SOI: 1.1/TAS DOI: 10.15863/TAS
International Scientific Journal
Theoretical & Applied Science

p-ISSN: 2308-4944 (print) **e-ISSN:** 2409-0085 (online)

Year: 2022 **Issue:** 07 **Volume:** 111

Published: 01.07.2022 **http://T-Science.org**

Issue **Article**

Denis Chemezov
Vladimir Industrial College
M.Sc.Eng., Corresponding Member of International Academy of
Theoretical and Applied Sciences, Lecturer, Russian Federation
https://orcid.org/0000-0002-2747-552X
vic-science@yandex.ru

Egor Tuykin
Vladimir Industrial College
Student, Russian Federation

Andrey Ivanov
Vladimir Industrial College
Student, Russian Federation

Ivan Proshin
Vladimir Industrial College
Student, Russian Federation

Aleksandr Odudovskiy
Vladimir Industrial College
Student, Russian Federation

Oksana Dubova
Vladimir Industrial College
Student, Russian Federation

Emil Akhmetov
Vladimir Industrial College
Student, Russian Federation

Aleksey Kuzin
Vladimir Industrial College
Student, Russian Federation

REFERENCE DATA OF PRESSURE DISTRIBUTION ON THE SURFACES OF AIRFOILS HAVING THE NAMES BEGINNING WITH THE LETTER K

Abstract: *The results of the computer calculation of air flow around the airfoils having the names beginning with the letter K are presented in the article. The contours of pressure distribution on the surfaces of the airfoils at the angles of attack of 0, 15 and -15 degrees in conditions of the subsonic airplane flight speed were obtained.*

Key words: *the airfoil, the angle of attack, pressure, the surface.*

Language: *English*

Citation: Chemezov, D., et al. (2022). Reference data of pressure distribution on the surfaces of airfoils having the names beginning with the letter K. *ISJ Theoretical & Applied Science, 07 (111),* 1-10.

Soi: http://s-o-i.org/1.1/TAS-07-111-1 ***Doi***: crossref https://dx.doi.org/10.15863/TAS.2022.07.111.1
Scopus ASCC: *1507.*

Introduction

Creating reference materials that determine the most accurate pressure distribution on the airfoils surfaces is an actual task of the airplane aerodynamics.

Materials and methods

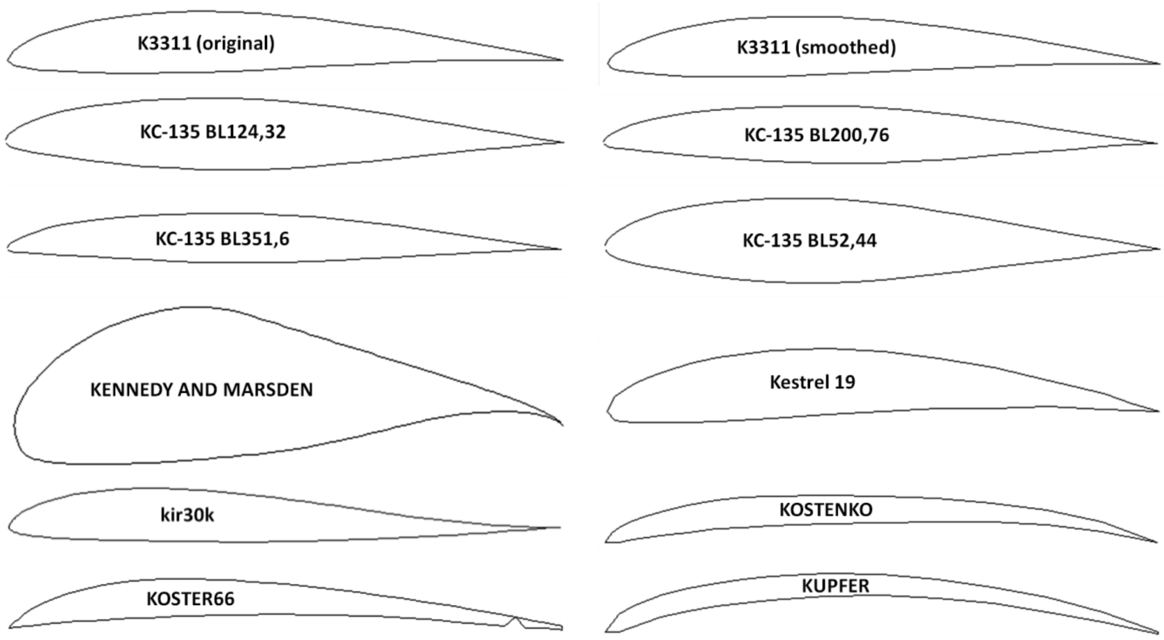
The study of air flow around the airfoils was carried out in a two-dimensional formulation by means of the computer calculation in the *Comsol Multiphysics* program. The airfoils in the cross section were taken as objects of research [1-26]. In this work, the airfoils having the names beginning with the letter *K* were adopted. Air flow around the airfoils was carried out at the angles of attack (α) of 0, 15 and -15 degrees. Flight speed of the airplane in each case was subsonic. The airplane flight in the atmosphere was carried out under normal weather conditions. The geometric characteristics of the studied airfoils are presented in the Table 1. The geometric shapes of the airfoils in the cross section are presented in the Table 2.

Table 1. The geometric characteristics of the airfoils.

Airfoil name	Max. thickness	Max. camber	Leading edge radius	Trailing edge thickness
K3311 (original)	11.0% at 30.0% of the chord	3.25% at 40.0% of the chord	0.8333%	0.0%
K3311 (smoothed)	11.03% at 30.6% of the chord	3.23% at 41.6% of the chord	0.7625%	0.0%
KC-135 BL124,32	12.98% at 40.0% of the chord	1.57% at 20.0% of the chord	0.9068%	0.0%
KC-135 BL200,76	10.59% at 40.0% of the chord	1.66% at 20.0% of the chord	0.5394%	0.0%
KC-135 BL351,6	8.99% at 40.0% of the chord	2.0% at 30.0% of the chord	0.3827%	0.0%
KC-135 BL52,44	15.49% at 35.0% of the chord	1.58% at 20.0% of the chord	1.416%	0.0%
KENNEDY AND MARSDEN	27.89% at 31.8% of the chord	7.67% at 34.7% of the chord	7.8079%	0.0%
Kestrel 19	12.5% at 30.0% of the chord	5.38% at 50.0% of the chord	1.6287%	0.0%
kir30k	9.75% at 28.1% of the chord	2.27% at 22.6% of the chord	1.1092%	0.0004%
KOSTENKO	5.49% at 25.0% of the chord	6.04% at 40.0% of the chord	0.7229%	0.0%
KOSTER66	6.75% at 25.0% of the chord	5.48% at 37.1% of the chord	0.2936%	0.84%
KUPFER	4.3% at 25.0% of the chord	8.9% at 40.0% of the chord	1.5919%	0.3%

Note:
K3311 (original) (Leon Kincaid K3311 airfoil (original));
KC-135 BL124,32 (Boeing KC-135 transonic airfoils);
KENNEDY AND MARSDEN (University of Alberta/Kennedy and Marsden high lift airfoil);
Kestrel 19 (H. Stock (USA));
kir30k (By Matteo Galizia – Italy).

Table 2. The geometric shapes of the airfoils in the cross section.



Results and discussion

The calculated pressure contours on the surfaces of the airfoils at the different angles of attack are presented in the Figs. 1-12. The calculated values on the scale can be represented as the basic values when comparing the pressure drop under conditions of changing the angle of attack of the airfoils.

12 airfoils of the KC, K and other series were studied in this work. All airfoils are asymmetrical.

The original K3311 airfoil has the larger leading edge radius than the smoothed K3311 airfoil. Other geometric parameters of the two airfoils have an insignificant difference in the value. However, under conditions of the airplane descent, the wing with the smoothed airfoil experiences negative pressure on the leading edge that is twice as large as the wing with the original airfoil.

The KC-135 BL351,6 has the smallest relative thickness and the largest camber of the considered airfoils of the KC series. Taking into account the small value of the leading edge radius, this contributes to the formation of negative pressure regions of the smaller value than that of the other airfoils of this series under conditions of the airplane descent. On the other hand, the large relative thickness and the leading edge radius, for example, the KC-135 BL52,44 airfoil, provide a decrease in negative pressure during the airplane climb.

The KENNEDY AND MARSDEN airfoil has the largest relative thickness and the leading edge radius of all studied airfoils. The configuration of the airfoil during horizontal flight and climb of the airplane leads to the formation of negative pressures of almost the same value. In this case, negative pressure is formed on the upper surface of the airfoil that is 2 times greater than positive pressure that is created on the leading edge and the lower surface.

The KOSTENKO and KUPFER airfoils have almost the same geometric shape in the cross section. They are characterized by the formation of large negative pressure at the angle of attack of 15 degrees and smaller negative pressure at the angle of attack of -15 degrees.

Maximum negative pressure (-121 kPa) occurs on the KOSTENKO airfoil during the airplane climb. Minimum negative pressure (-9.54 kPa) occurs on the KOSTER66 airfoil during the airplane descent.

The maximum increase in pressure on the leading edge occurs at the angle of attack of 15 degrees for the following airfoils: K3311 (original), KC-135 BL200,76, KC-135 BL351,6, Kestrel 19, kir30k, KOSTENKO, KOSTER66 and KUPFER. The maximum increase in pressure on the leading edge occurs at the angle of attack of -15 degrees for the other airfoils.

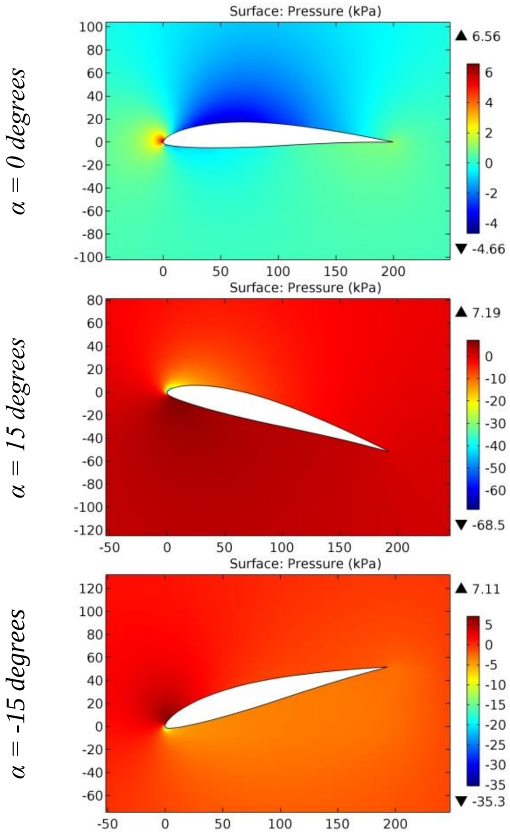


Figure 1. The pressure contours on the surfaces of the K3311 (original) airfoil.

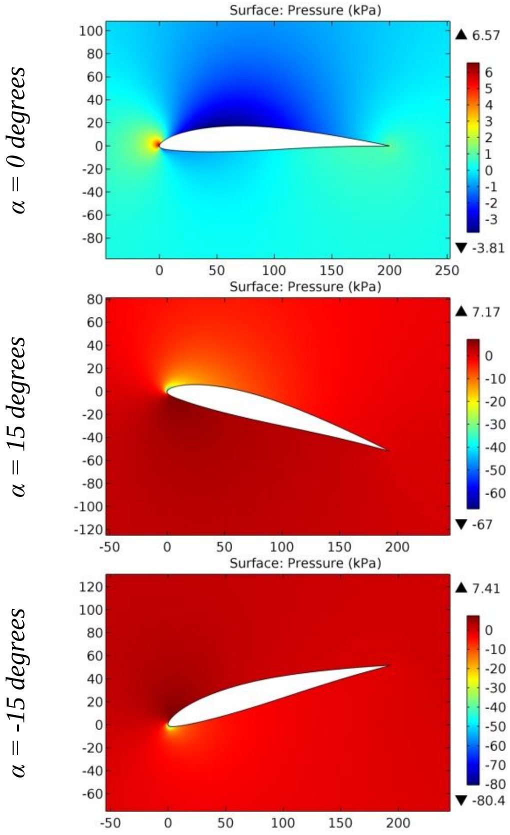


Figure 2. The pressure contours on the surfaces of the K3311 (smoothed) airfoil.

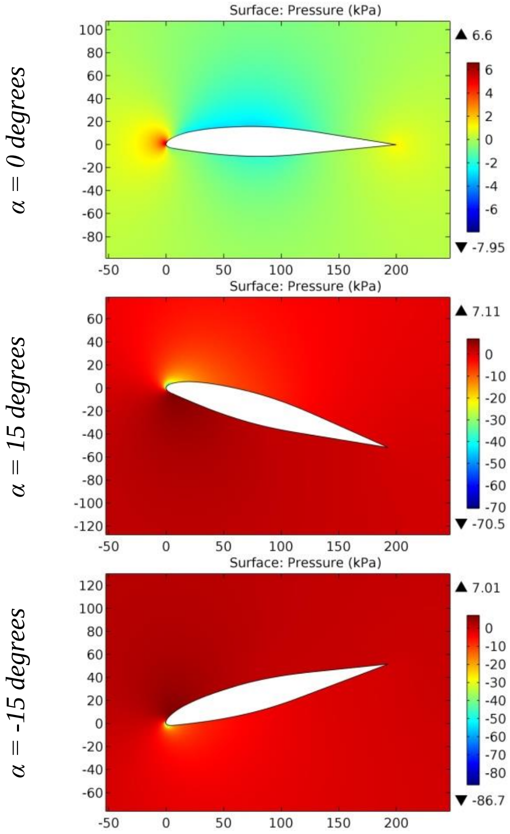


Figure 3. The pressure contours on the surfaces of the KC-135 BL124,32 airfoil.

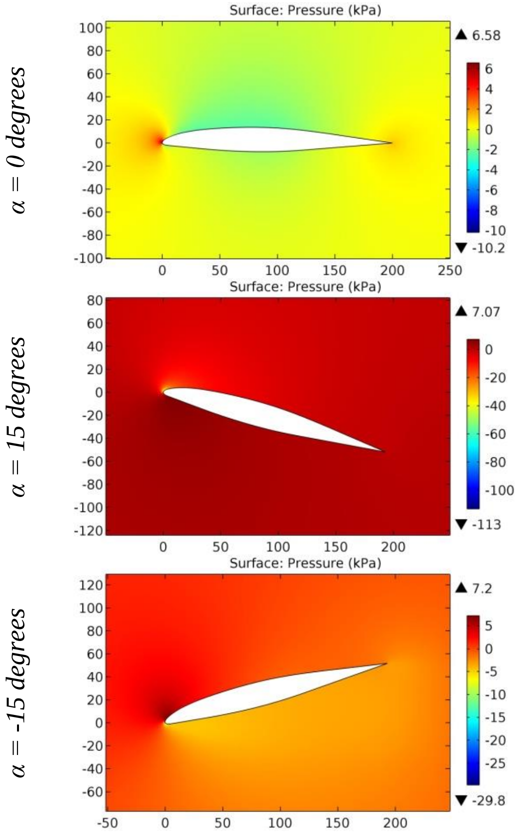


Figure 4. The pressure contours on the surfaces of the KC-135 BL200,76 airfoil.

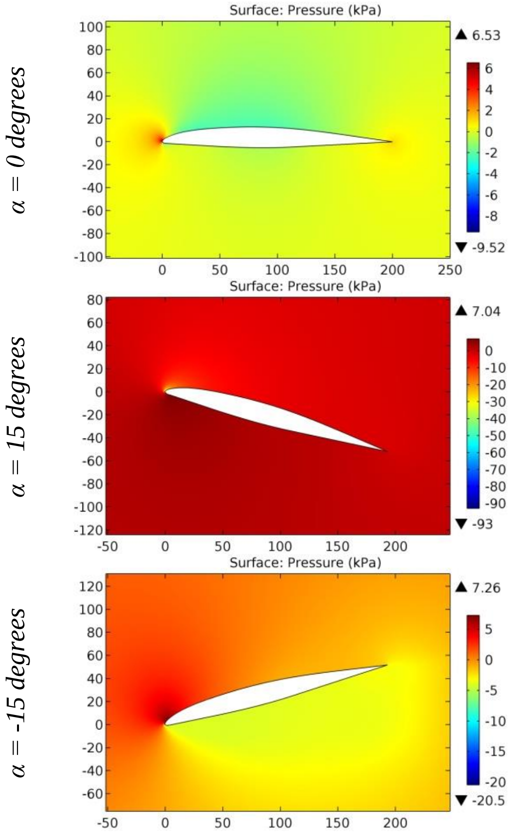


Figure 5. The pressure contours on the surfaces of the KC-135 BL351,6 airfoil.

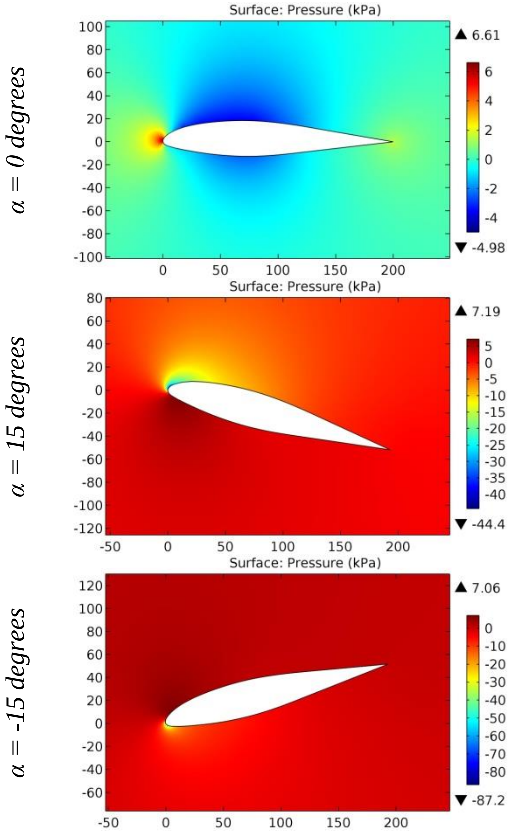


Figure 6. The pressure contours on the surfaces of the KC-135 BL52,44 airfoil.

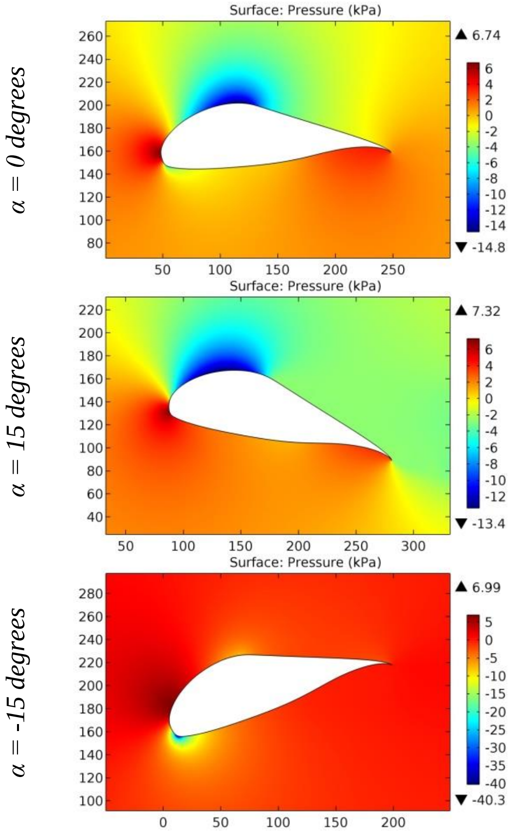


Figure 7. The pressure contours on the surfaces of the KENNEDY AND MARSDEN airfoil.

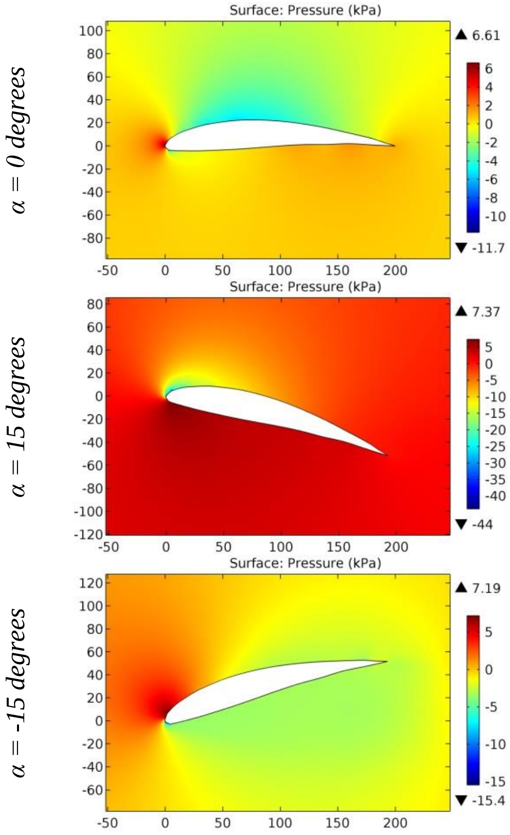


Figure 8. The pressure contours on the surfaces of the Kestrel 19 airfoil.

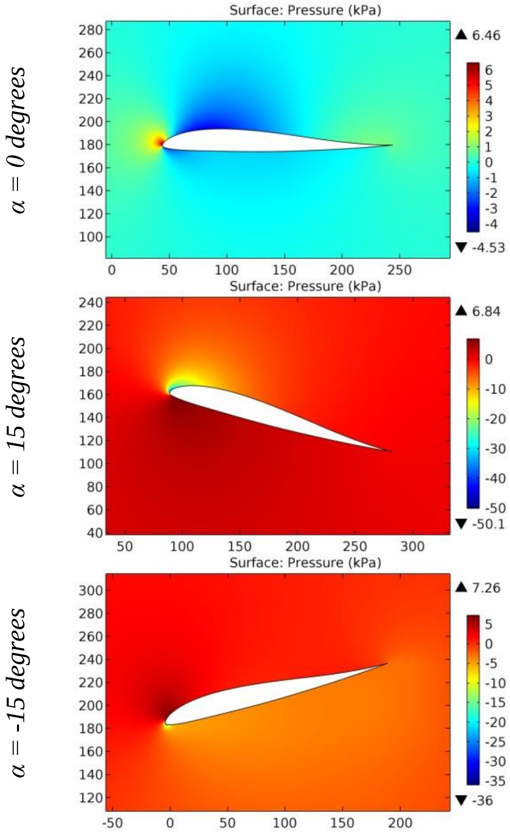


Figure 9. The pressure contours on the surfaces of the kir30k airfoil.

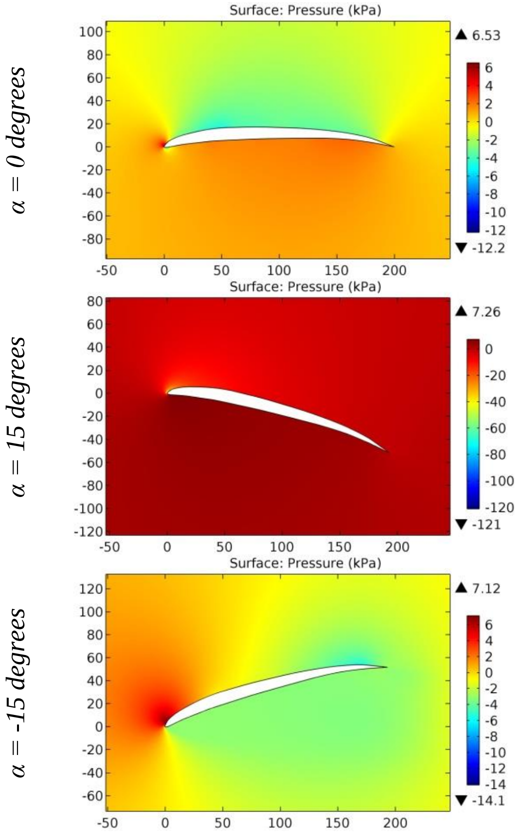


Figure 10. The pressure contours on the surfaces of the KOSTENKO airfoil.

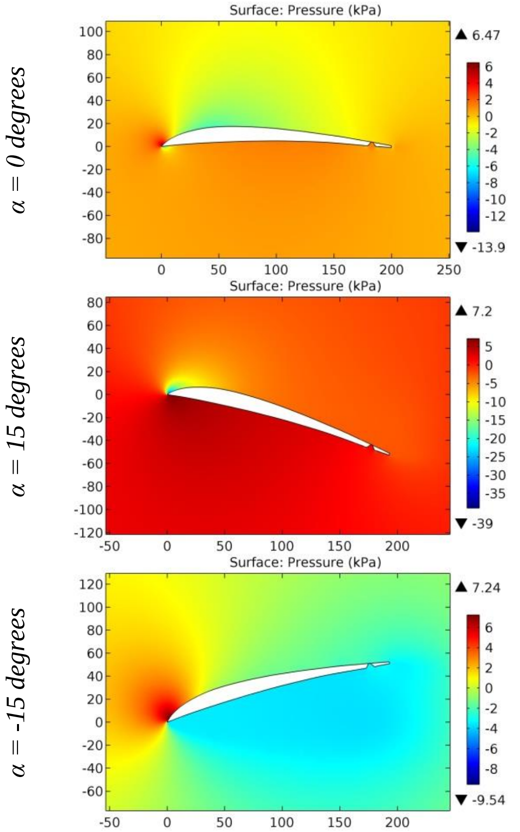


Figure 11. The pressure contours on the surfaces of the KOSTER66 airfoil.

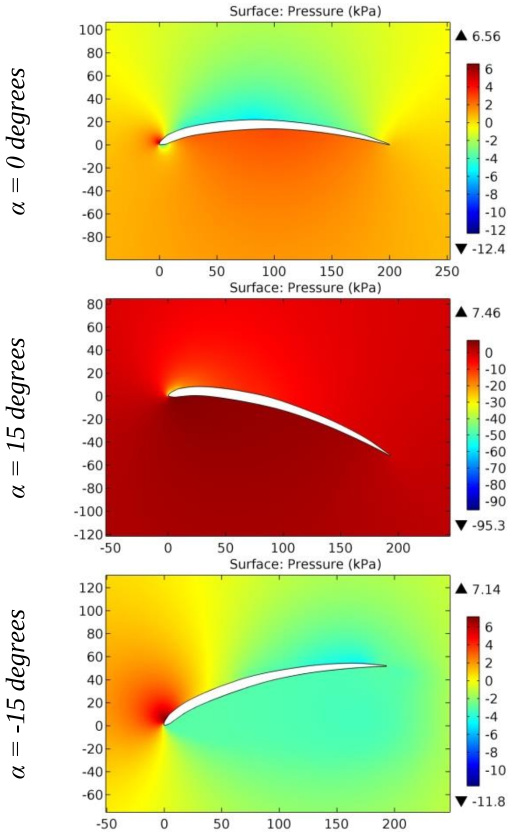


Figure 12. The pressure contours on the surfaces of the KUPFER airfoil.

Conclusion

Thus, the thin airfoils with the camber lead to an increase in negative pressure on the leading edge during the airplane climb, and to a decrease in the pressure value during the airplane descent. The thick airfoils cause more drag and increase lift, as evidenced by the calculated pressure values indicated on the color scales.

References:

1. Anderson, J. D. (2010). *Fundamentals of Aerodynamics*. McGraw-Hill, Fifth edition.
2. Shevell, R. S. (1989). *Fundamentals of Flight*. Prentice Hall, Second edition.
3. Houghton, E. L., & Carpenter, P. W. (2003). *Aerodynamics for Engineering Students*. Fifth edition, Elsevier.
4. Lan, E. C. T., & Roskam, J. (2003). *Airplane Aerodynamics and Performance.* DAR Corp.
5. Sadraey, M. (2009). *Aircraft Performance Analysis.* VDM Verlag Dr. Müller.
6. Anderson, J. D. (1999). *Aircraft Performance and Design.* McGraw-Hill.
7. Roskam, J. (2007). *Airplane Flight Dynamics and Automatic Flight Control, Part I.* DAR Corp.
8. Etkin, B., & Reid, L. D. (1996). *Dynamics of Flight, Stability and Control.* Third Edition, Wiley.
9. Stevens, B. L., & Lewis, F. L. (2003). *Aircraft Control and Simulation.* Second Edition, Wiley.
10. Chemezov, D., et al. (2021). Pressure distribution on the surfaces of the NACA 0012 airfoil under conditions of changing the angle of attack. *ISJ Theoretical & Applied Science, 09 (101)*, 601-606.
11. Chemezov, D., et al. (2021). Stressed state of surfaces of the NACA 0012 airfoil at high angles of attack. *ISJ Theoretical & Applied Science, 10 (102)*, 601-604.
12. Chemezov, D., et al. (2021). Reference data of pressure distribution on the surfaces of airfoils having the names beginning with the letter A (the

first part). *ISJ Theoretical & Applied Science, 10 (102)*, 943-958.

13. Chemezov, D., et al. (2021). Reference data of pressure distribution on the surfaces of airfoils having the names beginning with the letter A (the second part). *ISJ Theoretical & Applied Science, 11 (103)*, 656-675.
14. Chemezov, D., et al. (2021). Reference data of pressure distribution on the surfaces of airfoils having the names beginning with the letter B. *ISJ Theoretical & Applied Science, 11 (103)*, 1001-1076.
15. Chemezov, D., et al. (2021). Reference data of pressure distribution on the surfaces of airfoils having the names beginning with the letter C. *ISJ Theoretical & Applied Science, 12 (104)*, 814-844.
16. Chemezov, D., et al. (2021). Reference data of pressure distribution on the surfaces of airfoils having the names beginning with the letter D. *ISJ Theoretical & Applied Science, 12 (104)*, 1244-1274.
17. Chemezov, D., et al. (2022). Reference data of pressure distribution on the surfaces of airfoils (hydrofoils) having the names beginning with the letter E (the first part). *ISJ Theoretical & Applied Science, 01 (105)*, 501-569.
18. Chemezov, D., et al. (2022). Reference data of pressure distribution on the surfaces of airfoils (hydrofoils) having the names beginning with the letter E (the second part). *ISJ Theoretical & Applied Science, 01 (105)*, 601-671.
19. Chemezov, D., et al. (2022). Reference data of pressure distribution on the surfaces of airfoils having the names beginning with the letter F. *ISJ Theoretical & Applied Science, 02 (106)*, 101-135.
20. Chemezov, D., et al. (2022). Reference data of pressure distribution on the surfaces of airfoils having the names beginning with the letter G (the first part). *ISJ Theoretical & Applied Science, 03 (107)*, 701-784.
21. Chemezov, D., et al. (2022). Reference data of pressure distribution on the surfaces of airfoils having the names beginning with the letter G (the second part). *ISJ Theoretical & Applied Science, 03 (107)*, 901-984.
22. Chemezov, D., et al. (2022). Reference data of pressure distribution on the surfaces of airfoils having the names beginning with the letter G (the third part). *ISJ Theoretical & Applied Science, 04 (108)*, 401-484.
23. Chemezov, D., et al. (2022). Reference data of pressure distribution on the surfaces of airfoils having the names beginning with the letter H (the first part). *ISJ Theoretical & Applied Science, 05 (109)*, 201-258.
24. Chemezov, D., et al. (2022). Reference data of pressure distribution on the surfaces of airfoils having the names beginning with the letter H (the second part). *ISJ Theoretical & Applied Science, 05 (109)*, 529-586.
25. Chemezov, D., et al. (2022). Reference data of pressure distribution on the surfaces of airfoils having the names beginning with the letter I. *ISJ Theoretical & Applied Science, 06 (110)*, 1-7.
26. Chemezov, D., et al. (2022). Reference data of pressure distribution on the surfaces of airfoils having the names beginning with the letter J. *ISJ Theoretical & Applied Science, 06 (110)*, 18-25.