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Dependence of streaming potential on grain diameter and pore throat radius

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The Helmholtz-Smoluchowski (HS) equation is commonly used to relate the streaming potential coupling coefficient of porous media to a range of pore fluid parameters and the zeta potential of the rock. It contains no implicit dependence upon grain size, pore size or pore throat size. We have developed a form of the HS equation that depends on grain size, and compared it with another model, the conventional HS equation and the only previously available experimental data. While the standard HS model cannot match the data, either of the other two models can. Recognising the sparseness of experimental data, we have measured the streaming potential coupling coefficient for 12 sizes of bead and two fluid salinities. The new experimental data show that while both non-conventional models fit the new data very well, the model developed in this work is better when the model has no adjustable parameters. We have also developed equations that describe how the coupling coefficient varies with pore diameter and pore throat diameter. We have compared experimental determinations as a function of pore throat diameter with the new model and found it to match very well if the ratio of the mean pore diameter to the pore throat diameter is 1.627, which is valid for random distribution of monodisperse spheres. The zeta potential has been calculated from both models and found to be approximately constant and in agreement with the theoretically predicted values. This work provides relationships for the variation of streaming potential coupling coefficient as a function of (i) grain size, (ii) pore radius, and (iii) pore throat diameter (for cubic, tetragonal and random packing), as well as a high quality dataset of streaming potential coupling coefficients as a function of grain size, pore radius and pore throat diameter.