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HAWKINS' FORMULA FOR THE SKIN FACTOR

Using a two-region reservoir model, Hawkins clarified the concept of skin.

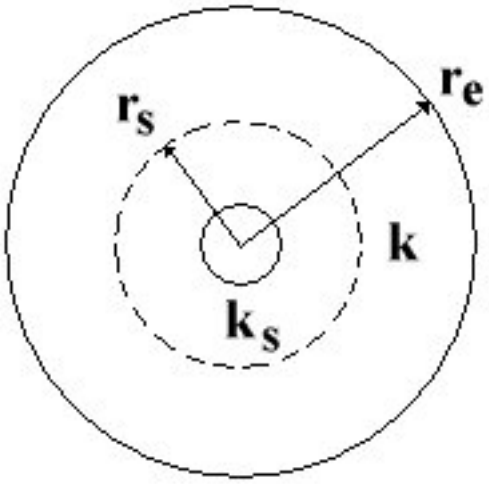

Figure 1: The two-permeabilty reservoir model

The boundary conditions at the internal boundary, $r = r_s$, are given by:

$$p_s^+ = p_s^- = p_s$$

$$q_s^+ = q_s^- = q$$

Superscripts + and – are used to denote the outer and inner hand side of the internal boundary. The flow in each region is governed by the radial flow equation. Thus:

$$p_s - p_w = \frac{qB\mu}{2\pi k_s h} \ln\left(\frac{r_s}{r_w}\right)$$

and

$$p_e - p_s = \frac{qB\mu}{2\pi kh} \ln\left(\frac{r_e}{r_s}\right)$$

Addition of the above equations yields:

$$p_e - p_w = \frac{qB\mu}{2\pi h}\left[\frac{\ln\left(\frac{r_s}{r_w}\right)}{k_s} + \frac{\ln\left(\frac{r_e}{r_s}\right)}{k}\right]$$

According to the skin model:

$$p_e - p_w = \frac{q\mu B}{2\pi kh}\left[\ln(\frac{r_e}{r_w}) + S\right]$$

Elimination of the total pressure drop, $p_e - p_w$, between the above equations, yields.

$$S = (\frac{k}{k_S} - 1)\ln\frac{r_s}{r_w}$$

This is the Hawkins equation.

Some comments are in order

- Damage ($k_s < k$) leads to a positive skin factor.
- Stimulation ($k_s > k$) leads to a negative skin factor.
- The skin factor and the reservoir permeability may be obtained by a well test. Hawkins equation involves two additional unknowns, r_s and k_s. If one of these is known from other sources, the other one may be determined from Hawkins equation.

The relationship between the composite model (two regions) and the skin model is illustrated below.

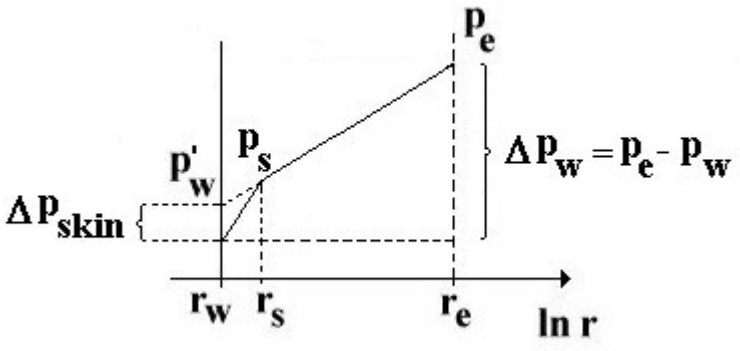

Figure 2: Pressure profiles for the two region and the skin model

The skin factor may assume high positive values for a damaged well. In fact, it may be so high that the well will not produce unless it is stimulated. The skin factor of a stimulated well , however, is rarely less than –7.