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Numerical Simulation of Steam Injection for Heavy Oil Thermal Recovery

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Abstract

The steam injection technology is widely used in heavy oil production. The higher the steam injection rate is, the more beneficial the exploitation of heavy oil is. In this paper, we choose the twodimensional rotati on axis symmetry model, using VOF model of steam injection wells, wet steam phase change, transient a nalysis of influence of different injection pipe string structure in vertical well section during the process o f steam injection on steam injection parameters and changes of single and dual steam injection steam inje ction well bore in steam parameters during the process of steam injection in horizontal wells. The analysis results show that the vertical well steam injection by high vacuum insulated tubing make minimize the dr yness of the steam; Toe end dry degree is higher than that of single tube steam injection when horizontal pipe steam injection, which is conducive to the balanced development of heavy oil.

Keywords:heavy oil thermal recovery; hot steam; vertical well; horizontal well; VOF model

1. Introduction

With the global resources get rare, the unconventional oil and gas, represented by heavy oil, will play a more and more important role in the world. Heavy oil is a very large and difficult flow of unconventional

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Nomenclature

m_v	Mass of vapor phase transition	λo	Coefficient of thermal conductivity of oil
m_l	Variable mass transfer in aqueous phase	ρ_w	Water density
β	Phase change coefficient	C_w	Specific heat of water
T_{sat}	Saturation temperature	λ_w	Thermal conductivity of water
$\vec{v}$	speed	C_v	Specific heat of steam
$<v>$	average velocity	λ_v	Thermal conductivity of steam
α_w	Liquid physical fraction	r_4	The diameter of horizontal single shaft
α_v	Steam physical fraction	r_5	Double inner tube diameter
σ	Surface tension coefficient	r_6	Double tube outer tube diameter
ς	Interface curvature	L	Horizontal wellbore length
h	Enthalpy of mixture	r_1	Inner diameter of thickened oil pipe
λ	Coefficient of thermal conductivity	r_2	Vacuum insulated tubing radius
S_h	Phase change heat (or heat)	r_3	High vacuum insulated tubing radius
S_i	Momentum source term	H	Vertical well depth
α_o	Oil volume fraction	M	Dryness of steam injection
dV	Basic volume unit	P_0	Steam injection pressure of vertical well
q_T	Thermal conductivity of porous framework	P_0'	Steam injection pressure of horizontal
R	thermal resistance	P	Reservoir pressure
δ	Material thickness	T_0'	Initial reservoir temperature
T_{in}	Steam injection temperature	ρ_o	Crude oil density
T_0	Surface temperature	C_o	Specific heat of crude oil
ΔT	Geothermal gradient		

crude oil, and in the global oil and gas account for a large proportion of. Steam injection thermal recovery is the main method of heavy oil production. By injecting hot steam into the heavy oil can increase the temperature of the reservoir and reduce the viscosity of heavy oil, and can increase the pressure of oil layer and drive oil easily.

It is important to understand the heat loss of the wellbore in the process of steam injection, which has an important influence on analyzing the steam injection efficiency. Many scholars domestic and overseas have studied the problem of energy loss in steam injection process. At home Yu Haitao[1]had studied the effect of steam injection effect on oil, and Lin Huichun[2]studied some controllable factors of steam injection. Yang Lihua[3] analyzed the heat loss in steam injection process and the improvement measures. And Liu Wenzhang[4] used the physical simulation method to determine the overall heat transfer coefficient. Dong Xiaohui[5] et al. to established a prediction model for thermal physical properties analysis of horizontal well thermal multi screen. Zhai Jianhua[6] considered the temperature and pressure drop in steam liquid two-phase flow in vertical wells. Considering the ground pipeline and well bore, the steam pressure and the decline of the dry degree of the were discussed by Shen Huifang[7]. Squier[8] et al. overseas proposed a complete calculation method for hot water through the wellbore. Hasan and Kabir[9,10] studied heat passage of the multiphase flow in the well, and established the perfect physics and mathematics. Emami-Meybodi[11] et al. Developed a transient heat conduction model to evaluate the heat transfer from the horizontal well to the formation. The heat loss of the wellbore during the injection of a hot fluid or a cold fluid through a casing is studied by Moss and White[12], Fokeev and Kapyrin[13]. The theoretical and experimental results of wellbore heat loss during steam injection are given by Huygen and Huitt[14], and the importance of the radiation heat loss is pointed out at the same time.

In this paper, the VOF model is used to analyze the innovation of the heat and mass transfer process of the oil reservoir and the heat injection; While we are in the process of setting up the model to select two