A NEURAL-BASED MODELLING APPROACH TO ESTIMATE RESIDENCE TIME AND SOLIDS FLOW RATE IN A CONICAL SPOUTED BED WITH AND WITHOUT DRAFT TUBES

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Spouted beds are an alternative contact method to the fixed and fluidized beds especially for handling coarse particles. Since its discovery in 1954 by Gishler and Mathur during grain drying in a fluidized bed, spouted beds have been widely studied and applied in different industrial processes, such as, particle coating, catalytic reactors, pyrolysis and drying of solids, pastes and suspensions. One of the main advantages of spouted beds over fluidized beds is its high degree of mixing between gas and solids within the bed due to a cyclical and uniform movement of particles, leading to high heat and mass transfer rates and also a homogeneous final product. Despite its advantages, the conventional configuration of the spouted bed still has some limitations; such as a high pressure drop for stable spouting, the existence of a maximum height for a stable spout with the corresponding scaling-up limitations and the highly dependable gas flow rates on stable spouting. In order to minimize these operational limitations, several spouted bed configurations have been proposed, the main ones being the spouted bed with a draft tube, the two-dimensional spouted bed and the spouted bed with supplementary aeration, among others. Solids residence time and flow rates are key parameters in the modeling, optimization and control of any process. Although predictions of solids residence time and flow rate are important issues that reflect the accuracy of the whole process simulation, difficulties arise in the use of either purely mechanistic or empirical approaches. In developing a reasonable theoretically based model, the only task is to estimate the values of the coefficients in the model, but, taking into account all relevant phenomena involved this model can prove to be impractical. Additionally, the seemingly overwhelming choice of structural options for empirical models may considerably hinder the modeling step. Artificial neural networks may be an effective alternative in that they can represent highly nonlinear processes, with flexibility and robustness against input noise and once they have been developed and their coefficients determined, they can provide a rapid response for a new input [1]. This neural network based model (MatLab® R2013a, Mathworks) uses the particle diameter dp, bed density ρb, cone angle γ, inlet diameter D0 and draft tubes characteristics as inputs whilst the maximum, mean and minimum residence times along with the solid flow rates are predicted with reasonable agreement with the experimental data, as shown in Figure 1.

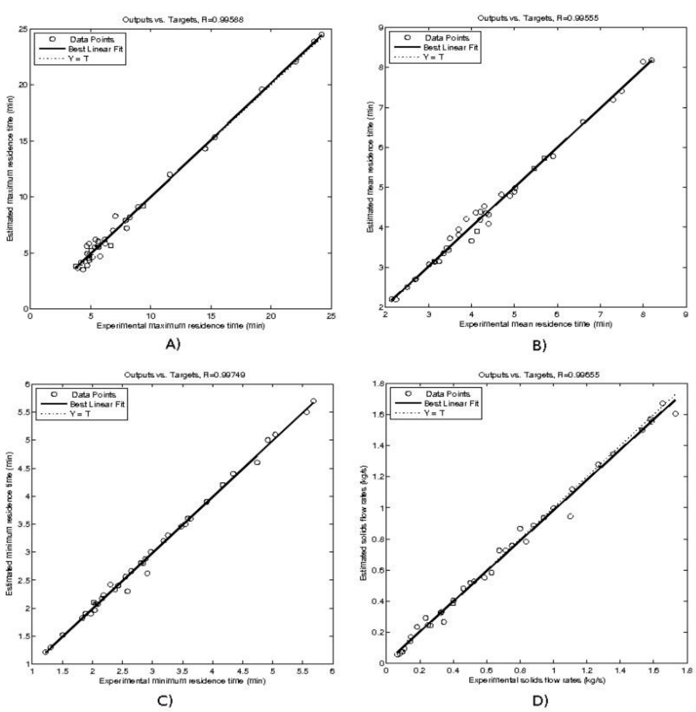

Figure 1: Calculated vs Experimental values for; A) maximum residence time, B) mean residence time, C) minimum residence time , D) solids flow-rate.

[1] D. M. Himmelblau, "Accounts of experiences in the application of artificial neural networks in chemical engineering," *Ind. Eng. Chem. Res.*, vol. 47, no. 16, pp. 5782–5796, 2008.