 PV, 100 PV, 150 PV and 200 PV, researchers only use up to 200 PV because the ammount of the injection fluid that maked is 200 ml. and to calculate the recovery factor researchers use the incremntal of the recovery factor.

First injection was only brine that researchers use as base case, OOIP (Original Oil in Place) that being used was 7,78 ml from artificial core that has been aging with crude oil, the result of recovery factor incremental on PV 200 was 8,5%, as we can seen on table 3.1.

ISBN: 978-979-3793-74-0

Table 1 Data of Brine Injection as Base Case

Concentration PPM	PV (ml)	Rf (ml)	Rf %	Rf *Incremental*
Brine (Base Case)	50	0,33	4,2%	4,2%
	100	0,21	2,7%	6,9%
	150	0,12	1,5%	8,5%
	200	0	0,0%	8,5%

The next injection was surfactant injection with 0,5% concentration, surfactant injection is the mixed of surfactant and brine so it can became the concentration, to make 200 ml of 0,5% surfactant concentration, we need 1 ml of surfactant and 199 ml of distilled water.

On this scenario, the result of incremental receovery factor on PV 200 was 6,0%, that was much worst compared by brine injection, so for this concentration is not good to applied with nanosilica. The result for this injection can be seen on table 3.2.

Table 2 Data of 0,5% Surfactant Injection

Concentration %	PV (ml)	Rf (ml)	Rf %	Rf *incremental*
Surfactant 0,5% + *brine*	50	0,15	1,9%	1,9%
	100	0	0,0%	1,9%
	150	0,32	4,1%	6,0%
	200	0	0,0%	6,0%

The next injection was 2,5% of surfactant concentration, that have more recovery factor than previous injection. The incremental of recovery factor is 9,3% on PV 200. But previously on phase behavior test, 2,5% concentration have the ammuont of crude oil volume is not much differentiation with other concentration on the test, so for the next concentration maybe it will have more incremental of recovery factor. We can see the data of this injection from table 3.3.

Table 3 Data of 2,5% Surfactant Injection

Concentration %	PV (ml)	Rf (ml)	Rf %	Rf *incremental*
Surfactant 2,5% + *brine*	50	0,43	5,5%	5,5%
	100	0,29	3,7%	9,3%
	150	0	0.0%	9,3%
	200	0	0.0%	9,3%

ISBN: 978-979-3793-74-0

The last of surfactant injection is 5% , from the beginning of the injection start, the oil that comes out the outlet of core chamber was plenty. At the end of injection (PV 200) the result of recovery factor incremental was 21,2%. And the data can be seen on table 3.4.

Table 4 Data of 5% Surfactant Injection

Concentration %	PV (ml)	Rf (ml)	Rf %	Rf *incremental*
Surfactant 5% + *brine*	50	0,45	5,8%	5,8%
	100	0,68	8,7%	14,5%
	150	0,52	6,7%	21,2%
	200	0	0,0%	21,2%

From 5% concentration of surfactant injection, researchers can concluded that 5% surfactant can be used for next injection, because it have the highest incremental of recovery factor.

The next injection was 5% surfactant + brine will be added nanosilica with concentration was 0,05 wt%, 0,1 wt% and 0,2 %. The result from 3 different concentration was significant, the result of the injection can be seen on picture 3.1.

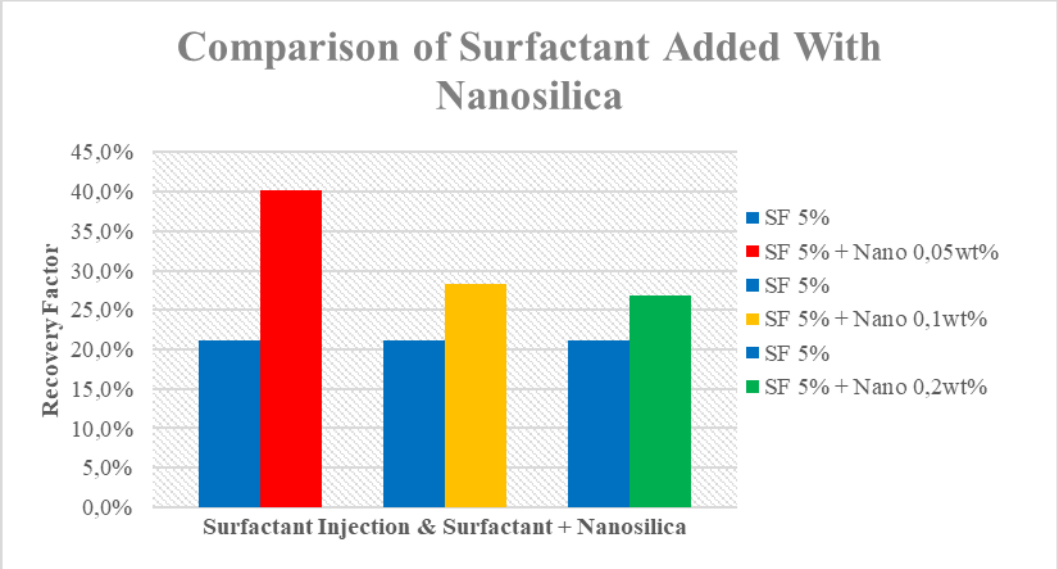

Figure 1 Comparison of Surfactant Added With Nanosilica

As the picture 3.1 shown, nanosilica with 0,05 wt% concentration have more result on incremental of recovery factor, which was 40,1%, and prove that nanosilica work properly with surfactant molecule that will increased the recovery factor. For 0,1 wt% and 0,2 wt% the result was 28,3 % and 26,8%, it has more result than surfactant 5% injection so with that said, nanosilica is worked as their properties with other molecule to increase their capability.

And it was has been proven by Fakoya on his studies in 2017 that said, to achieve more recovery factor, the concentration that needed was 0,05 wt% or less than that. And Ogolo on his studies in 2012 said nanomaterial if Integrated with other chemicals in injection will make the molecule on the chemicals worked more than the molecule it self in injection.

ISBN: 978-979-3793-74-0

4. CONCLUSION

From the result and discussion, researchers make a conclution was.

1. Surfactant injection with concentration 0,5%, 2,5% and 5%, have a different incremental recovery factor, and the highest incremental recovery factor was 5% concentration of surfactant with 21,2 %, because it was the highest recovery factor, it will be added nanosilica concentration in the next injection to see if the nanosilica will work as they do to increase other molecule properties.
2. Nanosilica injection that being used was 0,05 wt%, 0,1 wt% and 0,2 wt% concentration, and it worked properly as they do. The surfactant injection that added nanosilica increase the ammount of recovery factor incremental, the highest result in 0,05 wt% concentration with 40,1% recovery factor incremental. With that said nanosilica increase the properties of other molecule with much lower the interfacial tension between artificial core and crude oil.

REFERENCE

El-Diasty, A.I. dan Ragab, A.M.S. (2013). *Applications of nanotechnology in the oil & gas industry*. Paper SPE 164716, North Africa Conference & Exhibition in Cairo, Egypt. 15-17 April.

Engeset, B (2012) *The Potential Of Hydrophilic Silica Nanoparticles For EOR Purpose*. Norwegian University of Science and Technology, Norwegia.

Fakoya, M. F. dan Shah, S. N. (2017) *Emergence of nanotechnology in the oil and gas industry: Emphasis on the application of silica nanoparticles*. University of Oklahoma, Oklahoma, Page 1–15.

Indonesia Petroleum Association. (2017) *Mengembalikan Kejayaan Industri Hulu Migas di 2018*. Jakarta, Indonesia.

Ogolo, N.A., Olafuyi, O.A and Onyekonwu, M.O. (2012) *Enhanced Oil Recovery Using Nanopaticles*. SPE Saudi Arabia Section Technical Symposium and Exhibition, Al-Khobar, Saudi Arabia (SPE journal): SPE-160874-MS.