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Frequency-dependent streaming potential of porous media: Experimental approaches and apparatus design

Paul W.J. Glover (1), Jean Ruel (2), and Eric Tardif (2)

(1) University of Leeds, School of Earth and Environment, Leeds, United Kingdom (p.w.j.glover@leeds.ac.uk), (2) Department of Mechanical Engineering, Université Laval, Quebec, Canada

Electro-kinetic phenomena link fluid flow and electrical flow in porous and fractured media such that a hydraulic flow will generate an electrical current and vice versa. Although such a link is likely to be extremely useful, especially in the development of the electro-seismic method, surprisingly few experimental measurements have been carried out, particularly as a function of frequency because of their difficulty. We have carried out a study that considers six different approaches to making laboratory determinations of the frequency-dependent streaming potential coefficient of geomaterials. These are (i) motor and scotch yoke, (ii) motor and cam, (iii) pneumatic drive, (iv) hydraulic drive, (v) electro-magnetic drive, and (vi) piezo-electric drive. In each case, we have analysed the mechanical, electrical, and other technical difficulties involved. We conclude that the electro-magnetic drive is currently the only approach that is practicable, while the piezo-electric drive may be useful for low permeability samples and at specified high frequencies. We have used the electro-magnetic drive approach to design, build, and test an apparatus for measuring the streaming potential coefficient of unconsolidated and disaggregated samples such as sands, gravels, and soils with a diameter of 25.4 mm and lengths between 50 mm and 300 mm.