UNIVERSITI TEKNOLOGI MARA

NUMERICAL STUDY OF REYNOLDS NUMBER EFFECT IN FLUID JET IMPINGEMENT COOLING HEAT TRANSFER ON CONCAVE SURFACE

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ABSTRACT

Generally jet impingement is a technology of providing a medium for heat transfer on surface that is to be cooled by impinging fluid on it. This method of cooling has high heat transfer capability. This technology is applied in micro-electronic industries, gas turbine cooling, quenching process in chemical plant and so forth. Most research has been done on jet impingement, mainly on the effects of Reynolds number, Nusselt number, nozzle geometry of jet, distance nozzle to target surface and other parameters that could affect the heat transfer rate. However, most of this research are done on flat surface, the knowledge regarding this technology on cylindrical surface are no abundant let it be concave or convex. Thus, to increase the viability of this technology on various application and increase industrial process efficiency that relies on rapid cooling on cylindrical surfaces, this study will be carry out. The scope of this study will be on evaluating the effects of Reynolds number on the cooling process heat transfer rate on concave surface. The Re= 5000, 10000, 15000, 20000, 25000 and 30000 will be used. The value of Nusselt number will be evaluated to determine the heat transfer strength.
To carry out this study we will use the aid of simulation software. CFD ANSYS FLUENT will be used to simulate the jet impingement system by using standard equation of motion and the Navier-Stokes standard k-Ɛ equation model is used. The working fluid would be air. The results obtained are Nu = 28.74, 44.67, 56.82, 67.30, 76.58 and 84.9 with respective to the increment of Reynolds number. In conclusion it can be said that with higher Reynolds number, Nusselt number will increase which as well indicates high heat transfer.

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CHAPTER ONE
INTRODUCTION

1.1 Research Background

Jet impingement is a method that provide heat transfer rate. Because of this method capability of high heat and mass transfer on targeted specific location , jet impingement cooling is widely used in the industry that requires temperature control such as in food processing ,drying of paper, cooling gas turbine blades, cooling of reactor, and electrical component (Y. T. Yang, Wei, & Wang, 2011).

Jet impingement provide effective and flexible way to transfer mass and heat, we need to identify suitable method to predict its performance. The proper and right configuration of jet impingement parameters and application technique can efficiently increase transfer of thermal energy between the jet fluid and targeted location (Zuckerman & Lior, 2006)

It can be classified as free-surface or submerged. Submerged jets issues into a space with the same liquid at rest. It can either be as confined or unconfined, depending on the jet-to-target distance. Whereas submerged, the interaction of the jet and the stagnant fluid leads to drag in the shear zone and the formation of a potential core near the jet centre line. The potential core is the region where the velocity of the jet remains largely unaffected by the spreading of the jet due to drag (Elison & Webb, 1994).

The heat transfer rate of a jet impinging onto a surface is a function of many parameters: Nusselt number (Nu), Reynolds number (Re), Prandtl number (Pr), the nondimensional nozzle-to-plate spacing (H/B), and the nondimensional displacement from the stagnation point (x/D). Furthermore, the effects of nozzle geometry, flow confinement, turbulence, recovery factor, and dissipation of jet temperature have all been shown to be significant (Jambunathan, Lai, Moss, & Button, 1992)