PRODUCTIVITY OF OIL WELLS IN ARBITRARILY SHAPED RESERVOIRS

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1. INTRODUCTION

A boundary element approach for predicting the productivity of oil wells arranged in complex configurations within irregularly shaped reservoirs were developed. The integral equations are written for boundary points as well as for the locations of the wells which are treated as point sources and sinks with specified pressures but unknown strengths. Using this approach, the solution to the resulting matrix gives the values of the nodal boundary pressure and their normal derivatives, as well as the unknown flow rates of all the wells.

2. PROBLEM FORMULATION

Consider a hypothetical two-dimensional homogeneous reservoir S having NSS sources and /or sinks located randomly within an arbitrarily shaped reservoir. The following assumptions were used in developing the theory: a) the reservoir is in steady-state flow with reservoir pressure above bubble points i.e. undersaturated condition; b) single phase fluid having small (and constant) compressibility and constant viscosity is flowing in the system; c) the reservoir has a uniform thickness and it has a finite boundary; and d) gravitational effects are negligible.

The differential equation describing the unknown functions i.e. pressure, at all points in the reservoir, is obtained by the introduction of Darcy's law into the continuity equation. By imposing the conditions and assumptions stated above, the differential equation describing the pressure distribution in the reservoir is [1,2]:

$$\frac{\partial^2 p}{\partial X^2} + \frac{\partial^2 p}{\partial Y^2} + \frac{\mu}{k} \sum_{m=1}^{NSS} q_m \; \delta(X - X_m, Y - Y_m) = 0, \tag{1}$$

where p is the pressure , μ is the dynamic viscosity of the fluid, k is the permeability, q_m is the flow rate of the m^{th} well per unit area (positive for injectors and negative for producers), δ is the Dirac delta function, X, Y are coordinates axes, and X_m, Y_m are coordinates of the m^{th} source and/or sink, where m goes from 1 to NSS.