A model for evaluating the particle penetration efficiency in a ninety-degree bend with a circular-cross section in laminar and turbulent flow regions

X.C. Cong, G.S. Yang, J.H. Qu, J.J. Zhao

PII: S0032-5910(16)30767-7
DOI: doi: 10.1016/j.powtec.2016.10.074
Reference: PTEC 12073

To appear in: *Powder Technology*

Received date: 13 July 2016
Revised date: 25 October 2016
Accepted date: 31 October 2016

Please cite this article as: X.C. Cong, G.S. Yang, J.H. Qu, J.J. Zhao, A model for evaluating the particle penetration efficiency in a ninety-degree bend with a circular-cross section in laminar and turbulent flow regions, *Powder Technology* (2016), doi: 10.1016/j.powtec.2016.10.074

A model for evaluating the particle penetration efficiency in a ninety-degree bend with a circular- cross section in laminar and turbulent flow regions

X. C. Cong*, G. S. Yang, J. H. Qu, J.J.Zhao

Shandong Provincial Key Laboratory of Civil Engineering Disaster Prevention and Mitigation,

Shandong University of Science and Technology, Qingdao 266590, China

Abstracts

Understanding particle penetration losses in a bent section is useful for quantitatively evaluating the aerosol sampling error in a sampling system. This study intended to examine the physical factors that contribute to sampling error in a 90^0 bend installed in a sampling line and to evaluate current models that are used to predict penetration losses in continuous emission sampling (CPS).The particle penetration characteristics of seven size groups (0.1, 0.5, 1.0, 5.0, 10 and 20 μm) were numerically investigated via a Lagrangian particle-tracking model in a 90^0 bend with a circular cross-section. A particle–wall collision model was adopted to consider the particle–wall collision effect. Good agreement was achieved between gas mean velocity and particle penetration efficiency predictions and experimental data in the literature. An analysis was performed to study the particle penetration characteristics in pipes with different bend curvature ratios, geometries and various Re numbers. Our results indicated that approximately 20% particle losses for $\geq 5\mu m$ particles occur if the sampling line is bent. In addition, particle losses can typically be reduced by lowering the air velocity in the sampling line or by using a sampling line with a larger inner diameter. Models based on numerical data were developed as a function of related parameters to further predict the particle penetration efficiency. In a laminar flow, the model $\eta = \alpha \cdot e^{-\lambda \cdot St}$ is given with an error of 2.6% - 4.3%. In a turbulent flow system, however,