Formation pressure = Pe

Areal average reservoir pressure around a given reservoir location $\mathbf{r} = \{x, y, z\}$.

The definition of "areal average" is quite straightforward for wells which have never been produced and simply means the reservoir pressure at the well-reservoir contact.

In producing/injecting wells or wells which have been shut-in after production/injection the definition of "areal average" is ambiguous and defined in several ways depending on applications as summarised in the table below:

Formation Pressure Defintion	Application
Shut-in formation pressure estimate based on a wellbore sandface pressure after a given well is shut-in for t_e hours (1) $p_e = p_{wf}(t_e)\Big\|_{q=0}$	Well intervention This definition is based on the practical observation of wellbore pressure in shut-in wells for well intervention purposes. It is the simplest and the most popular definition of formation pressure and is widely used in all upstream industry applications. The definition of shut-in time t_e is specific to each field or sometimes field area depending on the rock properties and the past well intervention experience. Some conventions are to pick t_e at the end of the radial flow, as the most common number from the past pressure tests, which makes this definition close (but still not equal) to the (2)
Drain-boundary formation pressure estimate along the boundary of drainage area A_e (2) $p_e = \frac{1}{L_e}\int_0^{L_e} p(x,y,z)dl$ where L_e is the boundary of drainage area A_e	Pressure Testing This definition is based on the idea that there is a boundary line L_e which restricts radial flow around a well, which is a fair assumption in most practical cases. The advantage of this method over (1) is that: • it provides more accurate estimate of the pressure away from a given well • it is not dependent on a single value t_e, and accounts for varying t_e depending of drainage area $A_e(t)$ of a given well at a given moment of time
Drain-area formation pressure estimate within the drainage area A_e (3) $p_r = \frac{1}{A_e}\iint_{A_e} p(x,y,z)dS$	Well Flow Performance Analysis This definition is based on the productivity index estimate and assumption that it stays constant Historically this definition is using a specific symbol p_r instead of usual p_e

9-cell formation pressure estimate from reservoir flow simulation model (4) $$p_{e9,\,i,j} = \frac{1}{9}\sum_{k=i-1}^{i+1}\sum_{l=j-1}^{j+1} p_{k,l}$$	Dynamic Modelling It defines formation pressure as an arithmetic average of reservoir pressure values in all cells of reservoir flow simulation model adjacent to the cells containing a well-reservoir contact. In a particular case of vertical well the adjacent cells will be 9 cells around a cell with vertical well which raised the term 9-cell formation pressure. It provides a very rough and often inaccurate estimate of formation pressure and often used in history matching. It should be used with caution when planning new wells, workovers, well performance analysis and testing existing dynamic model against other estimates. A more accurate model estimate of formation pressure can be retrieved from a proper well shut-in in reservoir flow simulation model.

See Also

Petroleum Industry / Upstream / Subsurface E&P Disciplines / Petroleum Geology / Reservoir pressure

Subsurface E&P Disciplines / Production Technology

[Reservoir pressure] [Initial formation pressure, P_i] [Drilled formation pressure, P_d] [Startup formation pressure, P_0] [Multiphase formation pressure]

[Bottomhole pressure (p_{wf})]

[Formation pressure survey]