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Drying process of tobacco leaves by using a fuzzy controller

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Abstract

This paper presents the first results from a research project devoted to the application of the fuzzy control based technology to the drying process of tobacco leaves, which the authors are carrying out in the province of Pinar del Rio (Cuba). The fuzzy controller here reported has been designed and implemented by means of a fuzzy rule base constructed from the knowledge of the expert curers taking part in the natural drying process. The preliminary results obtained are very promising.

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1. Introduction

For several decades the curing of tobacco by control techniques, which accelerate the drying process of leaves, has been performed in Cuba. This type of curing provides a larger percentage of layers for exportation and in addition, it does not need so many traditional drying sheds where the curing of natural tobacco takes place. In order to achieve the required conditions in controlled curing, adequate temperature and relative humidity inside the drying shed must be guaranteed during the curing stages [2,4]. All of this process is actually controlled by an intelligent mechanism, which guarantees the monitoring of the curing program previously selected by the system operator. This person is known as the “curer” and it is him who, at the end, decides when to change from one stage to another from the analysis made on the

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state of leaves. So, the curer is the expert who makes the decisions about the change of stages according to the state of the leaves.

But, as a result of the country's conditions, there are limits to the controlled curing process of tobacco, and the technology that has been used up to now for controlling the drying process [9] does not allow for changes that, with the objective of increasing the quality of the final product and reducing the energy and fuel consumption, they could help to improve this process without affecting it.

In order to explore alternative technology ways, we are developing in the province of Pinar del Rio (Cuba) a cooperative research project devoted to study the suitability of the application of the fuzzy control based technology to the drying process of tobacco leaves. The context of the present work is thus determined by this situation. Consequently, without ignoring the experience that already exists on this subject, in this project we propose a change in technology, by using fuzzy logic based techniques, in order to acquire an expert-like knowledge to improve the performance of the leaf drying process.

The use of fuzzy logic in the controlling process has been extended within the last decade, throughout which there has appeared a large amount of literature ([3,6,9,10]). Its use in practical applications, above all in domestic electrical appliances, is something of a daily occurrence and also something that other control techniques, with many years of theoretical development, have not yet achieved. However in the context of the drying process of tobacco, and to the best of our minds, from the fuzzy control side there are not significant contributions on this topic. In this framework, the main aim of this paper is to demonstrate the usefulness of fuzzy methodology in the practice of the drying process of tobacco leaves. In this way, the original results presented here refer to the first part of the above cooperative research project that, although preliminary for having been obtained based on an experimental prototype, are encouraging.

In this context, the rest of the article is organized as follows. In Section 2 the technological process of controlled curing of tobacco is summarized. In Section 3 the design of the control system is shown. In Section 4 the results obtained are analyzed, and finally the conclusions and future work to be carried out are presented.

2. Controlled tobacco curing process

In the late eighties and mainly in the nineties, the technology for the controlled curing of tobacco in layers was introduced in Cuba on a production scale. Its objective was to increase the quality of raw materials in the tobacco production, and to maximize the curing capacity with regard to the traditional process, since a controlled process takes 21 days and a natural process 60 days [4].

The controlled tobacco curing system allows an effective control over two of the most basic climatic elements that are involved in the process. They are temperature and humidity and, in addition, there is a third element, the airflow found inside the curing house, which is maintained constant during the process.

From the studies carried out by the Cuban Institute of Tobacco Research [4] on the different stages of tobacco leaf in the natural curing process, four curing process stages were established, as well as the moisture and temperature conditions that should be obtained in each stage for carrying out this process in a controlled way.

The stages established in the controlled tobacco curing process are: (1) Yellowing, (2) Developing colour, (3) Veins and cloth drying, and (4) Central vein drying. Each one of these stages was subdivided, such that subtle variations in reference to the humidity and the temperature were achieved. The humidity in this process is critical and sudden changes in it should not be experimented with.

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