Comparison between NACA 65 profile and Circular Arc Blade based on Numerical Investigation

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Long Abstract

Introduction

In the present days axial flow fans are widely used indifferent areas. Because of the resource shortage many blade profiles have been designed and tested to develop a blade with high efficiency. For example, there are already well proven and explored NACA (National Advisory Committee for Aeronautics) profiles [1]. NACA profiles can provide good functionality and performance, but their development and production are also very expensive. In order to reduce the manufacturing costs, an alternative approach is circular arc blade.

In the present days, NACA profiles have been well tested. Charles H. et. al. [2] and L. Joseph Herrig et al. [3] have investigated the performance of NACA 65 at low speed and high Mach Numbers. James C. Emery [4] has conducted systematic series of low-speed cascade tests of NACA 65-series compressor blades at high inlet angles. Stanitz [5] examined the influence of the thickness of cascades with uncambered plates. This knowledge was used later by Lieblein [6] to develop a correlation for cascades consisting of NACA 65 profiles.

However, there is few information in the recent literature focusing on circular arc blade. Most researches about circular arc blade are based on theory of Weinig [7], who has developed an analytical theory based on potential flow for cascades consisting of thin cambered blades. John et al. [8] have examined the transonic flow around a circular arc blade at Reynolds number from 1×10^6 to 17×10^6. Masami et al. [9] have investigated the total pressure loss coefficient of thin circular arc blade in different camber angles. Masami's work showed that the result of CFD simulation is sufficiently useful when the camber angle of the circular-arc blade is below about $49{:}5^o$. According to his result, the camber angle of both investigated blades in this contribution is chosen as $\varphi = 40^o$.

1. Methods

In this contribution NACA 65 profile and circular arc blade are examined by numerical method. Both blades have a chord length l of 100 mm and a camber angle φ of 40^o. The stagger angle λ was 30^o. The Reynolds number was 2×10^5 and 4×10^5. Both blades possess the spacing ratio t/l of 0.5, 1.0 and 1.5. All examinations were performed for different incidence angles. The contribution shows the flow losses of both blades in dependence of incidence, Reynolds Number and spacing ratio. The flow losses and behavior of both blades are compared. The occurrence of flow behavior, such as separation bubbles at the leading edge, secondary flow and the corner stall is shown and discussed. The flow structure and streamline are given on basis of numerical flow picture. The main purpose of this paper is to compare the flow losses and behavior between NACA 65 profile and circular arc blade. According to the comparison, discover the optimizing direction of circular arc blade.

References

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