



Cairo University

# DEVELOPMENT OF AN ANALYTICAL MODEL TO PREDICT THE PERFORMANCE OF CHEMICAL EOR METHODS

By

Eng. Mohamed El-Sayed Ahmed Mohamed El-Tayeb

A Thesis Submitted to the  
Department of Mining, Petroleum, and Metallurgical Engineering,  
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  
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**Title of Thesis:**

Development of an Analytical Model to Predict the Performance of Chemical EOR Methods

**Key Words:**

Chemical EOR Methods; Predictive Model; Fractional Flow Theory; Areal Sweep Models; Areal Heterogeneity

**Summary:**

The main objective of this work is to develop an analytical forecasting model for the performance of chemical EOR processes. This predictive model is to be used as a pre-simulation tool for its simplicity and efficiency as it can consider most of the features accompanied by the chemical flooding besides the reservoir heterogeneity. The developed model is verified through the application of some field cases and many comparison cases with a well-known commercial chemical simulator.

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## **Dedication**

*To my Parents and my beloved sister.*

*This humble work is a sign of my love to you!*

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# Nomenclature

<b>Symbol</b>		
A	Area	ft <sup>2</sup>
A <sub>i</sub>	Adsorption of component i per unit mass of rock	μg/g rock
a	Pattern dimension	ft
C <sub>i</sub>	Concentration of component i in fluid per unit pore volume	lbm/ft <sup>3</sup>
$\hat{C}_i$	Concentration of component i in stationary phase (rock) per unit pore volume of rock	lbm/PV
D <sub>p</sub>	Amount of polymer adsorption expressed in pore volumes	Dimensionless
E <sub>A</sub>	Areal sweep efficiency	%
E <sub>ABT</sub>	Areal sweep efficiency at breakthrough	%
E <sub>D</sub>	Displacement efficiency	%
E <sub>Vertical</sub>	Vertical sweep efficiency	%
f	Fractional flow of a given phase	Fraction, Dimensionless
f <sub>w</sub>	Water fractional flow	Fraction, Dimensionless
F <sub>rr</sub>	Residual resistance factor	Dimensionless
G <sub>j</sub>	Shape factor of cell i	ft
h	Thickness	ft
K	Permeability	md
K <sub>ro</sub>	Relative permeability to oil	Fraction, Dimensionless
K <sub>rw</sub>	Relative permeability to water	Fraction, Dimensionless
K <sub>rwp</sub>	Relative permeability to water after polymer contact	Fraction, Dimensionless
L	Half distance between the injector and producer	ft
M	Mobility ratio	Dimensionless
m-exponent	Corey exponent for oil	Dimensionless
n-exponent	Corey exponent for water	Dimensionless
N <sub>p</sub>	Cumulative oil production	STB
N <sub>s</sub>	Original oil in place	STB
OIP	Oil in place	STB
ΔP	Pressure drop between the injector and producer	psi
q	Flow rate	bbl/day
q <sub>inj</sub>	Injection rate	bbl/day
Q <sub>i</sub>	Injected pore volume	Dimensionless
r <sub>w</sub>	Radius of well	ft
S	Saturation of a given phase	Fraction, Dimensionless
t	Elapsed time	Days