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The Study of Coefficient of Performance and Energy Efficiency of the 50 Tons Tube Ice Maker Machine by Finding the Optimal Diameter of a Heat Exchanger Machine for Installing In the Tube Ice Maker Machine

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Abstract

This research is about finding the optimum heat exchanger diameter tube for consumable tubular ice production using Computational Fluid Dynamics (CFD) and apply in a 50 ton ice production facility to determine actual results. The analysis will compare six heat exchanger tube diameters from 0.5 to 3 inches using Computational Fluid Dynamics (CFD) in terms of heat transfer. It was found that the configuration using two inch is the optimum diameter for production. The results are compared to the benchmarked research made by Nakornsri et al. [1] it was able to save more energy by approximately 3.49 %. In terms of production capacity it is able to produce more than the previous referenced research by 3.24 %. The results are a guideline for energy saving to other ice factories.

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Keywords: Tubular Ice; Heat Exchanger; Shell & Tube; Ice Factory; Numerical Analysis; ANSYS- FLUENT 6.3

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1. Introduction

In hot climate countries, ice consumption is popular among consumable products. There are over 1,500 ice factories in Thailand Nakornsri et al. [1] and will progress towards a higher trend according to the rising demand. This creates more energy demand in order to run the production facilities. The concept of ice production is to use Ammonia R-717 as a refrigerant to lower water temperature until it solidifies. This process will occur at the freezer as shown in Fig. 1. The ice production process takes approximately 36 minutes to complete with the inlet water temperature to be at approximately 28°C. In case that the inlet water temperature is lower, more production capacity will be gained.

Heat exchanger is a device that is commonly used in engineering fields and is designed to fulfill its purpose. Kim et al. [2] Richard et al. [3] Przemysław Błasiak et al. [4] Shenghan et al. [5]. In applying a heat exchanger to use with consumable ice production, only Nakornsri et al. [1] was found to study and apply a shell and tube type heat exchanger to decrease inlet water temperature into the cooling system. The heat exchanger is installed at two locations as shown in Fig. 1. for decreasing the production cycle time and energy consumption

From conducting a literature review, it was found that most researchers Chuchonak et al. [6] Rubinstein et al. [7] Carslaw et al. [8] Taylor et al. [9] Askar et al. [10] Prapainop et al. [11] Piruchvet et al. [12] Li B et al. [13] Pannucharoenwong et al. [14] had only focused on heat transfer between Ammonia R-717 refrigerant and water within the freezer. From studying it is found that there is no application of reusing cold drained water from defrost process. As shown in the above figure, there is also no heat exchanger installed at position 1 of Fig. 1. to decrease inlet water temperature.

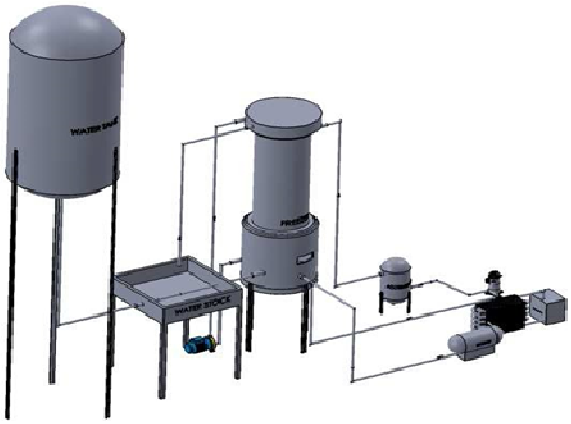
Therefore the objective of this research is to decrease the inlet water temperature into the freezer by collecting the discharged water from defrosting process at position 1 of Fig. 1 within a 1.5 m x 1.5 m x 0.3m reservoir. A shell and tube heat exchanger is then designed with smooth outer surface and will be analyzed using the following method.

I. Design a shell and tube type heat exchanger to install at the lower water reservoir and use theoretical Calculation in combination of ANSYS- FLUENT 6.3 program.

II. Analyze using ANSYS- FLUENT 6.3 according to heat transfer theories.

III. Analyze the obtained results before and after the application of a heat exchanger.

IV. Compare the results with previous research conducted by Nakornsri et al. [1]



DETAILS

1. Water Tank	5. Accumulator
2. Freezer	6. Compressor
3. Drain Pipe	7. Condenser
4. Water Pump	8. Receiver

Fig. 1. Schematic diagram of tubular ice making machine original.