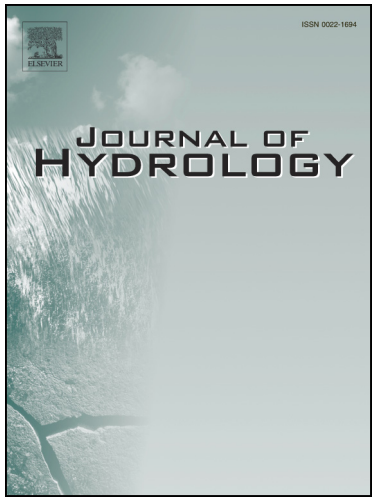

Research papers

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A generic analytical solution for modelling pumping tests in wells intersecting fractures

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Abstract

The behaviour of transient flow due to pumping in fractured rocks has been studied for at least the past 80 years. Analytical solutions were proposed for solving the issue of a well intersecting and pumping from one vertical, horizontal or inclined fracture in homogeneous aquifers, but their domain of application—even if covering various fracture geometries—was restricted to isotropic or anisotropic aquifers, whose potential boundaries had to be parallel or orthogonal to the fracture direction. The issue thus remains unsolved for many field cases. For example, a well intersecting and pumping a fracture in a multilayer or a dual-porosity aquifer, where intersected fractures are not necessarily parallel or orthogonal to aquifer boundaries, where several fractures with various orientations intersect the well, or the effect of pumping not only in fractures, but also in the aquifer through the screened interval of the well.

Using a mathematical demonstration, we show that integrating the well-known Theis analytical solution (Theis, 1935) along the fracture axis is identical to the equally well-known analytical solution of Gringarten et al. (1974) for a uniform-flux fracture fully penetrating a homogeneous aquifer. This result implies that any existing line- or point-source solution can be used for implementing one or more discrete fractures that are intersected by the well. Several theoretical examples are presented and discussed: a single vertical fracture in a dual-porosity aquifer or in a multi-layer system (with a partially intersecting fracture); one and two inclined fractures in a leaky-aquifer system with pumping either only from the fracture(s), or also from the aquifer between fracture(s) in the screened interval of the well. For the cases