

Investigation of Performance Characteristics of Centrifugal and Mixed Flow Impellers in Electronically Commutated Turbomachinery

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Extended Abstract

An electronically commutated (EC) fan is a very efficient fan powered by an EC motor that offers precise speed control and peak performance. EC motors are brushless direct current (DC) motors with built-in electronics that enable variable speed operation. Thus, they are ideal for applications requiring controlled airflow [1]. EC fans are significantly more energy-efficient than conventional fans, primarily due to their precise speed control, which effectively reduces power consumption. The performance of an EC fan is primarily influenced by its impeller design [2]. A well-engineered impeller minimizes turbulence and enhances aerodynamic efficiency, thereby improving both the effectiveness and durability of the fan.

This study presents a numerical comparison between centrifugal and mixed flow impellers to analyze fan performance and internal aerodynamic characteristics at constant specific speeds. A steady-state simulation was conducted by varying the flow rate (Q) at two different rotational speeds (N). Results indicate that the centrifugal impeller achieves 9.55% higher total efficiency and 14.81% higher static efficiency compared to the mixed flow impeller at the design operating condition. Furthermore, the centrifugal impeller generates an outlet static pressure that is 5.46% higher than that of the mixed flow impeller.

The internal flow characteristics of the mixed flow impeller reveal lower pressure on the pressure side and a low-velocity region near the leading edge compared to the centrifugal impeller, which accounts for its reduced performance. These differences highlight the superior efficiency and pressure generation of centrifugal impellers, making them more suitable for high-performance applications. In contrast, mixed flow impellers may be preferable in applications where space constraints and moderate efficiency are key considerations. Future research will focus on transient investigations of sound levels and vibrations to further enhance the understanding of EC fan performance.

Keywords: EC fan, computational fluid dynamics, centrifugal type, mixed-flow type, impeller, aerodynamic performance.

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