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Experimental Study of Stationary-Head/Channel Cover STHE Prototype Using ε-NTU Method

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Abstract

Our research focuses on the performance evaluation of the small shell-and-tube heat exchanger (STHE) – laboratory type. The experiment used the prototype design of stationary-head/channel cover using the ring rubber, which separate the hot and cold fluid in a chamber. The stationary-head prototypes unusually are designed using low cost manufacture and simple construction, without bolt or nut to join both the stationary-head and shell. The shell has four holes to supply hot/cold fluid, and next to the tube-sheet hole to supply cold/hot fluid, the position both of them are inside the stationary-head. The single and double segmental baffles were used in this study. Calculation of thermal performance and effectiveness of STHE were calculated based on ε-NTU method. The correlation of heat transfer proposed was based on the unique construction of stationary-head design for the effectiveness of STHE. The data were collected from the both single and double segmental baffles, which were investigated by varying flow rate. The investigation including Reynolds and Nusselt number, heat transfer coefficient, and pressure drop which all effects of the shell-and-tube heat exchanger effectiveness. The results show that the ratio of the actual heat transfers for single segmental was higher than double segmental and the average effectiveness of single segmental baffle was 10 to 30% less than the double segmental baffles.

Keywords Heat exchanger · STHE · Baffle · NTU · Stationary-head

Introduction

At present, energy consumption in industrial processes is very important to manage due to the limitation of fossil fuel. Heat exchanger is one of the equipment that is used in the industry to support the production and manufacturing and are related to heat transfer and energy.

Many researchers have been used the heat exchanger to develop and reduce the heat transfer time as well as increase the energy and fuel efficiencies. Many studies discussed about the specific aspect of shell-and-tube heat exchanger. Mica Vukic and Tomic discuss about the effectiveness of shell-and-tube heat exchanger using different variation number of segmental baffle [1]. Bayram and Sevilgen investigate the effect of variable baffle spacing on the thermal performance using numerical method (CFD) [2]. Ozden and Tari observe the shell side of the shell-and-tube heat exchanger using numerically modelling in a small heat exchanger [3]. They investigate the baffle spacing, baffle cut, heat transfer coefficient, and pressure drop with Bell-Delaware method results. Delaware method is also used by Gaddis and Gnielinski to calculate the pressure drop in an ideal tube bank coupled with correction factors [4]. Sparrow and Reifschneider discuss about the effect of interbaffle spacing in the shell-and-tube heat exchanger to determine the response of the heat transfer and pressure drop [5]. The other researchers, Wee and Aicher investigate using 32 different heat exchanger test experimentally. The heat exchanger differs by number of tubes, length, shell-and-tube diameter, nozzle diameter and tube pitch. They confirm that the tube pitch can be neglected in shell-and-tube

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