Deconvolution for Pressure-interfered Production Data of Multiple Shale Gas Wells Containing Sorption Characteristics

Joohyung Kim, Hyesoo Lee, Wonmo Sung
Department of Natural Resources and Environmental Engineering, Hanyang University
Seoul, Korea

ABSTRACT

When analyzing the production data acquired from multiple shale gas wells, it is essential to remove pressure interference for obtaining correct reservoir characteristics. In this study, we employed deconvolution process to remove pressure interferences, however, it cannot be applied directly to shale gas data due to the nonlinearity occurred from desorption. Therefore, we propose new deconvolution method implemented by sorption-corrected pseudopressure to make linearization of pressure-rate relationship. With linearized production data, the results show that the proposed method enables to remove pressure interference effect of multiple fractured wells. Ultimately, one can analyze production data to obtain correct reservoir characteristics.

KEY WORDS: deconvolution; desorption; pressure interference; shale gas; multiple wells.

INTRODUCTION

Pad drilling which drills many wells by a single drilling rig has been widely used for developing shale gas reservoirs (Fig. 1). Pad drilling techniques allow rig operators to drill groups of wells more efficiently. The benefit of a drilling pad is that operators can drill multiple wells in a shorter time than they might with just one well per site. In the past, a drilling pad may have five to ten wells, which are horizontally drilled in different directions. Hydraulic fracturing is essential in developing of shale gas reservoirs because of the extremely low permeability of shale formations. Hydraulic fractures of each well may connect with adjacent hydraulic fractures from another well and it might occur pressure interference on each well (Kim, Chun, Jung, Park, and Sung, 2015). Pressure interference that is occurred by high permeability fractures would large affect results of production data analysis. Accordingly, remove of pressure interferences from an adjacent well is mightily necessary in shale gas pad drilling.

Previous studies have used analytical solutions for removing pressure interference or multi-well type curve matching method. Especially, in shale gas reservoirs, the connected hydraulic fracture network created by adjacent multiple fractured horizontal wells has great effect on pressure interference in production data. However, due to heterogeneity and anisotropy yielded from hydraulic fracturing in shale formation, there is a limitation to implement previous method to remove pressure interference effect. In order to overcome this problem, deconvolution method is used. Deconvolution is a process to remove pressure interference; firstly, superposing the convolved result of production data acquired from multiple wells, and secondly, minimizing the error between the convolved result and the measured pressure data (Levitan, 2007; Cumming, Woolf, Whittle, Gringarten, 2014). This method has advantage for using in heterogeneity or anisotropy system because it does not employ analytical solution which assumes homogeneous and isotropic system. Nevertheless, deconvolution cannot be applied particularly in shale gas reservoirs, because as pressure declines desorption occurs, leading to nonlinearity due to large changes in compressibility which conflicts to the assumption of deconvolution (Kim, Jang, Ertekin, and Sung, 2015).

In this study, we propose a new deconvolution method implemented by sorption-corrected pseudo-pressure to make a linearization of nonlinear pressure-rate relationship occurred from desorption. With linearizing the production data, deconvolution enables to remove pressure interference effect of each multiple fractured horizontal well, and ultimately analyze the production data to find a correct reservoir characteristics.

Fig. 1. Schematic diagram of multi-well pad drilling.