Analysis of Air Circulation in Oyster Mushroom Farm

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Received: February 14th, 2012; Revised: April 28th, 2012; Accepted: April 30th, 2012

Abstract

Purpose: Oyster mushroom farm which could not meet optimum temperature range yields non-uniform sized, low quality products. Thus, this study, utilizing STAR CCM+, one of the computational fluid dynamics (CFD) programs, analyzed the impact of air circulation and temperature distribution. Methods: After we visited numerous mushroom farms, we measured the temperature at the discharge ports of heaters, fan capacity, and the locations of the air circulators in the farms. According to the data, most mushroom growers installed the heaters near the entrance and discharge ports of the heaters at the third growing bed on the same height as the heaters in the entrance. The temperature at the discharge port of heater was 26°C, and the fan capacity was 4,500 m³/hr. The air circulator was placed in the center of the mushroom farm 50cm above the ground, and its capacity of inlet port was 1,100 m³/hr and discharge port 1,600 m³/hr. The mushroom farm was insulated. Results: According to the analysis of the temperature distribution in the vertical plane of the entrance side, no air circulation causes the high temperature zone of 296~299K at the discharge port of the heater to take up 34% of area while the operation of air circulators causes it to occupy only 9%. This means that not using air circulators leads to a concentration of high temperature at the discharge port near the entrance. In addition, with the results of the analysis of the temperature distribution in the vertical planes of the center, no air circulation causes the temperature zone of 295~298K at the discharge port of the heater to take up 48% of area while the operation of air circulators causes it to occupy 80%. This shows that the high outlet port temperature disseminated to the center. Conclusions: After ninety minute operation of both heater and air circulator, the interior temperature became stabilized in the mushroom farm. Air circulation made the high temperature at the discharge port disseminate to the center and exit in the farm and equalize the temperature distribution.

Keywords: Simulation of temperature distribution, Air circulation, None air circulation Effect of air circulator, Oyster mushroom farm

Introduction

While mushroom consumption is increasing, the lack of advanced production technology leads to a decline in quality and quantity of mushrooms. In Korea, the total number of oyster mushroom farms reaches to 2,200. Its cultivating area is 215ha, which takes up 30% of the total mushroom cultivating area. The quantity of production is 45,200 M/T, which occupies 26% of the total production of mushrooms. Oyster mushrooms contribute significantly to the country’s agricultural income (Ministry for Food, Agriculture, Forestry and Fisheries, 2010).

The oyster mushroom farm is constructed to accommodate two sides of four growing beds, in total 8 growing beds. Due to the relative position on the growing bed, the temperature differences ranged from 13°C to 5°C (Yoon, et al., 2004). These temperature differences led to non-uniform growths and decline in the quality and quantity of mushrooms. Thus, the mushroom farm must retain a balanced temperature distribution throughout the entire interior.

This study will analyze the impact of air circulation and the temperature distribution in the oyster mushroom farm...
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Journal of Biosystems Engineering • Vol. 37, No. 2, 2012 • www.jbeng.org

Methods of Air Flow Analysis

Oyster Mushroom Farm

The oyster mushroom farm is constructed to accommodate two sides of four growing beds, in total 8 growing beds. The width of each growing bed is 17.8 m and the length of it is 1.4 m (see figure 1).

CFD Simulation

Most mushroom farms are small in size, so mushroom growers use small-scale heaters such as 10 KW-heaters. We visited numerous mushroom farms to search the locations of installment and discharge ports of the heaters. We measured the temperature at the discharge ports of heaters, fan capacity, and the locations of the air circulators in the farms to accurately glean the data for the air flow analysis. According to the data, the heaters were installed near the entrance, and the discharge ports of the heaters were placed at the third growing bed on the same height as the heaters in the entrance. The temperature at the discharge port of the heater was 26°C, and the fan capacity was 4,500 m³/hr. The air circulator was situated in the center of the mushroom farm 50 cm above the ground.

The air circulator’s capacity of inlet port was 1,100 m³/hr, and discharge port 1,600 m³/hr. The mushroom farm was insulated. After ninety minute operation of both heater and air circulator, the interior temperature became stabilized in the mushroom farm. This observation was used for air flow analysis.

Figure 2 shows the polyhedral mesh generation of the