Predicting the Efficiency of Chaotic Mixing of Granular Pharmaceutical Materials Using Image Processing

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Mixing is an interesting but still not well understood process by the scientific community with significant applications in pharmaceutical, food processing, ceramics, fertilizer, and petrochemical industries. Maintaining the blend homogeneity of all the ingredients in the mixture is extremely important in all these products. Mixing of granular solid materials in a rotary tumbler depends on the size and surface characteristics of granular materials, speed of rotation, shape of the tumbler, axis of rotations, and many other factors. My hypothesis is that even though the mixing is a chaotic process, we should still be able to predict the quality of the final mixture. A double cone mixer was assembled from two glass funnels, and commonly accessible materials. A rotary drive mechanism was designed using the LEGO NXT kit at home. I chose three types of granular materials for my study, 3mm plastic beads, 1mm plastic beads, and fine art-sand which closely resembles pharmaceutical granular solids. The mixture concentration of different granular materials was determined non-intrusively using image analysis technique to detect the red and green pixels in the digital image. The study shows that the efficacy of the mixing process was the highest for larger sized (3mm) beads and lowest for art-sand. I found a direct relationship for each of the three granular materials for concentration as a function of mixing time. I observed that efficiency of the mixing process increases with increasing speed of rotation for all three granular materials, as evident from the Intensity of segregation vs RPM plots. This is a novel study to solve an age old problem to improve the efficacy of the mixing process to produce better mixture based products and minimize the industrial loss.

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