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"Development on the margin"

Improving Air Distribution and Drying Uniformity in a Batch Dryer for Agricultural Products

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Abstract

Batch dryers are the most common practice of drying on farm level in tropical countries, *e.g.* for paddy, cocoa and other agricultural products. Uneven air distribution is a main problem in their performance. Zones receiving a higher airflow rate dry faster, and this heterogeneity reduces efficiency by increasing energy consumption and drying times. A box dryer was built and tested and computational fluid dynamics was used to simulate its air distribution. The dryer consisted of a plenum chamber above which plastic boxes holding the product are placed. A middle wall separated the plenum in two equal halves, so that the whole dryer or only one half can be used. A fan was connected to both halves through a Y-shaped duct of the same cross-section as the fan outlet.

Simulations showed that this configuration produced a deficient air distribution to the different boxes. Trying to overcome this problem, simulations were conducted with a modified design consisting of a wide inlet into the plenum chamber. The results showed an almost perfectly uniform air distribution. This was therefore considered satisfactory for further study, which consisted of finding a suitable diffuser to serve as transition between the small cross-section of the air ducts and the wide entrance to the plenum. It was seen, both from theory and from flow simulations, that simple diffusers need to be prohibitibely long to serve their purpose. However, short, wide-angle diffusers can be equipped with air guides and perforated plates to remain effective. Simulations were done of different diffuser designs, trying to find one which fulfils its function with a minimum of length.

Drying trials with woodchips were conducted for the original and modified dryer configurations, during which the drying course and airflow of each box were measured. Results for the original configuration showed, like the simulations, a wide variation in airflow among boxes, and also the expected wide differences in drying rate. A very significant correlation between these two variables was found in all cases. The modified version resulted in much more homogenous air distribution and drying rates and therefore represents a viable option to improve dryer efficiency.

Keywords: Air distribution, batch dryer, computational fluid dynamics, dryer performance

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