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RESEARCH ARTICLE

EXPERIMENTAL INVESTIGATION ON PERFORMNACE OF KFm & MH AIRFOIL

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ABSTRACT

In the recent past, there has been many research works going on to examine performance of airfoils, on their aerodynamic characteristics. There is no definite airfoil, which can define aerodynamic characteristics more precisely. This paper is an attempt made to fabricate, define and compare aerodynamic characteristics by MH and KFm airfoils. Fabrication of said airfoils MH and KFm airfoils as per requirements and specifications airfoil's can be manufactured using composite material in two halves and providing tapings on it for pressure measurement over airfoil surface with the help from multi-tube manometer. This experiment was conducted in open circuit, low speed wind tunnel for velocity up to 25.3m/s and Reynolds number of 3.56*10^5. Corresponding manometric head readings noted and graphs C_p vs X/C plottedlift and drag coefficient, calculated along with graphs as C_L and C_D vs AOA.

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INTRODUCTION

An airfoil is a shape of a wing or blade or sail used for different testing applications of aerospace industry. This produces the aerodynamic force when moved through a fluid. Fig.1 shows the line diagram of an airfoil and that can be either symmetrical o asymmetrical type of an airfoil and is responsible for the wing of an aircraft to produce the necessary lift. The airfoil design is major facet in aerodynamics, this serves in flight regimes and asymmetric airfoils can generate lifts at zero degree angle of attack. Subsonic airfoils have round leading edge and are insensitive to various angles of attack. There are supersonic airfoils even, which have sharp leading edge, sensitive to angle of attack. In this paper, it is discussed about how the angle of attack effects in the variation of aerodynamic characteristics.

LITERATURE REVIEW

The usage of energy has tremendously grown besides the use of fossil fuels has drastically gone down with their resources and even the environmental conditions this has led to the utilization of renewable energy naturally available. The major airlift systems use high lift systems to increase lifting capacity of aircraft, is a major part during take-off and landing for developing high lift at minimum speed, generally used in subsonic aircraft systems and controlled by mechanical devices. Here are some of references that considered during the course of this paper.

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Wlezien and others: (Wlezien, 1998) stated that aircraft wing gets more complex due to its high-lift system. Due to this drag of an aircraft increases and makes much noise.

Fertis: (Fertis, 1986) designed an airfoil with a step facing towards back on upper side of airfoil later on same person published patents on NACA series airfoil for 1 to 5 lakh Reynolds number and up to 38° angle of attack.

Seyed Ali Kazemi: (Kazemi, 2016) used the NACA0021 series airfoil for experimentation in wind tunnel, investigated the smoke flow visualization, and found out computationally by RANS (Reynolds Averaged Navier-Stokes) method.

Ingham, *et al.* (1983) studied on low Reynolds number of the rotating cylinder and obtained steady viscous flow for rotating cylinder.

Shiels, *et al.* (1996) studied the drag force related to the rotating cylinder and discussed about the two-dimensional incompressible flow and simulated that to different Reynolds number.

Sengupta (2003) and others studied the stability of flow around the rotating cylinder.

Thouault (2012) and others tried up keeping the disc on the two sides of the rotating cylinders and making a small improvement in the aerodynamic character.

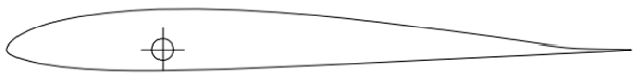


Fig. 1. Line diagram of an airfoil

Kray and others (2012) experimentally studied that the behavior of solid spinning sphere and other aerodynamic characteristics of it and the changes that occur are due to the Reynolds number and the lift, drag ratio.

Karabelas (2012) investigated the behavior of cylinders in high Reynolds number with different rotational speeds.

Kheirandish (2013) experimented by building up a small two-blade turbine, conducted both experimental and numerical analysis.

METHODOLOGY

The experimented airfoil fabricated using fiber-reinforced plastics. The following figure Fig No: -2 shows different fabricated airfoil models that is used for testing in this current experiment.

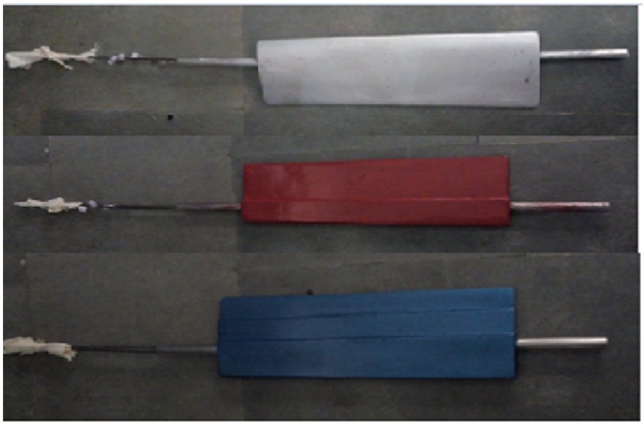


Fig No 2. Airfoil models

The airfoils are tested in open circuit low speed wind tunnel and pressure measured by using tapings provided on surface of airfoil, aerodynamic characteristics being studied. The same procedure repeated for other two airfoil and their characteristics are studied.

RESULTS AND DISCUSSION

This paper has shown a data that is prepared for a MH and KFm series airfoil that is mounted in a low speed wind tunnel. Based on values of coefficient of pressure aerodynamic characteristics such as Lift and Drag force was calculated which is summarized in Fig No: - 3, used for comparison of airfoils. The further study examined for aerodynamic properties and is concluded as performance of MH airfoil is better than that of KFm for a same Reynolds number and angle of attack ranging from 0° to 12°

AOA		0	2	4	6	8	10	12
MH-45	C_L	0.502412	0.785062	1.354173	1.385149	1.510963	1.41075	1.315406
	C_D	0	0.027596	0.093719	0.145622	0.212255	0.248686	0.279596
KFm-1	C_L	0.402315	0.428663	0.779284	0.875203	0.932945	1.017024	0.992906
	C_D	0	0.014969	0.054493	0.091988	0.098478	0.179329	0.104807
KFm-2	C_L	0.920041	0.948133	0.93091	0.954574	1.033885	1.143051	1.105529
	C_D	0	0.033028	0.065047	0.100305	0.145237	0.201496	0.234999

Fig No 3. Summary of results

Lift coefficient initially increased until critical angle of attack and decreased later on whereas the drag coefficient has a gradual increase with the increase in angle of attack. The lift and drag coefficient for a stepped airfoil had a downward curve for low-pressure circulation zone. Here are some of graphs, which shows typical lift and drag coefficients, and coefficient pressure changes of three airfoils for different angle of attack and X/C ratio.

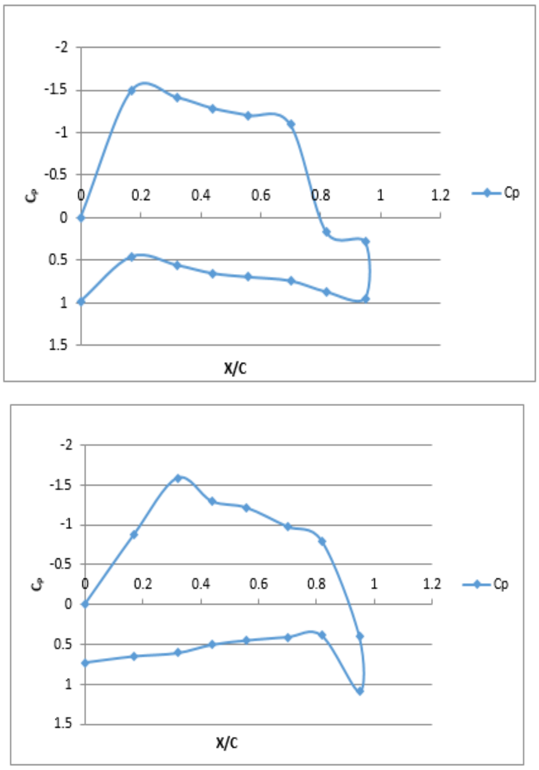
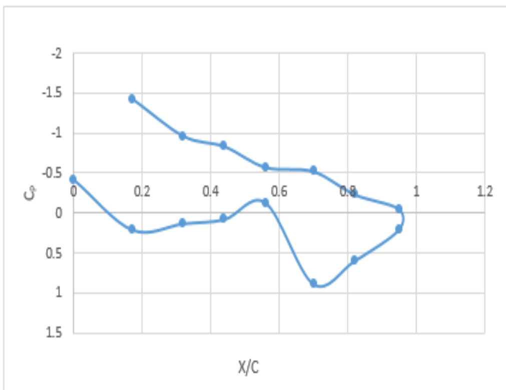


Fig No 4. Coefficient of Pressure vs X/C for MH-45 at 8 and 10 degree AOA



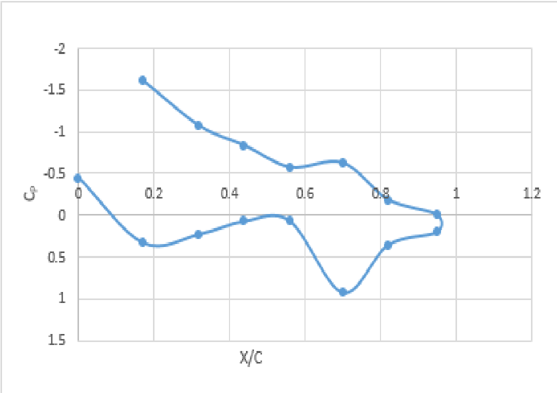


Fig No 5. Coefficient of Pressure vs X/C for KFm-1 at 8 and 10 degree AOA

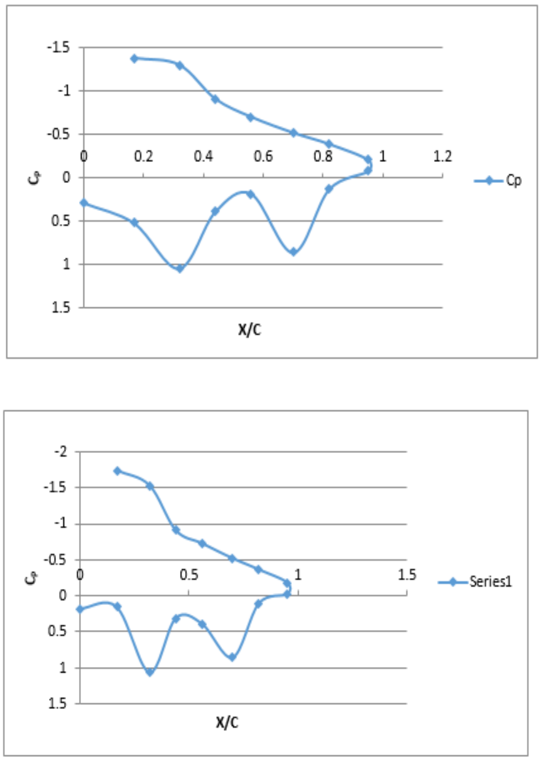


Fig No 6. Coefficient of Pressure vs X/C for KFm-2 at 8 and 10 degree AOA

This graph shows Coefficient of pressure and X/C graph, coefficient of pressure is greater at higher angle of attack irrespective of airfoils and is due to its orientation in wind tunnel's test section. As there is increase in angle of attack there will be more pressure experienced by lower surface of airfoil than that of other side.

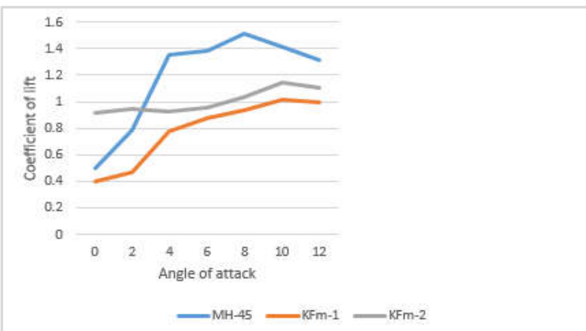


Fig No 7: - Coefficient of lift vs angle of attack

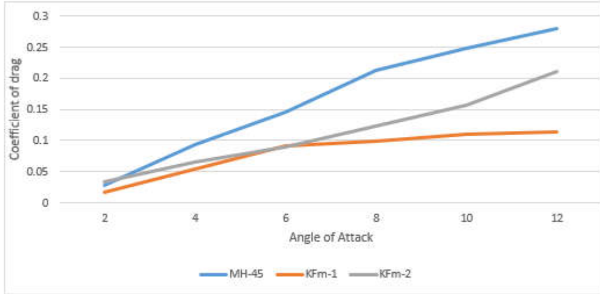


Fig No 8. Coefficient of drag vs angle of attack

The aboveimageFig no: - 8 and 9shows lift and drag coefficient vs angle of attack, it will be better if lift is higher for lower angle of attack. Considering three airfoils we have a good lift for MH airfoil at an approximately 8^{o} angle of attack, but in case of drag this has an increasing tendency hence for higher degree of angle of attack there will be more drag. Considering three airfoils we have a good lift for MH airfoil has more drag at 12^{o} angle of attack.

EQUATIONS

$$C_n = \frac{\int_0^c (C_{PL} - C_{Pu})\, dx}{c} \quad (1)$$

$$C_P = \frac{P_i - P_o}{0.5 * \rho * V^2} \quad (2)$$

$$C_L = C_n \cos \alpha \quad (3)$$

$$C_d = C_n \sin \alpha \quad (4)$$

$$R_e = \frac{\rho * V * l}{\mu} = \frac{V * l}{\gamma} \quad (5)$$

Conclusion

This study of experimental investigation of comparing aerodynamic characteristics of MH and KFm series airfoil concludes that because of some changes in profile of airfoil and varying angle of attack some variation was observed in its aerodynamic properties. This was conducted at 25.3m/s velocity and Reynolds number of 3.56*10^5. By providing step on the lower surface of an airfoil degrades the aerodynamic characteristics of airfoil. As this paper is compared with two-steppedairfoil, so as step of an airfoil, increases lift increases and MH airfoil has more lift coefficient. Whereas drag had a linear, follow through for all the 3 airfoils. Hence, we can say that an airfoil with a backward or a forward step has less effective aerodynamic characteristic than that of the other.

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