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Experimental Analysis of a Rotary Heat Exchanger for Waste Heat Recovery From the Exhaust Gas of Dryer

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Abstract

In this paper, a rotary heat regenerator is fabricated to preheat the inlet air of the air jet impingement food dryer for by recovery of flue's energy. This regeneration heat exchanger is a rotary matrix made of zigzag shape aluminum sheets with a thickness of 0.5 mm. The effect of thermal recovery on efficiency of air jet impingement dryer is investigated. In addition, the influence of the temperature of the input air, the rotation speed of the matrix and the flow rate of the hot air is investigated on the temperature of fresh air entering at ambient temperature. The experiments are carried out at three levels of parameters. Results show that increasing the rotational speed of the matrix and discharge flow result in decrease of both the outlet temperature of the hot fluid and the efficiency of the heat exchanger. It can conclude that the hot air inlet temperature has the most significant effect on matrix efficiency and heat storage. The efficiency of heat recovery is improved up to 42.2%.

Keyword: Regenerator, Heat Exchanger, Dryer, Efficiency.

1. Introduction

Nowadays, Energy crisis and limitation of energy resources cause to researches to consider this area. After the energy crisis in the early 1970s, more attention was garnered towards the design and optimization of energy systems. These efforts have been focused on either improvement of efficiency or finding new energy resources. One way to improve efficiency and prevent energy loss is to recycle energy, *i.e.*, redirect energy wasted as heat recovery into the consumption cycle by using heat exchangers. The heat exchangers used for this purposed are known as regeneration heat exchangers, which are categorized into two types: the rotating and the constant.

Air jet impingement dryer technology is widely used in many industrial drying processes, such as paper towel drying, film photography, fabric, *etc.*, mainly because of its high heat transfer coefficient [1]. This type of dryer allows for quick drying in a short period of time. The impact air jet impingement dryers are hot air dryers that transfer heat by displacement method, and are mainly used to dry products with free moisture. In these dryers, the air temperature is often in the range of 50-150 °C and the air velocity for food in the range of 1-50m/s [1, 2]. According to studies at the point of jet collision with the desired surface, the thickness of the boundary layer is zero and the highest amount of heat transfer occurs [3]. Supmoon et al. [4] investigates the effect of air jet impingement drying and conventional convective drying on potato being processed as potato chips in term of drying characteristics and Specific Energy Consumption or SEC of the dryer. The results show that a bit increment of air velocity causes a decrease in the total SEC value.

This kind of air preheating, as a regenerator, is one of the most important thermal recovery processes in steam generators, first introduced by Ljungstrom [5] in 1920. This heat exchanger was designed for a drying process. Using regenerators for drying unit operations is desirable due to the high energy consumption of such unit operations. The recovery and optimization of the air jet impingement dryer results in a tailored heat recovery design that lead to decrease in energy consumption.

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