DETERMINING SEED COTTON MASS FLOW RATE BY PRESSURE DROP ACROSS A BLOWBOX

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Abstract

A seed cotton mass flow rate sensor would offer useful feedback for gin managers and provide a critical input for advanced process control systems. Several designs of seed cotton mass flow rate sensors have been evaluated in the laboratory, but none have found acceptance in commercial gins. The objectives of this research were to develop a system for predicting seed cotton mass flow rate based on the pressure drop measured across a blowbox; investigate the effect of duct diameter, cultivar, moisture content, feed rate, and fan speed on this relationship; and provide recommendations for developing a prototype system for testing in commercial gins. A negative pressure pneumatic conveying system was constructed, with variable speed capability on both the feed control and fan. The blowbox pressure drop and other variables were recorded during testing and used to develop a model to predict the seed cotton mass flow rate. The model was calibrated by conveying a known mass of seed cotton through the system and integrating the model over this time. Two duct diameters, 17.8 cm (7 in.) and 25.4 cm (10 in.); two varieties, ST 4554 B2RF and DP 161 B2RF; two moisture content levels, averaging 8.7% (w.b.) and 10.8%; three feed rates, 22.7, 45.4, and 68.1 kg min^{-1} (50, 100, and 150 lb min^{-1}); and three fan speeds, 2620, 3050, and 3490 rpm; were tested in a split-plot design with three replications as main blocks and the duct diameter as sub-blocks. As expected, duct diameter significantly affected the model parameters and each diameter was analyzed separately with unique model parameters. The resulting mean absolute error in predicting seed cotton mass was 7.35%. Cultivar and moisture content had no effect on the model regression coefficients. Significant differences existed between the regression coefficients of different feed rates; however, these only occurred at mass flow ratios much larger than achieved in commercial gins. The effect of fan speed was small and likely not practically significant. Cross-validation prediction error was 8.74%, indicating that frequent calibration may not be necessary with this system. Measuring the pressure drop across a blowbox is a suitable basis for further development of a seed cotton mass flow rate sensor for commercial gins.