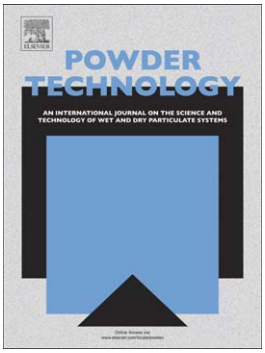

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New simple correlation formula for the drag coefficient of calcareous sand particles of highly irregular shape

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Abstract

This paper presents a study of the terminal fall velocity and drag coefficient of natural particles of highly irregular shapes in a wide range of Reynolds number (0.01~3,700). The study is based on experimental measurements of the terminal fall velocities of calcareous sand particles settling in liquids of different densities and viscosities. A total of 133 calcareous sand particles of highly irregular shapes were measured and 521 experimental data points were obtained. To characterize the particle shapes, a shape descriptor which can take into account both sphericity and inverse circularity, were introduced and it can be measured via image particle analysis techniques. This shape descriptor is particularly suitable for non-spherical and highly irregular particles, such as calcareous sand particles. The drag coefficient has been correlated to the particle Reynolds number and the shape descriptor, and a new model for predicting drag coefficient has been correlated; the correlation has the functional form of a power law. Its simple explicit form makes it easy to use in computer models and other applications. The performance of seven widely-used correlation laws has been examined; and the fitting of experimental measurements with the new correlation model shows that the new correlation model predicts the drag coefficients and the terminal fall velocities of irregularly-shaped particles, i.e., calcareous sand particles, more accurately than other shape-dependent drag laws. In addition, the influence of presence of neighboring particles on drag coefficient and terminal velocity was investigated under conditions where the test particle is surrounded by other equal-sized and similar-shaped particles arranged in different configurations. Furthermore, through proposing a new