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INVESTIGATION OF SMALL WIND TURBINE AIRFOILS FOR KAYSERI WEATHER CONDITIONS

Cevahir TARHAN[1*] and İlker YILMAZ[2]

1. Faculty of Aeronautics and Astronautics, Erciyes University, Kayseri, Turkey; email: ctarhan@erciyes.edu.tr
2. Faculty of Aeronautics and Astronautics, Erciyes University, Kayseri, Turkey; email: iyilmaz@erciyes.edu.tr

*Corresponding author

Abstract

Wind energy has an increased usage in last years. Its importance is because of the renewability and potential for usage with a low budget. In this study we focus on the small wind turbines which can easily usable by public and small operations with a small budget. 14 types of best small wind turbine airfoils (A18, BW3, Clark Y, E387, FX77, NACA 2414, RG 15, S822, S823, S6062, S7012, SD6060, SD7032, SD7062) determined from past studies and examined with Ansys Fluent fluid dynamics program. Their lift and drag coefficients determined for 50000 Reynolds number which is a function of Kayseri's common wind speed and air density. As a result best suited small wind turbine airfoil type is determined for Kayseri usage.

Keywords: Wind Turbine, Airfoil, Lift, Drag

Nomenclature

C_d Drag Coefficient
C_l Lift Coefficient

1. INTRODUCTION

As a result of increasing demand to energy, increasing greenhouse gases and the need for energy independence; most of the developed countries investing in renewable energy area in recent years. One of the most advantageous types of renewable energy is wind energy. Sun's heat produces wind on earth's surface and this wind energy can be used for benefit of mankind by usage of wind turbines. For areas of low wind potential; small, cheap and portable wind turbines are beneficial. Airfoils are used in wind turbines to capture the wind and to rotate the rotor. In this study we performed simulations for 14 types of (A18, BW3, Clark Y, E387, FX77, NACA 2414, RG 15, S822, S823, S6062, S7012, SD6060, SD7032, SD7062) small scale wind turbine airfoils which are commonly used in small wind turbines[1-3]. Simulations performed for 50,000 Reynolds number with Ansys Fluent fluid dynamics program. This Reynolds number choice is because of the air density of 1.036 kg/m^3 and average wind speed of 7 m/s for Kayseri, Turkey, [4]. $(C_l/C_d)_{max}$ and $C_{l\ max}$ parameters are choosed for evaluation process. This is because of the dependency of efficiency to high lift coefficient and low drag coefficient while converting wind power to torque power.

2. PERFORMED SIMULATIONS

At Fig. 1 and Fig. 2, C_l and C_d results for the choosen airfoils after the performed simulations with Ansys Fluent fluid dynamics program are given. As seen on Fig. 1, BW3airfoil has best lift coefficient and the second best one is A18.

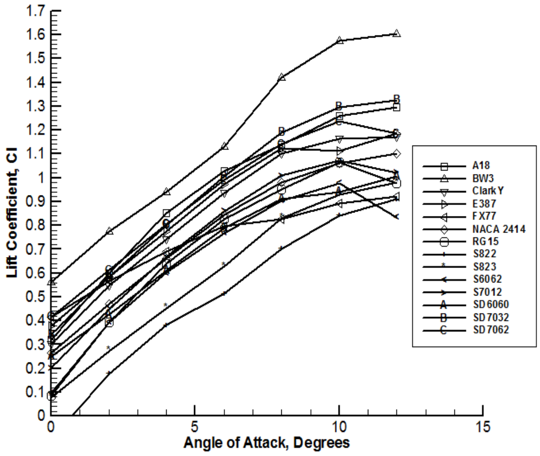

Figure 1. Lift Coefficient Curves for the Airfoils at Re= 50,000

Fig. 2, shows us the drag coefficients of the airfoils and as seen on figure that BW3 has far better drag coefficient results.

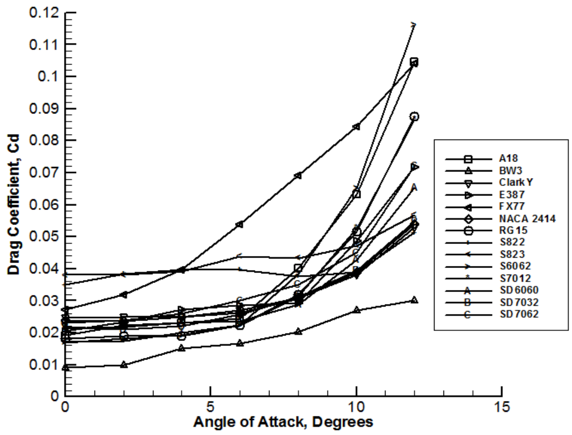

Figure 2. Drag Coefficient Curves for the Airfoils at Re= 50,000

As seen at Fig. 3, lower drag coefficient results of BW3 gives us the best airfoil C_l/C_d for this type.

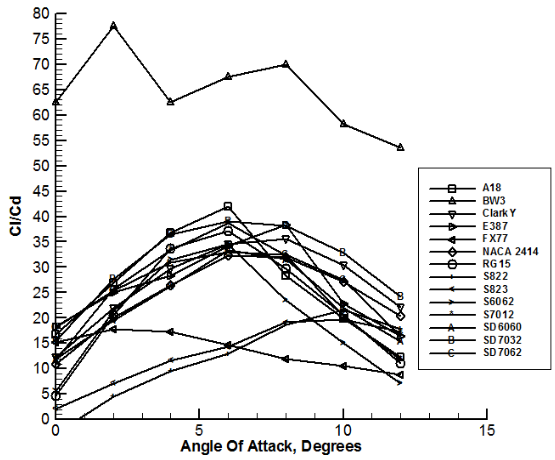

Figure 3. Lift Coefficient / Drag Coefficient Curves for the Airfoils at Re= 50,000

In Table 1, all 14 airfoilôs evaluated performance parameters are given. $(C_l/C_d)_{max}$ corresponds to the best value for angle of attacks between 0^o to 12^o for the airfoils. C_l and C_d are coefficients which are used for the calculation of $(C_l/C_d)_{max}$ ratio.

Table 1. Performance Parameters for the Airfoils Considered

Airfoil	$(C_l/C_d)_{max}$	$C_{l\ max}$	C_l	C_d
A18	42.00	1.29	1.02	0.024
BW3	77.56	1.60	0.77	0.010
Clark Y	35.56	1.17	1.10	0.031
E387	38.42	1.19	1.12	0.029
FX77	17.73	0.92	0.56	0.031
NACA2414	32.29	1.10	0.84	0.026
RG15	37.08	1.06	0.82	0.022
S822	21.70	0.91	0.84	0.039
S823	19.68	0.97	0.93	0.047
S6062	34.59	0.97	0.77	0.022
S7012	38.78	1.07	0.86	0.022
SD6060	33.33	1.01	0.80	0.024
SD7032	39.10	1.32	1.00	0.026
SD7062	33.00	1.23	0.99	0.030

3. CONCLUSION

After the numerical simulations BW3 airfoil is evaluating as the best suited airfoil for small wind turbines in Kayseri weather conditions and for similar areas where the Reynolds Number is near 50,000. BW3 has far better C_l/C_d ratio and high lift coefficient when compared to other choosen small wind turbine airfoils.

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