Analysis of dynamic characteristics and cooling performance of ultrasonic micro-blower

Chien-Ping Wang, Guan-Bo Wang, Yung Ting

PII: S0167-9317(18)30133-3
DOI: doi:10.1016/j.mee.2018.03.021
Reference: MEE 10777

To appear in: *Microelectronic Engineering*

Received date: 11 October 2017
Revised date: 11 March 2018
Accepted date: 19 March 2018

Please cite this article as: Chien-Ping Wang, Guan-Bo Wang, Yung Ting , Analysis of dynamic characteristics and cooling performance of ultrasonic micro-blower. The address for the corresponding author was captured as affiliation for all authors. Please check if appropriate. Mee(2017), doi:10.1016/j.mee.2018.03.021

Analysis of Dynamic Characteristics and Cooling Performance of Ultrasonic Micro-Blower

Chien-Ping Wang*, Guan-Bo Wang, Yung Ting

Department of Mechanical Engineering, Chung Yuan Christian University, Taoyuan City, 32023, Taiwan, R.O.C.

Corresponding author: cpwang@cycu.edu.tw

Keywords: Thermal, Piezoelectric, Micro-blower, Cooling

Abstract

The present study investigated both dynamic characteristics and cooling performance of the ultrasonic micro-blower devices made by Murata™ Manufacturing Corporation. Experiments were performed to investigate associations among input voltage, diaphragm deflection, and jet velocity under varying axial and radial positions. The increasing rate of jet velocity with respect to input voltage was found to decrease obviously as axial distance increased. The experimental results show that transient deflection of the diaphragm vibrated with a frequency of 25.6 kHz for different input voltages. The decreasing rate of the maximum diaphragm deflection with respect to radial position increased sharply as increasing the input voltage. Convective heat transfer coefficient were examined in order to evaluate cooling performance of the micro-blower. The maximum enhancement factor was obtained of approximately 11 times than under natural convection. The Nusselt number was highly dependent on the input voltage and axial distance of the micro-blower. The optimal cooling performance was obtained at the axial position L/D=20 between the heater and the blower.

1. Introduction

Miniature cooling devices have attracted many interests due to the increase of cooling requirements for portable electronics devices, such as laptop, tablet computers, and smart phone. The high power density and limited space inside the electronic devices are the major challenge for cooling system design. Piezoelectric blower is one of the promising candidate for active cooling due to its compact and miniature size [1-4]. To increase the output jet velocity, it is necessary to operate the blower with the resonant frequency to generate maximum deflection of the actuator diaphragm. However, noise issue restricted the implementation for electronic cooling application [5, 6]. Noise reduction of the blower is quite difficult without decreasing jet velocity. Therefore, the ultrasonic piezoelectric micro-blower has become a promising solution for portable