RESERVOIR PRESSURE IN TIGHT GAS FORMATIONS FROM A PRESSURIZED CORE SYSTEM

Abstract:

At reservoir conditions in a dry gas well, the fluid is outside of the pressure-temperature envelope and thus in a single phase. The reservoir temperature is above the cricondentherm (maximum temperature above which liquid cannot be formed regardless of pressure). Hence, the fluid can only be in a gaseous phase.

Estimation of reservoir pressure in tight gas formations, such as unconventional, has been elusive and highly uncertain. Industry common practices analyze buildups and drawdowns with Pressure Transient Analysis (PTA) (Tongyi, 2014). An example of PTA is well testing. In tight gas reservoirs, however, this method is neither reliable nor accurate since a virgin formation will not yield enough gas due to its low permeability, typically in the order of micro or nanodarcys. Other methods include Rate Transient Analysis (RTA) or Dynamic Data Analysis (DDA), which consists of applying the fundamental flow-pressure relationships on production data, matching the responses to preexisting reservoir models with the use of type curves. This method is more robust than PTA, but requires substantial time to collect enough data points in tight gas formations.

While drilling conventional formations, wellbore fluids (of density ρm) exert a hydrostatic pressure (Phyd) that is greater than the reservoir pressure (PRes) so mud filtrate (of density ρmf) invades the formation up to a radius of invasion (ri). Mud additives quickly create a pseudoimpermeable layer (mudcake) that prevents the filtration process to continue. While the formation effective porosity (ϕe) determines the extent of the ri for low- to high-permeable formations, it is the formation permeability (k) that controls the instantaneous or spurtinvasion process. Similar fluid dynamics occur while coring. The mud present in the borehole transmits the Phyd to the formation that is exposed by the core barrel while coring, which would tend to displace gas (of density ρg) deeper into the formation. However, in extremely low permeability, and with a coring process lasting only minutes, the ri in the core is negligible so that the mud filtrates only cover ("paint") the core, but do not penetrate it.

A tight gas formation is a system where the fluids do not flow or barely flow, and hence are static as opposed to dynamic. In addition, since in-situ water and rock compressibilities are easily calculated, the only change in volume is due to gas, which correlates with pressure and temperature downhole and in lab conditions. The current methods use dynamic measurements. This paper describes a static measurement of a static system. The method presented in this paper uses data from pressurized cores obtained downhole. The fundamental gas laws, P1V1T2=P2V2T1 and PV=ZNRT, together with mixing laws for density of fluids are used to calculate the original PRes in a dry gas-bearing tight formation. The method relies also on fluid and rock compressibilities and the estimation of porosity from wireline logs.

Bio:

Luis Quintero is Chief Advisor - Production Management for Halliburton. He holds a BS in electrical engineering from Universidad Simón Bolívar, Venezuela; and Msc and PhD in petroleum engineering with a minor in geology from Louisiana State University, USA. His career spans 30+ years in well logging, reservoir engineering, and production management in more than 40 countries. He was President of the Society of Petrophysicists and Well Log Analysts (SPWLA) during 2016-2017, and SPWLA's VP of Technology (2015-2016). In 2014, Quintero was awarded the Gold Medal of SPWLA for career services. He has authored or coauthored more than 30 technical papers and has 14 patents.