Analyzing the Feasibility of Outcome of Perforation inflow Test Analysis in Tight Gas Reservoirs; a Comparison

Shakeel[1], Atif Zameer[1], and Yasir Ali[1]

[1] Final Year Students, Petroleum & Gas Engineering Department, UET Lahore

Extended Abstract

Well tests have been the primary and most reliable means of quantifying deliverability, characterizing reservoirs and collecting reservoir fluid samples for decades. However, there has been a growing trend over the last several years to search for alternatives such as perforation inflow test, that could yield the desired information in less time, in a more environmentally-friendly manner, and at a cheaper cost than conventional well tests. The desired change has inevitably been towards tests of shorter duration especially in shale and tight gas reservoirs. Although it is accepted that results from short tests with small radii of investigation may not be as reliable as those from conventional well tests, it is reasonable to accept that they could be of value in assisting with strategic decisions about field development.

Perforation inflow test involves conditioning the wellbore for maximum underbalanced perforating conditions and then monitoring the surface or subsurface pressure response. Unlike conventional testing procedures, the surface valve is closed during the entire flow period. In this paper a case study of tight gas reservoir is presented which will illustrate some practical aspects of analyzing real data with the proposed methodology, and an attempt is made to estimate reservoir parameters like initial reservoir pressure, permeability from late time region and skin from early time region.

Then the results of this test are compared with conventional build up test using commercial well test software. As detailed in the paper, the results of conventional buildup test are in good agreement with the perforation inflow test analysis (PITA) results, which nominate PITA as a precious method for obtaining key reservoir parameters, reducing both time and cost in tight gas reservoirs; thereby making the evaluation of tight gas reservoir more reliable and economical.

The aim of this study is to evaluate the reservoir parameters permeability, reservoir pressure and skin at the early stage of life of the tight gas reservoir. Since conventional Build up and drawdown test require long time for stabilization, hence making the evaluation of tight gas reservoir uneconomical.But we can get these parameters from a new well testing technique that is Perforation inflow test.

In this paper the design of Perforation inflow test,analysis and interpretation of data obtained during the test is elaborated. To find the reservoir properties from PITA, it is necessary to differentiate between early and late time data. For this purpose a special derivative known as impulse derivative (IDER) is used, which is important in order to choose appropriate data ranges from a perforation inflow test for appropriate analysis. Impulse derivative (IDER) is defined as:

$$IDER = (\Delta t_a)^2 \frac{d\psi_w}{d\Delta t_a}$$

Impulse derivative behaves in a slightly different way from the traditional well test derivative. It is shown that early time data (wellbore storage) has slope of 2 (conventional welltest derivative has a slop of 1), and the late time data (reservoir flow) has slop of 0 (same as the conventional well test derivative). Thus, once the impulse derivative has been plotted with pseudo time in log-log scales, it is easy to recognize flow regimes. Thenlatetime data is analyzed to find the initial reservoir pressure and permeability by plotting pseudo pressure (Ψ) vs. inverse of pseudo time $(1/t_a)$ on Cartesian coordinates.

Working equation for late time analysis

$$\Psi_w = \Psi_i + \frac{(24)(141.2 \times 103\ )V_w(\Psi_i - \Psi_{wo})}{2kh\,t_a}$$

Then we analyzed the data of early time region to obtain the skin by plotting Pseudo pressure (Ψ) vs Pseudo time (t_a) on Cartesian coordinates. Working equation for early time analysis

$$\Psi_w = \Psi_{wo} + \frac{kh(\Psi_i - \Psi_{wo})t_a}{(24)\,(141.2)V_w S}$$

After the inflow test, the well was flowed for about three days and then a buildup test was run for fourteen days. This was to verify the results obtained from PITA. The well was flowed for 66 hours and then shut for 2 weeks

- Conventional Build up analysis estimated the permeability 0.012md, skin +4.3, and pressure 1420 psi which are in good agreement with the PITA results.
- Instead of performing long duration well tests, it is better to first get an idea about well potential through PITA at a very early stage.
- PITA can be used as pre-frac reservoir test.