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Investigating Skin Factor Caused by Production Rate in Gas Condensate Reservoirs with Non-darcy Flow

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INTRODUCTION

It is essential to understand gas condensate reservoir behaviour, correctly. A special way of meeting this requirement is taking the advantage of well testing analyses. The simultaneous presence of condensate and gas in a reservoir alters the gas relative permeability around a production well. It influences the well test responses. Moreover, another parameter that more alters this behavior is non-Darcy flow of fluid around the well. Furthermore, some factors, such as the rate of production and type of gas condensate reservoirs play a crucial role in condensate formation. These factors have important impacts on the formation of condensate. In other words, they add additional skin factors that are caused by the formation of condensation around wells.

The techniques for analyzing the production data of single-phase oil and gas reservoirs have progressed significantly in recent years [1]. The well testing methods used for the interpretation of single-phase reservoirs due to the higher compressibility of the present fluids (i.e, gas and condensate) cannot be implemented in gas condensate reservoirs. Therefore, various methods such as pressure squared method or pseudo pressure approach have been introduced for predicting the behavior of these reservoirs. Recent efforts to investigate the behavior of condensate reservoirs reveals that when the bottom hole pressure of a well is lower than the dew point pressure, a condensate bank spreads around a production well. This mechanism forms radial flow around the well [2]. The condensate bank continues to grow as pressure decreases. The relative permeability of gas around the well decreases, which reduces the gas production from the well [3]. Therefore, recognizing the condensate bank behaviour is essential

in predicting the behavior of condensate reservoirs. The condensate bank size changes in different regions around the well over the lifetime of the reservoir [4]. The flow regimes around a condensate well have been studied by a lot of researchers and two-region and three-region models have been introduced [5].

The aim of this study is to consider the correlation between production rate and the skin factor. The data obtained from a compositional reservoir model is implemented to investigate the transient behavior around the producing well and reinterpreting the results of the reservoir model during well test analysis. In this way, by creating different scenarios of production and build-up tests, we examine the effect of downward and upward trends of the production rate on the condensate formation and its effect on the well-test data. Some weight functions to represent production rate changes versus skin factor are developed as well.

METHODOLOGY

Near-wellbore areas have the most significant impact on well productivity, especially in condensate reservoirs. Therefore, consideration of effective parameters on the composition of condensate in these areas is so important. The well-testing of condensate gas reservoirs is one of the most important methods to analyze these reservoirs. Therefore, by investigating different scenarios of drawdown and build-up tests, the effect of increasing production rate on condensate formation and on the response of the wells are investigated. The effect of production rate changes on the skin factor was studied as well. At high production rates, the formation of a condensation bank and the effect of non-Darcy flow increases the skin factor. This skin factor rising causes more energy loss of the reservoir over the production time.

In this study, a cylindrical reservoir model with a vertical well at its center was assumed. The reservoir system was created with a commercial reservoir simulator. The reservoir properties are summarized in Table 1. The fluid properties are determined based on the Ping Robinson equation of state. The Corey relative permeability equation was used to model the relative permeability of condensate-gas and water-condensate systems.

Table 1: Reservoir and well properties.

Properties	Value	Properties	Value
Dew point	psi 5980	Porosity	% 10
Temperature	F 211	Reservoir Radius	12,000 ft
Thickness	ft 100	Well Radius	ft 0.285
Permeability	md 10	Initial water saturation	% 40

RESULTS AND DISCUSSION

RELATIONSHIP BETWEEN PRODUCTION RATES RISING AND SKIN FACTOR

With the assumption that the pressure of the gas condensate reservoir is slightly higher than its dew point pressure (6000 psi), the well begin to produce the condensate fluid. The production scenario in this model is that at first, the reservoir flows for one day. Then, the well is shut in for another 1 day. The process is sequentially repeated for higher production rates (i.e. isochronal test). Only in the first test, the pressure of the reservoir is quite higher than the dew point pressure. Fig. 1 shows the log-log plot of pressure and pressure derivative versus time of different build-up tests.

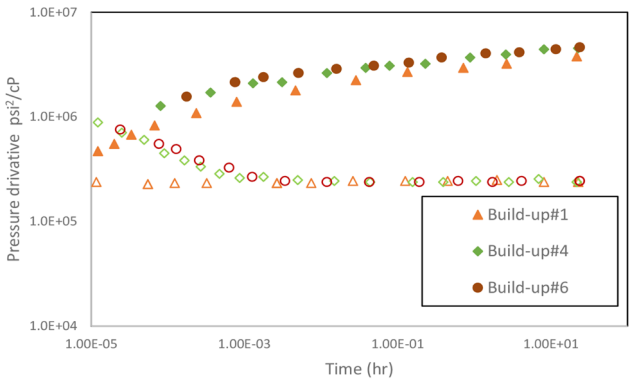

Figure 1: Pressure and pressure derivative plots for different production rates.

By increasing production rates, the amount of condensate formation has increased due to a further pressure drop in the reservoir. This led to an increase in the fall of the derivative plot and higher ramp at the early time responses, which is directly influenced by the more condensation effect.

INVESTIGATION OF THE EFFECT OF NON-DARCY FLOW ON SKIN FACTOR

In this study, the skin factor changes when the flow regime switches from Darcy to non-Darcy flow. Initially, the reservoir model was considered at a pressure above its dew point pressure (6000 psi). The important point is that in both production scenarios, no condensation is formed and the obtained skin factor is related to the type of the flow regime. The well production is fixed at the rate of 7000 MMSCF/DAY. According to Fig. 2, it is observed that for a state in which the type of Darcy flow regime is dominant, the skin factor is smaller than that in the non-Darcy flow. Moreover, the difference between these two models at the beginning of the reservoir response is quite evident. It shows that the non-Darcy flow has an additional pressure drop in the model.

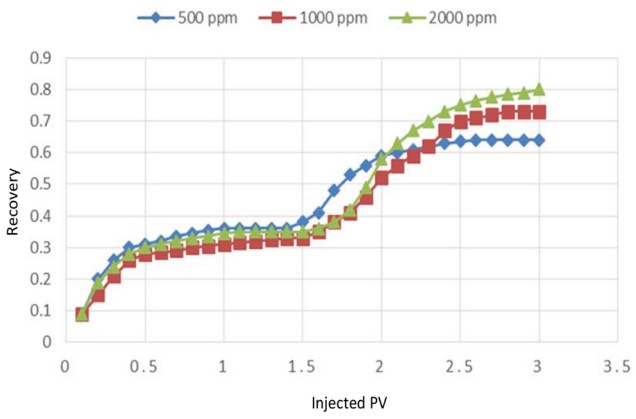

Figure 2: Log-log plot of build-up test for Darcy and non-Darcy flow.

CONCLUSIONS

• The appearance of condensate in a formation brings higher pressure drop and more skin factor in the formation.

• In low permeability reservoirs, the presence of skin factor due to well completion can be very problematic. Because the simultaneous presence of skin from condensate and reservoir damage greatly reduced the amount of well production.

• The calculations shows a linear relationship between skin factor and production rate in a non-Darcy flow.

REFERENCES

[1]. Boogar A. S., Gerami S. and Masihi M., *"New modification on production data of gas condensate reservoirs for rate transient analysis,"* Petroleum Science and Technology, Vol. 32, No. 5, pp. 543-554, 2014.

[2]. Bozorgzadeh M. and Gringarten A. C., *"New Estimate for the radius of a condensate bank from well test data using dry gas pseudo-pressure,"* in: SPE Annual Technical Conference and Exhibition, Society of Petroleum Engineers, 2004.

[3]. Boogar A. S. and Masihi M., *"New technique for calculation of well deliverability in gas condensate reservoirs,"* Journal of Natural Gas Science and Engineering.Vol. 2, No. 1, pp. 29-35, 2010.

[4]. Gringarten A. C., Bozorgzadeh M., Hashemi A. and Daungkaew S., *"Well test analysis in gas condensate reservoirs: theory and practice,"* in: SPE Russian Oil and Gas Technical Conference and Exhibition, Society of Petroleum Engineers, 2006.

[5]. Farhoodi S., Sadeghnejad S. and Dehaghani A. H. S., *"Simultaneous effect of geological heterogeneity and condensate blockage on well test response of gas condensate reservoirs,"* Journal of Natural Gas Science and Engineering, Vol. 66, No., pp. 192-206, 2019.