بسم الله الرحمن الرحيم

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تم رفع هذه الرسالة بواسطة / سلوي محمود عقل

بقسم التوثيق الإلكتروني بمركز الشبكات وتكنولوجيا المعلومات دون أدنى مسئولية عن محتوى هذه الرسالة.

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MITIGATION OF FINE MIGRATION USING NANO MATERIALS IN LIMESTONE RESERVOIRS; AN EXPERIMENTAL CASE STUDY FROM ABU ROACH FORMATION-F MEMBER, WESTERN DESERT, EGYPT

By

Mohamed Aly Hussein Sakr

A Thesis Submitted to the
Faculty of Engineering at Cairo University
in Partial Fulfillment of the
Requirements for the Degree of
MASTER OF SCIENCE
in
Petroleum Engineering

FACULTY OF ENGINEERING, CAIRO UNIVERSITY,
GIZA, EGYPT
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Under Supervision of

Prof. Dr. Abdulaziz M. Abdulaziz

…….
Professor of Petroleum Engineering,
Dept. of Mining Metallurgical Engineering,
Faculty of Engineering,
Cairo University

Prof. Dr. Ahmed Zakaria Noah

…….
Professor of Petroleum Engineering,
Egyptian Petroleum Research Institute,
Nasr City

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Approved by the
Examining Committee:

_____

Prof. Dr. Abdulaziz M. Abdulaziz **(**Thesis Main Advisor)
Prof. of Petroleum Engineering, Cairo University

_____

Prof. Dr. Ahmed Zakaria Noah (Advisor)
Prof. of Petroleum Engineering, Egyptian Petroleum Research Institute, Nasr City

_____

Prof. Dr. Abdel Sattar A. Dahab (Internal Examiner)
Prof. of Petroleum Engineering, Cairo University

_____

Prof. Dr. Bassem Nabawy (External Examiner)
Professor and Head of Geophysical Research Department, National Research Centre

FACULTY OF ENGINEERING, CAIRO UNIVERSITY,
GIZA, EGYPT
2022

Engineer's Name: Mohamed Aly Hussein Sakr
Date of Birth: 03/03/1992
Nationality: Egyptian
E-mail: Muhammad.ali.sakr@gmail.com
Phone: 01001203821
Address: Kafr Saqr – Mubarak District – Bahr Mouis Street – Beside Dr/ Ahmed Adel Pharmacy

Registration Date: 01/03/2015
Awarding Date: …../..…/2022
Degree: Master of Science
Department: Mining, Petroleum and Metallurgy

Supervisors:

Prof. Dr. Abdulaziz Mohamed Abdulzaiz
Prof. Dr. Ahmed Zakaria Noah (Professor of Petroleum Engineering, Institute of Petroleum Research, Nasr City).

Examiners:

Prof. Dr. Abdulaziz M. Abdulaziz (Thesis main advisor)
Prof. Dr. Ahmed Zakaria Noah (Thesis advisor)
Professor of Petroleum Engineering, Institute of Petroleum Research, Nasr City.
Prof. Dr. Abdel Sattar A. Dahab (Internal Examiner)
Prof. of Petroleum Engineering, Cairo University
Dr. Bassem Nabawy (External Examiner)
Professor and Head of Geophysical Research Department, National Research Centre

Title of Thesis: Mitigation of Fine Migration Using Nano Materials in Limestone Reservoirs; An Experimental Case Study from Abu Roach Formation-F Member, Western Desert, Egypt

Key Words: Nanoparticles, Fine Migration, Limestone Reservoir, Nano-Silica, Nano-Alumina

Summary: Formation damage is an operational and economical problem that may occur during various phases of oil and gas operations. It has been explained that fine particles lifting, migration, and subsequent plugging of the pore necks, eventually resulted in a significant permeability reduction. In the present work, Al_2O_3 and SiO_2 Nano fluids are injected in a formation damage cell at various concentrations and flow rates into three limestone cores. This enabled to study the fines trapping capacity of Nano-materials to migrating fines and to evaluate the effect of reservoir fluid and other conditions on fines trapping performance. In addition, the fines produced before and after Nano fluid injection are counted to evaluate the effect of nanomaterials on trapping fines in-place. Results showed that the tested Nano-materials have a high capacity to trap limestone fines in place.

DISCLAIMER

I hereby declare that this thesis is my own original work and that no part of it has been submitted for a degree qualification at any other university or institute.

I further declare that I have appropriately acknowledged all sources used and have cited them in the reference section.

Name: Mohamed Aly Hussein Sakr Date: / / 2022

Signature:

DEDICATION

This thesis work is dedicated to my beloved parents who have meant and continue to mean so much to me. Although they are no longer of this world, their memories continue to regulate my life. May Allah (SWT) grant them Jannah Firdaws.

I also want to remember my wife, Hour, who has been a constant source of support and encouragement during the challenges of life. I am truly thankful for having you and our daughters, Sedra and Celia, in my life.

Last but not least I am dedicating this to my sister, Samah, and all of my family members.

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NOMENCLATURES

A	: Cross sectional area of sample (cm^2)
Al_2O_3	: Aluminum oxide
API	: American Petroleum Institute
bpd	: Barrel per day
EGPC	: Egyptian General Petroleum Corporation
ENE	: East North East
ESE	: East South East
g/l	: Gram per liter
g	: Gram
GOR	: Gas oil ratio
K	: Permeability
kV	: Kilo Volt
M	: Meter
mA	: Milli ampere
mD	: Milli Darcy
mL/min	: Milli liter per minute
MMbbl	: Million barrels
Mol	: Mole
N	: North
NE	: North East
nm	: Nanometer
NPS	: Nanoparticles
NW	: North West
PVT	: Pressure Volume Temperature
S/T well	: Sidetracked Well
SE	: South East
SiO_2	: Silicon Oxide
STB	: Stock Tank Barrel
SW	: South West
TEM	: Transmission Electron Microscopy

WNW : West North West

WSW : West South West

XRD : X- Ray Diffraction

μ : Viscosity of gas (cP)

ABSTRACT

Well productivity reduction has been commonly observed for oil and gas wells as a result of producing the reservoir fines. This phenomenon has been explained by the fine particles lifting, migration and subsequent pores plugging, which finally results in decreasing permeability. This problem has been observed in various core flood tests and field cases. Many techniques have been applied to mitigate this problem, but some have failed, others have low efficient performance or have caused wellbore plugged.

This research is designed to study and evaluate formation damage due to fine migration in Limestone Formations (Abu Roash F member, Abu Roash Formation at The Western Desert of Egypt), which has resulted in considerable losses in well productivity. It is based on studying the fines trapping capacity of two Nano fluids "Alumina and Silica" in limestone cores, and evaluating the effect of reservoir fluid and other conditions on their performance.

The results showed that Alumina and Silica Nano fluids have a high capacity to trap the reservoir fines and could formulate a good solution for fine migration problem in Limestone Formations. Adsorption of nanoparticles onto the fine/grains surface occurred and such adsorption increased the retention of the fines attached on the pore surface by reducing the surface potential between grains and fines. This had the prime role in locking the fine particles in place, closing some pore throats, and decreasing the permeability in some cases. Results indicated that the recommended flow rate range of Al_2O_3 and SiO_2 Nano fluids of 50 nm size injection is 25 cc/min. This flow rate helps in keeping the fines stagnant at their original locations/sources.