



10th International Symposium on Heating, Ventilation and Air Conditioning, ISHVAC2017, 19-22 October 2017, Jinan, China

## Analysis on efficiency optimization of tobacco leaf flue-curing process

Gengshuo Cao<sup>a,b</sup>, Yafeng Bao<sup>c</sup>, Chao Wu<sup>d</sup>, Yong Wang<sup>a,b\*</sup>

<sup>a</sup>Key Laboratory of the Three Gorges Reservoir Region's Eco-Environment, Chongqing University, Chongqing 400045, China

<sup>b</sup>National Centre for International Research of Low-carbon and Green Buildings, Chongqing University, Chongqing 400045, China

<sup>c</sup>China Haisum Engineering Co., Ltd, Xuhui District, Shanghai 200031, China

<sup>d</sup>Chongqing Architectural Design Institute, Yuzhong District, Chongqing 400015, China

### Abstract

Tobacco leaf flue-curing process consumes large amounts of energy. Comparing to the traditional heating approach using coal, the heating source like heat pump would be more energy efficient and environmental friendly. Using heat pump for tobacco drying is proposed in this study. A 3D numerical model is established based on the theory of heat and mass transfer in porous medium. Field measurements were conducted in an actual curing barn in Chongqing. The effects of wall insulation performance and circulating air volume were obtained by comparative analyses of the key parameters. The feasibility and energy efficiency were proved by comparative analyses and experimental data. The result can help improve energy efficiency of relevant projects in agriculture baking.

© 2017 The Authors. Published by Elsevier Ltd.

Peer-review under responsibility of the scientific committee of the 10th International Symposium on Heating, Ventilation and Air Conditioning.

*Keywords:* Tobacco flue-curing; Heat and Mass transfer; Wall thermal insulation; Circulating Air volume; Energy saving optimization

### 1. Introduction

Tobacco leaf flue-curing process consuming large amounts of energy is all-important to the quality and availability of tobacco [1]. At present, coal is the main heat source of curing barn, occupied above 70% of the market share in China [2]. Most curing barns adopt coal as the heat source, low efficiency (only about 20%) and severe air pollution [3]. According to the existing research results, a variety of factors relevant to the quality of tobacco flue-

\* Corresponding author. Tel.: +86-23-65120750; fax: +86-23-65120773.

E-mail address: [cqwangyong@cqu.edu.cn](mailto:cqwangyong@cqu.edu.cn)

curing which determine the availability and economic benefits of tobacco [4]. Therefore, it is essential for the development of tobacco industry to solve the issue about low efficiency heat source and improve the quality of flue-cured tobacco.

Heat pump drying technology has applied in agriculture, food production and industry manufacture widely with outstanding merits of energy efficiency and environmental friendliness [5,6]. Neslihan. C et al. founded the feasibility and economy of applying heat pump as a heat source to tobacco flue-curing [7]. P. Sun et al. applied heat pump system, heat pump and electric hybrid system, heat pump and solar hybrid system to the tobacco leaf flue-curing respectively and obtained good feedback [8,9]. Compared with the traditional curing barn, the energy saving rate can reach 20% to 50% [10,11]. Therefore, the heating source like heat pump are more energy-efficient and environmental friendly than the traditional heating approach using coal. It can play an irreplaceable and important role in the promotion of energy sustainable utilization.

Regard to factors affecting the quality of tobacco flue curing, L. Yue et al. founded that baking method, tobacco varieties, barn type and other factors have different effects on the quality of tobacco baking [12]. Through analyses on temperature-humidity changing status for curing barn, H. Wang et al. discovered that the stability of the temperature and humidity of the curing barn play an important role in the improvement of the tobacco flue-curing quality [13,14]. At the same time, the stable temperature and humidity conditions also require that the barn have a good thermal insulation performance and suitable circulating air volume. Therefore, it is necessary to study the effect of circulating air volume and wall thermal insulation performance on the quality of tobacco flue-curing process.

In this study, a 3D numerical model is established based on the theory of heat and mass transfer in porous medium [15,16,17], where the hanging tobacco leaves in the bulk curing barn can be regarded as continuous porous media, thus the process of flue-curing can be addressed by the model of heat and mass transfer in porous media [18,19]. Combining theory with experiment, field measurements were conducted in an actual curing barn in Chongqing. External conditions such as wall thermal insulation performance and circulating air volume influenced on process were obtained by comparative analyses of the key parameters. The feasibility and energy efficiency were proved by comparative analyses and experimental data. The result can help improve energy efficiency of relevant projects in agriculture baking.

## Nomenclature

CFD	computational fluid dynamics
K	wall heat transfer coefficient
$E_1$	energy consumption before taking energy saving measures
$E_2$	energy consumption after taking energy saving measures
$\varepsilon$	energy saving rate

## 2. Methodology

The temperature and humidity distribution of the barn plays a vital role in the quality of tobacco flue-curing, which can be affected by different external factors including baking methods, the varieties and maturity of tobacco leaves, and the types of curing barn [5]. As the temperature and humidity environment is sensitive to the building envelope performance and the circulating air volume, special attention has been paid to the impacts of the wall insulation performance and circulating air volume on the quality of tobacco flue-curing. This research combined theory with experiment as follows:

### 2.1. Theoretical calculation method

Based on the theory of heat and mass transfer in porous media, the process of tobacco leaves flue-curing is regarded as a typical heat and mass transfer process in porous media. As the tobacco leaves are assumed to be virtual continuum media from a larger scale, with internal heat and mass transfer process ignored. Thus a mathematical

Download English Version:

<https://daneshyari.com/en/article/7227801>

Download Persian Version:

<https://daneshyari.com/article/7227801>

[Daneshyari.com](https://daneshyari.com)