ABSTRACT

Bagasse Drying for Caribbean Cane Sugar Factories

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Bagasse drying has increasingly been examined and practiced in the sugar industry with the aim of enhancing the potential of bagasse both as a fuel and as a source of downstream by-products. However, to date, it has not been incorporated into Caribbean sugar factory operations. Thus in this study, much emphasis is placed on projecting its applications to the situation in Caribbean sugar factories.

This work determined the fundamental drying characteristics of bagasse mainly by evaluating the results of single layer drying experiments. These results showed that most of the drying occurred in the falling rate period when drying rates increased with increasing air temperatures, air velocities and with decreasing air humidities and particle sizes. A correlation between these four variables and the drying constant was derived as follows:

$$k = 0.0019 \exp(0.0073T) + 0.0292 \exp(-0.89S) + 0.00078V + 0.00057 H^{-0.57} - 0.00088V \exp(-0.89S) - 0.03135$$

where k - Drying constant

T - Drying air temperature, °C

S - Particle size, m

V - Air velocity, ms^{-1}

H - Air humidity, kg water kg dry air^{-1}

When used to predict drying constants, good agreement with experimental values was obtained. Along with the material properties, the results led to establishing the mechanism of internal moisture movement to be by diffusion from within the fibres and by capillary action from between the fibres of the bagasse particles.

The thesis reviews the reported work on bagasse driers in the sugar industry and an assessment is made of the relevant drier types for the Caribbean situation. The vertically oriented crossflow and counterflow packed bed types with gravity flow are particularly appropriate but the latter is shown to be not practical for incorporating in some factory situations.

Experimental work and computer simulation modelling of packed bed drying were pursued. The drying curves from the simulations when compared with the experimental drying curves displayed good agreement. The curves showed that acceptable amounts of drying could be obtained in about 5 minutes while the bulk of the drying would be completed in 10 minutes.

The simulation model, modified to apply to crossflow packed bed drying, was used in designing aspects of such a drier. Computations show that typical dimensions for each half of a crossflow drier were 6 m height by 3 m width by 0.30 m thickness for a 4 minute residence time in a case when two such driers would be required for 33 tonnes bagasse per hour from 100 tonnes cane per hour. Such driers by their size and also by virtue of their flexibility in design configuration could easily be retrofitted into existing factories and could be constructed on site by factory personnel.