

A Criterion for Non-Darcy Flow in Porous Media

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Abstract

Non-Darcy behavior is important for describing fluid flow in porous media in situations where high velocity occurs. A criterion to identify the beginning of non-Darcy flow is needed. Two types of criteria, the Reynolds number and the Forchheimer number, have been used in the past for identifying the beginning of non-Darcy flow. Because each of these criteria has different versions of definitions, consistent results cannot be achieved. Based on a review of previous work, the Forchheimer number is revised and recommended here as a criterion for identifying non-Darcy flow in porous media. Physically, this revised Forchheimer number has the advantage of clear meaning and wide applicability. It equals the ratio of pressure drop caused by liquid–solid interactions to that by viscous resistance. It is directly related to the non-Darcy effect. Forchheimer numbers are experimentally determined for nitrogen flow in Dakota sandstone, Indiana limestone and Berea sandstone at flowrates varying four orders of magnitude. These results indicate that superficial velocity in the rocks increases non-linearly with the Forchheimer number. The critical Forchheimer number for non-Darcy flow is expressed in terms of the critical non-Darcy effect. Considering a 10% non-Darcy effect, the critical Forchheimer number would be 0.11.