



Effect of Using Triangular Vortex Generator Straight Arrangement in Air Naca 43018 with Smoke Generator

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Abstract. Airplanes can fly because of the slightly curved wing shape or usually called an airfoil. The occurrence of flow separation on the part of the flow attached to the wing (boundary layer) can cause a stall. Separation of flow occurs when the angle of attack begins to increase. This can be done by adding a turbulent generator to the upper surface airfoil. A vortex generator is a type of turbulent generator that can accelerate the transition from the laminar boundary layer to the turbulent boundary layer. The method uses a tool in the form of a Wind Tunnel Open circuit. By applying smoke to the Wind Tunnel and accelerating the fan against smoke. In this experiment, the variations used are Airfoil NACA 43018, triangular type vortex generator with the straight arrangement, vortex generator distance x/c 20% from the leading edge, angle of attack (α) = 0° , 3° , 6° , 9° , 12° , and 15° , and freestream velocity speed 3 m/s. From the experimental results, this study shows that using a triangular vortex generator has been shown to improve aerodynamic performance and the performance of the NACA 43018 type airfoil. The 43018 type airfoil that uses a vortex generator compared to an airfoil that does not use a vortex generator can increase the transition from laminar flow to turbulent flow.

Keywords: Airfoil NACA 43018 · Vortex Generator · Smoke Generator · Wind Tunnel

1 Introduction

Before the process of making an aircraft, it is necessary to carry out an indispensable analysis of the aerodynamic performance of the aircraft. Stability characteristics of the aircraft model can be obtained to predict the maneuvers that may be carried out by the aircraft from several aerodynamic analysis methods, research that is useful for predicting aerodynamic loads can also be tested using the wind tunnel test method. High flow can withstand shear forces from adverse pressure gradients. Vortex generators are small shaped fins placed on the surface and stabilizers that change the flow around the surface, creating a boundary layer to inhibit the stagnation of the separation.

This method uses a wind tunnel. The wind tunnel has a working method, it can suck wind into the room, the room is in the form of a venturi tube, and inside there is a test instrument in the form of a NACA 43018 airfoil. The selection of this triangular vortex generator is the development of previous research, which still uses a rectangular or rectangular vortex generator. Other types of vortex generators. By changing the speed of the wind tunnel and the acceleration of the fan against the smoke. And change some angles on the airfoil. To be able to compare or analyze airfoils on NACA 43018. Experiments on vortex generators have long been studied by experts, but almost every year there are new discussions about them, including: Trinder [1], Manovski, et al. [2], Gurjot [3], Gao [4], Raval, et al. [5], etc.

2 Method

The method used is a wind tunnel simulation by placing the test object in a wind tunnel or a test section with air flowing through it. This experiment uses a wind tunnel with a length of 1 x 10.5 m, this is so that the results obtained can be validated.

The model of the test object used in this experiment is a wing with a NACA 43018 Airfoil profile and is powered by a smoke generator from sewing machine oil which is heated by a smoke generator, then flows through a small pipe at the end of the airfoil (Figs. 1, 2 and Table 1).

The airfoil used in this research is the NACA 43018 type airfoil with plain wing, with triangular VG type at $D = 0.124.C$ and $D = 0.174.C$.



Fig. 1. Wing Airfoil NACA 43018

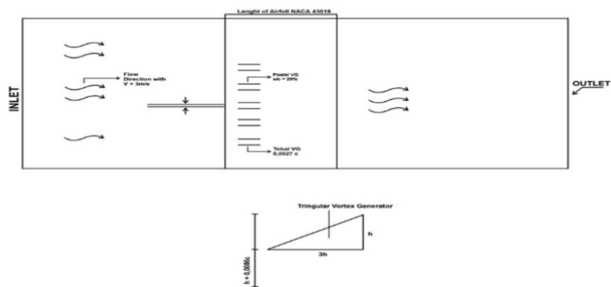


Fig. 2. VG Placement on Airfoil NACA 43018 [6]

Table 1. Experiment Parameters [7]

PARAMETER	EKSPERIMEN
Shape	<i>Triangular</i>
H	0,0086.c
l/h	3
α	$0^{\circ}, 3^{\circ}, 6^{\circ}, 9^{\circ}, 12^{\circ}, 15^{\circ}$
x/c	20%
c	200 mm
d	0.124.c dan 0,174.c
Position	<i>Straight</i>
V	3 m/s

3 Results and Discussion

3.1 Research Result

From the results of this experiment, it can be concluded that the research experiment that has been carried out from an angle of attack of $\alpha = 0^{\circ} - 15^{\circ}$ to the NACA 43018 airfoil, then obtained the flow on the upper surface that passes through the airfoil without a vortex generator and with a vortex generator at $D = 0.124.C$ and $D = 0.174.C$ there is a difference in the separation flow, then the use of a vortex generator is more effective in delaying the separation flow in the airfoil than without a vortex generator.

3.2 Analysis Flow Separation

Analysis of the difference between using a triangular vortex generator and not using a vortex generator there is a difference in the flow that flows over the surface of the airfoil. When using triangular VG the flow is still directed and follows the shape of the airfoil. While not using VG directional flow only when the front of the airfoil. After passing

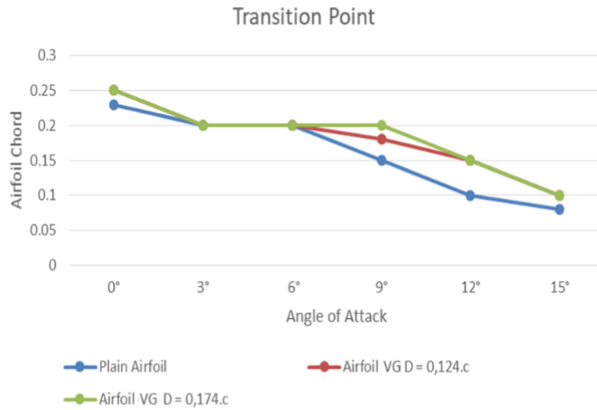


Fig. 3. Point of Separation

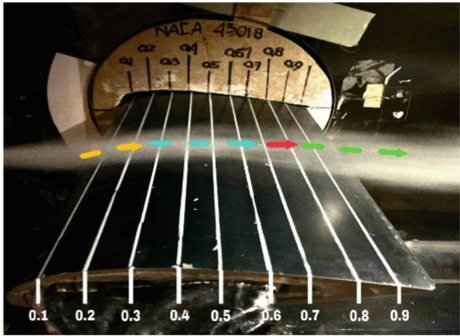
through the airfoil and when above the surface the airflow does not follow the shape of the airfoil but directly towards the back of the trailing edge. The following is in Fig. 3 a diagram of the comparison of the separation points.

3.3 Characteristics of Smoke Flow on Airfoil Without Vortex Generator and Using Triangular Vortex Generator Airfoil with Distance 0.124.C and 0.174.C

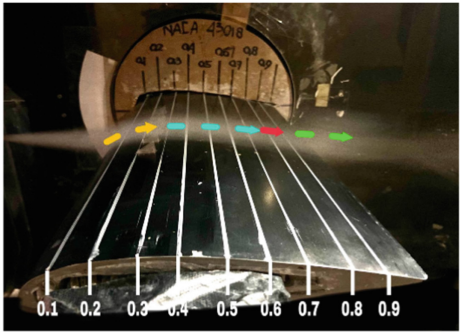
On the NACA 43018 airfoil, there are lines on the surface of the airfoil that serve to determine the separation point (X_s) with red dots, transition points (X_l) with blue dots, stagnation points (X_p) with yellow dots, and vorticity points (X_t) with a green dot that aims to be able to determine the effect of adding a triangular vortex generator with variations in the angle of attack. Numbering on the airfoil is obtained by counting 1 full part of the airfoil from the leading edge to the trailing edge. Get 10 parts by dividing 10% on each part. The placement of the triangular vortex generator is located at 20% of the leading edge, which is on the 0.2 line.

From the research experiments conducted using the NACA 43018 airfoil without using a vortex generator and using a vortex generator at a distance of 0.124.c and 0.174.c, the following data were obtained.

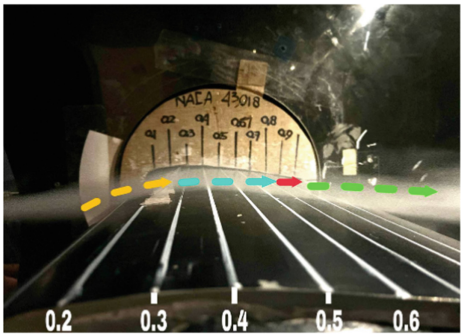
Figure (a), (b), (c) below shows the airfoil in an angular position of 0° with a freestream speed of 3 m/s, in Figure (a) smoke flows on the surface of the airfoil, and the transition point is indicated by point 0.23 – 0.6, the point of separation is indicated by the point 0.7, the vorticity point is indicated by the point 0.85 to the back. Figure (b) by adding triangular VG to the NACA 43018 airfoil at a distance between VG of 0.124.c, the transition point is indicated by point 0.25 – 0.7, the separation point is indicated by point 0.8 and the vorticity point is indicated by point 0.9 to the rear of the trailing edge. Figure (c) uses a triangular VG with a distance between vortexes of 0.174.c, the transition point is indicated by a point 0.25–0.8, the separation point is indicated by a 0.85 point and the vorticity point at 0.95 is indicated by a flow that is no longer touches the surface of the airfoil to the rear of the trailing edge (Figs. 4, 5, 6 and 7).



(a) Plain Wing

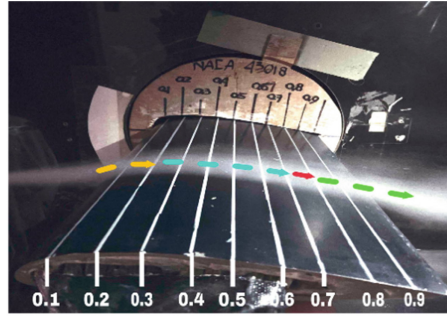


(b) Airfoil dengan Triangular VG on $D = 0,124.c$

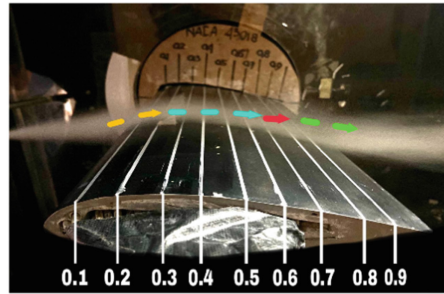
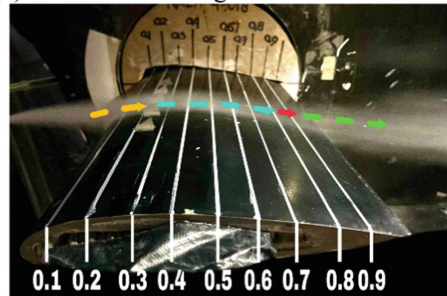


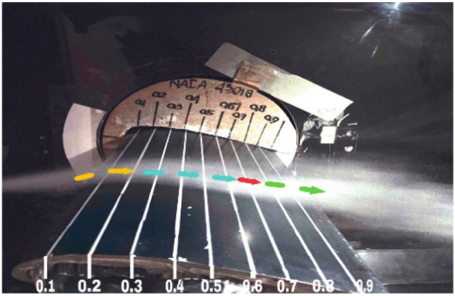
(c) Airfoil with Triangular VG on $D = 0,174.c$

Fig. 4. Smoke generator flow with $\alpha = 0^\circ$

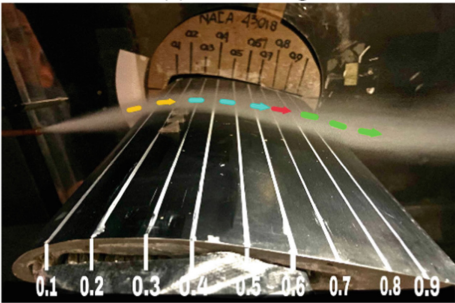


(a) Plain Wing

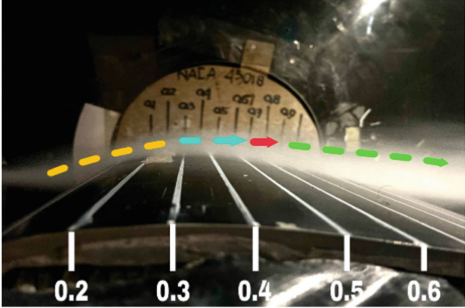
(b) Airfoil with Triangular VG on $D = 0.124.C$ (c) Airfoil with Triangular VG on $D = 0.174.C$ **Fig. 5.** Smoke generator with $\alpha = 3^\circ$



(a) Plain Wing

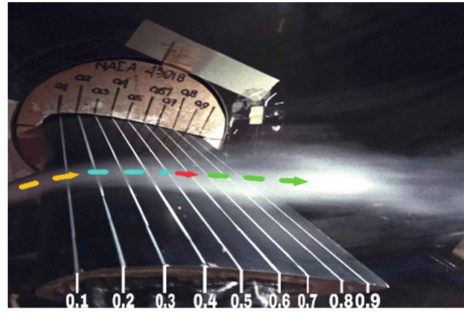


(b) Airfoil with Triangular VG on $D = 0.124.c$

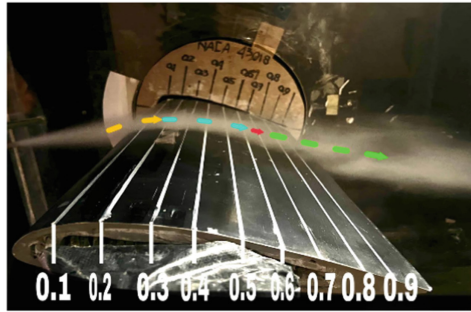
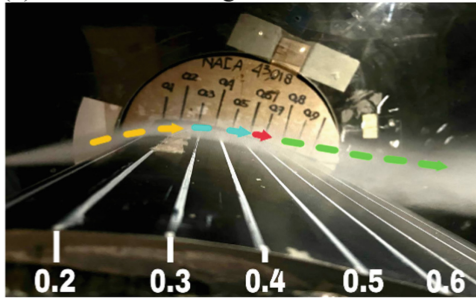


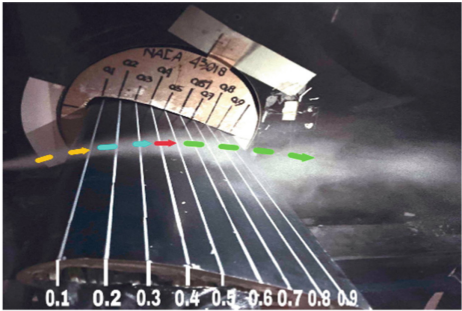
(c) Airfoil with Triangular VG on $D = 0.174.C$

Fig. 6. Smoke generator with $\alpha = 6^\circ$



(a) Plain Wing

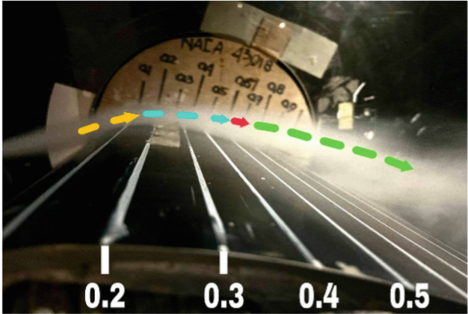
(b) Airfoil with Triangular VG on $D = 0.124.C$ (c) Airfoil with Triangular VG on $D = 0.174.C$ **Fig. 7.** Smoke generator with $\alpha = 9^\circ$



(a) Plain Wing



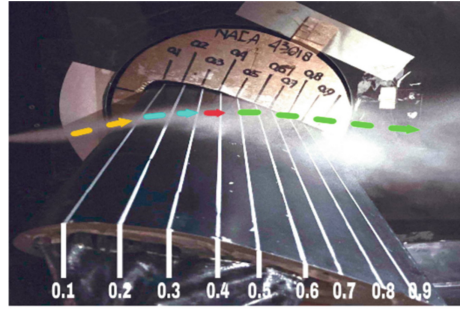
(b) Airfoil with Triangular VG on D = 0.124.C



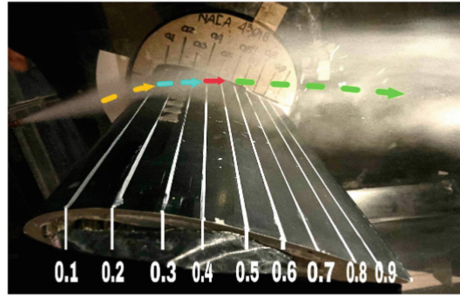
(c) Airfoil with Triangular VG on D = 0.174.C

Fig. 8. Smoke generator with $\alpha = 12^\circ$

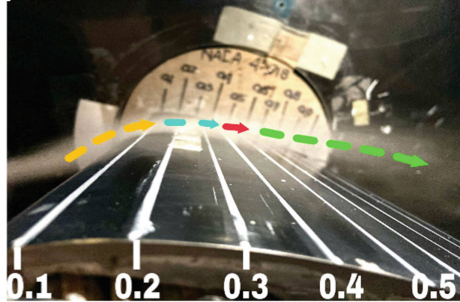
Figure 8 is the last study with an angle of attack of 15° with the same speed of 3 m/s. after some data collection the results obtained are laminar and turbulent flows have begun to be seen more clearly and can be seen with the addition of a vortex generator to delay the flow separation which can cause a stall. Figure (p) shows the flow of smoke on the surface of the airfoil, the point of separation is indicated by point 0.3, the point of vorticity is indicated by point 0.4 which causes the flow to be interrupted and the flow does not touch the surface of the airfoil towards the back. Figure (q) by adding a triangular vortex generator to the NACA 43018 airfoil at a distance between the vortex



(a) Plain Wing



(b) Airfoil with Triangular VG on D = 0.124.C



(c) Airfoil with Triangular VG on D = 0.174.C

Fig. 9. Smoke generator with $\alpha = 15^\circ$

generator 0.124.c the separation point is indicated by the 0.35 point and the vorticity point is indicated by the 0.5 points towards the back. Figure (k) uses a triangular vortex generator with a distance between vortexes of 0.174.c the point of separation is indicated by point 0.4 and the point that does not touch the airfoil surface is indicated by point 0.6 to the back of the trailing edge (Fig. 9).

4 Conclusion

From the simulation results of the measurement of the separation point on the upper surface area of the NACA 43018 airfoil using a wind tunnel, it can be concluded that:

1. Characteristics of airflow through or flowing on the upper surface airfoil type NACA 43018 using a triangular vortex generator tend to be more able to delay the flow of separation than not using a triangular vortex generator. Because the triangular vortex generator can reduce air separation and prevent turbulence boundary layer.
2. From the research experiments that have been carried out from an angle of attack of $\alpha = 0^\circ - 15^\circ$ to the NACA 43018 type airfoil, it is obtained that the flow on the upper surface that passes through the airfoil without a vortex generator and with a vortex generator there is a difference in the separation flow, then the use of a vortex generator is more effective for delays flow separation in the airfoil compared to without a vortex generator.
3. With the addition of a triangular vortex generator to the NACA 43018 airfoil at an angle of attack $\alpha = 12^\circ - 15^\circ$, it is clear that the formation of laminar flow and turbulence flow is visible. At that angle, there is still a lift (lift).

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