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IMPROVEMENTS OF THE AERODYNAMIC AND THERMAL CHARACTERISTICS OF AN S-SHAPED WINDOWED HDD ARMS

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Introduction

Recently, hard disk drives (HDDs) having averages of 7,200 rotational per minute (rpm) are the norm. However, high-end HDDs which require higher revolutionary speed and higher track density need smart countermeasures for flow-induced vibration (FIV) such as arm vibrations; and HDDs excessive heat rise, without increasing its power consumptions. The authors propose a new actuator arm with a better window, whereby each arms in the arm actuator has a large hole with the same outer size as the original actuator arm. Another improvement that the authors propose is by creating the outer design to be a novel S-shaped design to promote better air flow in between. In this paper, the behavior of these air flows inside an HDD with the consideration of a bigger window and an S-shaped design arm actuator was studied.

Higher rotational-speed disk rotation in an HDD would inevitable to attract unnecessary vibrations to the moving parts in the HDD; such as the actuator arm and platter disk, due to the high-speed airflow. Past researches have shown that in order to improve the performance of HDDs, one of the ways is to increase its rotational speed while maintaining its dynamic stiffnesses [1]. However, higher rotational speed will induce vibrations [2], high internal pressure [3] and excessive unnecessary heat which will eventually leads to significant effect on the positioning error of the head by causing delay or/and error in reading and writing data. The vibrations can be reduced by considering its aerodynamic factors. By improving the aerodynamic factors of these vital parts of HDDs, the frontal area can be decreased and this would reduce drag forces in between these parts. Since the drag force is the most significant factor on the moving parts of the HDDs with high revolutionary speed, the aerodynamic and thermodynamic properties improvement of the mechanical parts of the HDD has been chosen for the study in this paper. The countermeasures are to introduce a better and bigger designed window on the actuator arm integrated with an S-shaped design on the actuator arm.

In this paper, three designs based on disassembled conventional commercialized HDDs designs were compared with the improved S-shaped and windowed HDD arm. These designs were numerically verified, aerodynamically and thermodynamically. These analyses showed that these types of arms would reduce the vibrations and simultaneously improved its thermal dissipation management by allowing smoother air flow in between them. This also proves that the effect of improving the aero-dynamical performance of the mechanical parts eventually can contribute solution towards solving vibration and heat rise problems of HDDs' internal parts.

Numerical Designs of HDD Compartments and Its Actuator Arms

Three models of commercialized HDDs from three different HDD's manufacturer has been disassembled and investigated. It was observed that these HDD possess different compartment and internal parts designs. It is also noticeable that the arm design did not have any uniform similarities with respect to any HDD manufacturer. Hence, in this paper, the designs on arm actuator were chosen to be investigated numerically its thermal and aerodynamics characteristics in the attempt to propose a generalized arm designs used in HDDs.

The HDD compartments were designed based on the actual commercialized HDD compartment characteristics using computational aided design software. The arms are then allocated in the compartment designs based on the current commercialized HDD size and configurations. The compartment design is shown in Fig. 1. The meshes parameters configurations are also expressed as in the following Table 1.

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