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Studying the Effect of Perforation Parameters on Vertical Well Performance

Haider Sami Mohammed [1,*], Emad Abdullah Khazal [2], Hussein Sadeq Sultan [3]

[1,2,3]*Department of Mechanical Engineering, College of Engineering, University of Basrah, Basrah, Iraq*
E-mail address: Eng.haider.sami@gmail.com , emad.khazal@uobasrah.edu.iq , hussein.sultan@uobasrah.edu.iq
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Abstract

This paper presents a pressure drop analysis in perforated vertical wellbores for different perforation parameters. The effect of the density of the perforations (number of perforation), the phase angle of the perforations, the diameter of the perforation and the flow rate of the crude oil from the perforations on the pressure drop and the productivity index of the perforated vertical wellbores were studied. The analysis of the vertical wellbore was performed numerically using ANSYS FLUENT 15.0 software. Three dimensional, steady-states, turbulent and incompressible fluid flow is assumed during the numerical solution of the governing equations. The results of this study show that, increased perforation density of the perforated vertical wellbore caused an increase in pressure drop, and also, decreased productivity index due to increasing the friction losses. Friction pressure drop has a significant effect on crude oil flow into the wellbore. When the main velocity is 1.5 m/s and the inlet velocity from the perforations is 2 m/s, the friction pressure drop is about 66 % and the acceleration pressure is approximately 34 % of the total pressure drop.

Keywords: Vertical wellbore, Perforation, Pressure drop, Productivity index, Inflow.

1. Introduction

In the field wellbore completion improvement, fluid flow in the wellbore and reservoir is concerned with the field researchers. The researchers are interested in single-phase and multi-phase flow to obtain information to the reservoir and the index of oil and gas production.

Oil and gas production wells prepared for production by general steps which are; firstly after drilling the production casing is perforated after the cementing. The perforation permits the fluid to flow into the wellbore. Perforating guns are used to create the perforation. The aim of perforating is to penetrate the casing, cement and extend into the virgin reservoir to provide a flow path for reservoir fluids to flow into the wellbore. Perforating design optimizes the gun configuration and wellbore conditions to achieve maximum productivity. Numerous studies have been performed on perforation parameters and the efficiency of flow. Karakas and Tariq [1] they studied the productivity of wellbore for various parameters of reservoir and perforations for two cases, 2D and 3D finite element for the inflow of perforations. They presented a semi-analytical solution for the wellbore productivity ratio. Their results showed that the crushed zone around perforations essentially increases the vertical resistance to flow and the productivity ratio increases with increasing perforation length. Ansah et al. [2] developed a model for wellbore inflow that can be used for studying the effect perforation shot density, entrance casing hole, perforation phase angle and the damage around the perforation on the wellbore productivity. A numerical solution for 3D flow was performed using ANSYS 5.7 based on the finite element method. Their results showed that, the performance of wellbore production affected by the shape of perforations. The length of the conical perforation has a significant influence on flow performance. Also, the pipe diameter has an important effect on the productivity ratio. Yildiz [3] developed a semi-analytical 3D model for a perforated vertical wellbore. The model can be used to predict the relationship for the inflow performance of the wells. The predictions of the model have been compared with experimental data for verification. The results showed that the permeability of the zone around the perforation has an important effect on the productivity of the well. Hagoort [4] in this study the productivity of perforated wells have been predicted by using an analytical model. In this model, the solution for single-phase, and Darcy flow for single perforation in the porous medium. Was obtained the model gives an equation for the perforation skin as a function of the important perforation parameters. The results show that, the productivity ratio increase with increasing perforation length, while the perforation diameter has a slight effect on productivity ratio. Fayal and Lakhdar [5] studied the effect of friction and acceleration losses in perforated horizontal wellbore on a total pressure drop. The conditions of the flow are steady-state, Newtonian, incompressible flow and single-phase flow. The flow model was solved by using CFD simulation FLUENT program. The results show that acceleration pressure drops about 30 % of the total pressure drop. Xu et al. [6] studied how perforations distribution effect on the productivity of a vertical well. A programming algorithm is applied to vertical well optimization models established under finite and infinite conductivity, respectively. HTHP (high-temperature high pressure) gas well was studied to demonstrate how the model through optimization of the perforation position and there was a