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WeARE Research Area

The research focused on analyzing the relationship between the surface area of a Potassium Chloride water mixture used for humidifying seed cotton and the volume of conditioning chambers, as well as their effects on the rate at which water is absorbed by seed cotton.

Motivation or Background

All phases of cotton harvesting and processing are affected by moisture levels in the cotton. A low level of moisture in cotton before and during harvesting will allow for better quality product, reduce cotton deterioration, and increase harvesting efficiency. In order to understand the moisture systems of cotton, conditioning tests are frequently performed by ARS and many other companies to assess for these factors; however, their methods consume cumulatively large amounts of resources such as energy and water. Our research is intended to improve the efficiency in cotton conditioning methods while reducing wasteful use of resources.

Objectives

1. Establish the relationship between the conditioning time of cotton and the ratio between the surface area of a Potassium Chloride water mixture and the volume of the conditioning chambers.
2. Create first order response models of the relative humidity inside the empty conditioning chamber, along with models of the cotton lint and cotton seed's water absorption.

Methodology

A series of tests were run to compare the time needed for an enclosed space(conditioning chamber) to reach equilibrium using one tub, two tubs, three tubs, four tubs, and five tubs of Potassium Chloride (KCl) water mixture. Relative Humidity (RH) sensors were used to track the RH and temperature levels inside the conditioning chambers over time. This data was used to create functioning models of both empty conditioning chambers (first order response), and chambers with seed cotton in them (2nd order response) with the varying numbers of KCl tubs.

$$H(s) = \frac{K_p}{\tau s + 1}$$

$$H_{lint+seed}(s) = \left[\frac{K_{plint}}{\tau_{lint}s + 1} \right] + \left[\frac{K_{pseed}}{\tau_{seed}s + 1} \right]$$

Where:

$H(s)$ = First order response.

K_p = Cotton humidity at equilibrium.

τ = Time constant.

$s = j\omega$.



Fig. 1 Potassium Chloride water mixture tub.



Fig. 2 Setup inside a conditioning chamber with sensors

Results

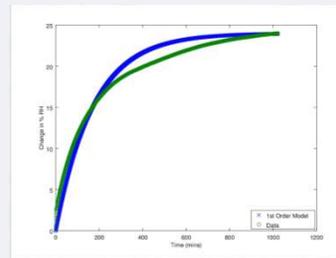


Fig. 3 Change of RH in 25 ft³ Chamber with 1 tub

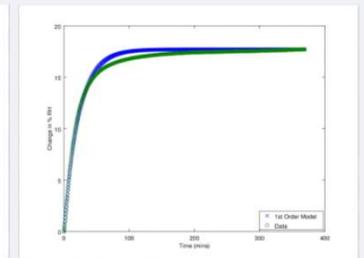


Fig. 4 Change RH in 25 ft³ Chamber with 5 tubs

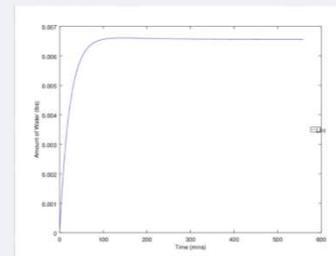


Fig. 5 Water absorbed by Cotton Lint

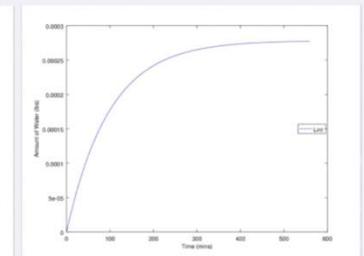


Fig. 6 Water absorbed by Cotton Seeds

Skills and Experience

The research team gained experience in using: FreeCAD, Arduino IDE, Octave GNU, circuitry, LinuxOS, fabrication, standard research protocols, safety protocols, teamwork, interpersonal and professional communication skills.

Future Plans

In order to expand this research area, future experiments could consist of modification of variables such as: closed environment temperature, cotton surface area, saturated salts surface area, and air circulation within the conditioning chamber.

What I Learned

We learned the importance of developing the ability to apply knowledge from the classroom in real life. We also learned how to develop professional work ethics and behavior.

Acknowledgments



This research was made possible by the U.S. Department of Agriculture/Cropping Systems Research Laboratory. This work is supported by the USDA National Institute of Food and Agriculture, Interdisciplinary Hands-on Research Traineeship and Extension Experiential Learning in Bioenergy/Natural Resources/Economics/Rural project, U-GREAT (Undergraduate Research, Education And Training) program (2016-67032-24984).

References

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