Quantifying non-linear Relationship Among Volumetric flow, Aperture, and Anisotropic Wall Roughness of Fractures

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ABSTRACT

Fractures are discrete features in geologic media that facilitate fluid flow. Flow rates through fractures are a function of fracture aperture, roughness, and hydraulic head. Fracture aperture is the distance between opposing fracture surfaces with variability defining roughness. Flow through smooth, wide fractures follows a cubic law, but this relationship is not valid for smallaperture fractures and those with significant roughness. Fracture aperture and roughness govern turbulent losses. At the field scale, relationships between flow rate, hydraulic head, aperture, and roughness are critical. To my knowledge no study has reported any statistical relationships between flow rate, hydraulic head, aperture, and roughness yet, which is the goal of this study. This study quantified fracture-characteristics (aperture and roughness) using highresolution LASER scans and flow rates at three different hydraulic heads for total 20 fractured limestone cores. The head versus flow curve for 20 core shows nonlinear flow pattern. Fracture characteristics are independent of core. The flow rates, hydraulic heads will be correlated with fracture-characteristics to develop a multivariate statistical relationship between flow rate, hydraulic head, and fracture-characteristics. The relation will improve flow prediction in fracture dominant petroleum engineering, groundwater, nuclear waste disposal, and geothermal-energy flow models.

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