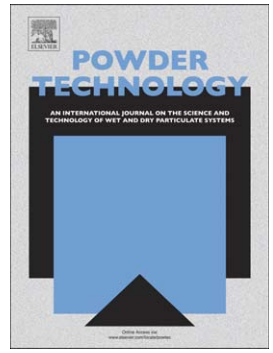

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Mechanical characterization of compressible chromatographic particles

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Abstract

During operation of packed-bed chromatography columns, the mechanical properties of the porous chromatographic particles determine the overall macroscopic compression behavior. The porous particles are biphasic materials consisting of a solid matrix and interstitial fluid. Mechanical characterization of selected arrays of two types of polymeric chromatographic particles made of agarose and methacrylate with a mean particle diameter of 60 µm and 83 µm, respectively, was carried out by applying a high-resolution micromanipulation technique. The effect of compression speed and displacement level was investigated. Both particle types showed pronounced time-dependent compression behavior and force relaxation. Long-time compression load relaxation experiments revealed that two different time-dependent mechanisms were involved. It was shown that the characteristic force relaxation times describing either mechanism differed by a factor of 13-31. Short-time quasistatic compression experiments were excellently described by a Maxwell-type standard linear solid model in which the force relaxation time matched the shorter relaxation time. It was assumed, that force relaxation occurring at short time is ascribed to poroelastic material behavior and at longer times to viscoelastic material behavior. This enabled the determination of fundamental particle properties, i.e. instantaneous and relaxed particle shear and Young´s moduli, Poisson's ratio, and coefficient of restitution.

Keywords: Indentation; mechanical characterization; micromanipulation; polymeric chromatographic particles; poroelasticity; viscoelasticity