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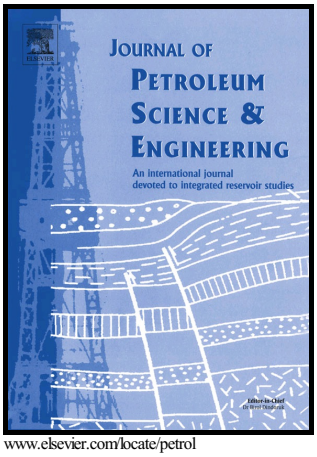

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Numerical modeling on in-situ combustion process in the Chichimene field: ignition stage

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Abstract

In this paper were evaluate the ignition behavior of the In-Situ combustion (ISC) process in the Chichimene Field using a reservoir commercial software. To development this study, the reactions of partial oxidation were represented by a single reaction in which oil reacts with oxygen and produces oxygenated oil. To achieve this, experimental evaluations were carried out in order to determine the stoichiometric coefficients and the kinetic parameters of the proposed reaction. In this approach was using a numerical model based on mass and energy balances to the closeness of the injection wellbore in order to adjust the frequency factor of the reservoir numerical model. The results indicated that is possible simulate the ignition stage of ISC process in a commercial software by using just one reaction, and for the specific case of Chichimene field this numerical model show that it will present a short ignition delayed which indicate high probability to get a spontaneous ignition to the current reservoir conditions and the distance at which ignition occurs can be modified by the air injection rate.

***Keywords*:** Ignition, In-Situ combustion, LTO kinetic parameters, ignition delay, numerical simulation.

Nomenclature

ISC	=	In-situ combustion
RF	=	Recovery factor
URF	=	Ultimate recovery factor
HTO	=	High Temperature Chemical Reactions
LTO	=	Low Temperature Chemical Reactions
RTO	=	Ramped temperature oxidation test
Φ_f	=	Porosity
ρ_O	=	Specific oil gravity, [g/cm^3]
C_O	=	Oil heat capacity, [Kcal/g °C]
S_O	=	Oil saturation
ρ_w	=	Specific gravity of water, [g/cm^3]
C_w	=	Heat capacity of water, [Kcal/g °C]
S_w	=	Water saturation
ρ_S	=	Specific gravity of the rock, [g/cm^3]
C_s	=	Heat capacity of the rock, [Kcal/g °C]
M_{O2}	=	Molar mass of O_2 [kg/mol]
T_r	=	Reservoir temperature, [ºC]
Pr	=	Activation energy [K]
E	=	Activation energy [K]
k*	=	Equivalent thermal conductivity, [kcal cm^{-1} s^{-1} ºC^{-1}]
r	=	Radial coordinate, [cm]
V	=	Gas flow, [cc cm^{-1} s^{-1}]
X_{O2} , x	=	Mole fraction of oxygen
Q	=	Reaction heat, [Kcal/mol O_2]
$(\rho c)^*$	=	Equivalent heat capacity per unit of volume of the porous medium, [kcal cm^{-3} ºC^{-1}]
n	=	Reaction order
p_{O2}	=	Oxygen partial pressure, [atm]
R	=	Gas constant, [atm cm^3/mol K]
k_0	=	Pre exponential factor, [s^{-1} atm^{-n}]
C	=	Concentration of oxygen, [mol/cm^3]
D	=	Diffusion coefficient, [cm^2/s]
b	=	Oxygen stoichiometric coefficient

1. Introduction

The ISC is an enhanced oil recovery method for heavy and extra-heavy oils. In this technique, air is injected in the oil reservoir and burns part of the oil in place (between 5 and 10%). The heat generate is used to facilitate the flow of the unburned fractions, and so to increase the recovery factor. The enhanced recovery by ISC process has shown great potential in its application to fields with a wide range of features, achieved in some cases recovery factor of 52.7% (Petcovici, 1981). However, the global average success (technical and economical) is only about 44.6%; a full review of the ISC and its statistics was presented by Partha S. Sarathi (1999). The main cause of this low success has been the lack of knowledge of the phenomena