293f A Generalized Particle Model for Pressure Drop through Structured and Random Packings

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One of the most fundamental and successful particle models for correlating pressure drop in structured and random packings was that proposed by Stichlmair et al. [Gas Sep. Purif., 3, p. 19, March 1989]. The Stichlmair model requires three packing-specific constants (determined from experimental dry pressure-drop data) to compute the friction factor in terms of Reynolds number of the gas at dry conditions. The authors used a limited data base for both structured and random packings to validate their model thus restricting its application range to a few number of packings. In an attempt to extend the direct applicability of the Stichlmair model to virtually any packing, we made use in this work of a neural-network-based approach to generalize the Stichlmair constants in terms of readily available packing characteristics such as packing geometry and shape, material of construction, etc. For this purpose, two separate three-layer feed-forward neural-network arrangements were devised and trained using those regressed constants originally reported by Stichlmair et al. (1989) for 8 structured packings and 31 random packings. The performance of the two neural networks during the training process was excellent for both types of packing despite the fact that a limited data base was used for such a purpose; the packing descriptors chosen as neural network inputs played a very important role in successfully correlating the Stichlmair constants. The predictive capabilities of the trained neural networks were further tested by computing the Stichlmair constants of two packings (one structured and one random) not considered in the original data base and then using these constants in the particle model for pressure-drop predictions. The agreement between predicted and observed pressure-drop data was highly acceptable thus demonstrating the abilities of the two neural networks in predicting suitable values of the Stichlmair constants for structured and random packings within the present hybrid framework that combines a deterministic model with a "gray-box" model allowing generalization.