Predicting bulk density of binary powder mixtures from pure component properties

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Bulk density of pharmaceutical powders (ρ_b) is an essential parameter for solid dosage forms. For example, during manufacturing, it can indicate the amount of powder that can fit in a hopper, tablet die or capsule filler and its knowledge is valuable in many stages of product research and development. For mixtures, ρ_b is not an additive property, so that it must be determined experimentally for each mixture. Therefore, the possibility of predicting mixture ρ_b using properties of pure components would make the development of new formulations faster and cheaper and eliminate the risk of process failure. Moreover, ρ_b is closely connected with powder ability to flow gravitationally, making it the key parameter of mixtures intended for direct compression.

The aim of this study is a prediction of binary mixture ρ_b based on properties of starting materials using a simple mathematical equation. This equation arises from hypothesis based on presumption that one component serves as a matrix and particles of the second component are incorporated into voids of that matrix. To verify the validity of the equation, real data of mixtures containing one of the two studied ibuprofen powders and one of five different pharmaceutical excipients in several ratios (30, 50, and 70 % by weight) were used.

The results revealed that the suggested equation provides a satisfactory prediction of ρ_b for mixtures consisting of components with different void fractions. For such systems, it is common that their ρ_b values are located in the range defined by the values of pure components. However, in case of mixtures comprising compounds having analogous void fractions, the mathematical equation is not suitable and predicted values are higher than the real ones. Although obtained trends in values are similar regarding the development of ρ_b with mixture composition. Moreover, these mixtures are characterised with higher ρ_b than pure components. Probably, this unsuitability of the equation might be given by the fact that used compounds alternate each other and there is no fixed matrix in real systems in comparison with our set hypothesis. Therefore, application of an advanced approach to the calculation of binary powder mixture ρ_b would be carried out as a further step of this work.