Sudan University of Science and Technology

College of Petroleum Engineering and Technology

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Steam Flooding Pilot Test Design in FULA Central (Case Study)

تصميم إختبار تجريبي للحقن بالبخار في حقل الفولة المركزي (دراسة حالة)

Project submitted in Partial Fulfillment of Requirements of the Degree of B.Sc in Petroleum Engineering.

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الاستهلال

قال تعالى:

{وَأَوْفُوا الْكَيْلَ إِذَا كِلْتُمْ وَزِنُوا بِالْقِسْطَاسِ الْمُسْتَقِيمِ ذَلِكَ خَيْرٌ وَأَحْسَنُ تَأْوِيلًا (35) وَلَا تَقْفُ مَا لَيْسَ لَكَ بِهِ عِلْمٌ إِنَّ السَّمْعَ وَالْبَصَرَ وَالْفُؤَادَ كُلُّ أُولَئِكَ كَانَ عَنْهُ مَسْئُولًا (36) وَلَا تَمْشِ فِي الْأَرْضِ مَرَحًا إِنَّكَ لَنْ تَخْرِقَ الْأَرْضَ وَلَنْ تَبْلُغَ الْجِبَالَ طُولًا (37) كُلُّ ذَلِكَ كَانَ سَيِّئُهُ عِنْدَ رَبِّكَ مَكْرُوهًا (38)}

صدق الله العظيم

[سورة الإسراء: الآيات 35-38]

Dedication

This project is dedicated to our Moms and Dads For their Countless sleepless nights filled with prayers for our success in our life, the least we can do is to dedicate the fruit of our efforts for the most two influential people in our life, this is for you.

Our professors and teachers who have given us all their renewed support with singularly honest, Thank you for bring us to this stage.

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Abstract

With the decline in oil discoveries during the last decades it is believed that Enhanced Oil Recovery (EOR) technologies will play a key role to meet the energy demand in years to come. Enhanced oil Recovery methods had been used around the world for enhancing oil production and getting higher recovery factor from oil reserves, Sudan also seeks to take advantage of the enhanced oil recovery techniques.

Steam injection is one of the most common and widely spread thermal recovery methods. It is mainly used in heavy oil reservoirs. In this project, the design of pilot test has been conducted.

Sudanese field contain heavy oils which required applying Enhanced Oil Recovery (EOR) techniques to be capable to increase the cumulative oil production therefore, recovery factor increase. Also represented in this project a description for Fula Sub-basinand Bentiu formation. CMG Thermal simulator STARS had been used for simulation implementing.

The pilot test results showed that the cumulative production raised to 22,230bbl. When applying steam flooding with increasing volumetric percentage of 31%, so we recommended implementing of steam flooding to Bentiu formation.

التجريد

تراجع الاكتشافات النفطية خلال العقود الماضية أدى إلى زيادة الاعتقاد بأن تقنيات الاستخلاص المعزز للنفط ستلعب دورا رئيسيا لتلبية الطلب على الطاقة في السنوات المقبلة ، حيث تم استخدام طرق الاستخلاص المعزز للزيت حول العالم حتى يتم زيادة كميات النفط المنتجة و بالتالي زيادة معامل الاستخلاص الكلي من الاحتياطي النفطي ، كما يسعى السودان إلى الاستفادة من تقنيات الاستخلاص المعزز للنفط .

حقن البخار من أكثر طرق الاستخلاص الحراري شيوعاً وانتشاراً على نطاق واسع ، كما يستخدم بشكل أساسي في مكامن النفط الخام الثقيل ، حيث تم في هذا المشروع تصميم اختبار تجريبي لطريقة تدفق البخار (Steam-Flooding) .

الحقل السوداني يحتوي على خام النفط الثقيل مما يتطلب استخدام تقنيات الاستخلاص المعزز للنفط من أجل التمكن من زيادة الكميات الكلية المنتجة من النفط الخام، و بالتالي زيادة معامل الاستخلاص ، كماتم في هذا المشروع وصف حوض الفولة و تشكيل بانتيو ، تم استخدام برنامج محاكاة حاسوبي (CMG,STARS) من أجل تنفيذ المحاكاة .

أوضحت نتائج الاختبار التجريبي لطريقة تدفق البخار (Steam Flooding) أن الإنتاج الكلي للزيت الخام ارتفع عند تطبيق تقنية تدفق البخار (Steam Flooding) نسبة زيادة حجميه 31%، بناءً على النتائج المتحصل عليها تم التوصية بتطبيق تقنية تدفق البخار (Steam Flooding) على طبقة بانتيو في حوض الفولة الأوسط.

Key words:

- Thermal EOR.
- Steam flooding.
- Pilot test design.
- CMG software.

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Nomenclature

Abbreviation	Meaning
AOR	Advance Oil Recovery
API	American Petroleum Institute
ASP	Alkyne, Surfactant and
Bbl	Barrel
bbl/bbl	Barrel per barrel
BOPD	Barrel Oil per Day
BTU	British Thermal Unit
CMG	Computer Measuring Group
CO2	Dioxide
CSS	Cyclic Steam
EIA	Energy International Agency
EOR	Enhanced Oil Recovery
F	Fahrenheit
Fig	Figure
FN	Fula North
Ft	Feet
GEM	Generalized Equation-of-State Model Reservoir Simulator
H2	Hydrogen Gas
IEA	International Energy Agency
Inc.	Incorporated
IMEX	Implicit-Explicit Black Oil Simulator
IOR	Improved Oil Recovery

JPT	Journal of Petroleum Technology
Kro	Oil Relative Permeability
Krow	Oil Relative Permeability in Water Phase
Krw	Water Relative Permeability
md	Mile-Darcy
M3/d	Cubic Meter per Day
MS	Microsoft
N2	Nitrogen Gas
NNW	North-Northwest
Nov	November
OEPA	Oil Exploration and Production Authority
OGJ	Oil and Gas Journal
OOIP	Oil Originally in Place
PC	Capillary Pressure
PDVSA	Petroleum de Venezuela, S.A
Prod	Production
RF	Recovery factor
SAGD	Steam Assisted Gravity drainage
SF	Steam Flooding
STARS	Steam, Thermal and Advanced Process Reservoir Simulator
SPE	Society of Petroleum Engineering
STB/D	Stock Tank Barrel/day
SW	Water SATURATION
US	United American States

T	Temperature
TEOR	Thermal Enhanced Oil Recovery
TWT	Two-Time Way
○	Degree
$	United American State Dollar