THESIS

ELECTROMECHANICS OF PACKED GRANULAR BEDS

Submitted by

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ABSTRACT OF THESIS

ELECTROMECHANICS OF GRANULAR PACKED BEDS

Strong, electrical, interparticle forces are induced by applied electric fields within packed beds of dielectric particles. Proposed applications utilizing electropacked beds (EPBs) or electrofluidized beds (EFBs) include air filtration and gas clean-up, fine particle separation, commercial drying and coating processes, heat and mass transfer, and bulk bed control.

A new distributed circuit model of the electrical interparticle force is presented that identifies the role of surface roughness as determining the interparticle spacing. The dc steady state force is predicted to increase nearly linearly with the applied electric field and is theoretically independent of particle surface conductivity.

Two experimental techniques are used to estimate the electrical stress acting in EPBs. A new slope equilibrium technique involves measuring the angle of repose as a function of the applied electric field. In the sled yield locus method, the shear force required to initiate movement of a metallic sled resting on the surface of an EPB is measured as a function of the applied field.

Using these techniques, the electric stress is found to vary nearly linearly with the applied electric field. Data are generally consistent with the theoretical contention that increased surface roughness decreases electromechanical effects. Surface conductivity variations of three to four times have no measurable effect on the dc steady state electric stress. The electric stress is insensitive to the dielectric properties of the interstitial gas eliminating Townsend discharge as a candidate for the nonlinear charge transport process thought to occur near interparticle contacts. The theoretical upper bound of the electric stress calculated using the distributed circuit model falls within the scatter of the data if a limit on the electric field in the interparticle gap which models nonlinear charge transport is in the range of 1 - 6 x 10^7 V/m. Estimates of the charge relaxation time using transient angle of repose experiments are somewhat smaller but comparable with theoretical values calculated by ignoring nonlinear charge transport.

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