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Issue **Article**

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

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

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

***Language**: English*

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***Scopus ASCC**: 1507.*

Introduction

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

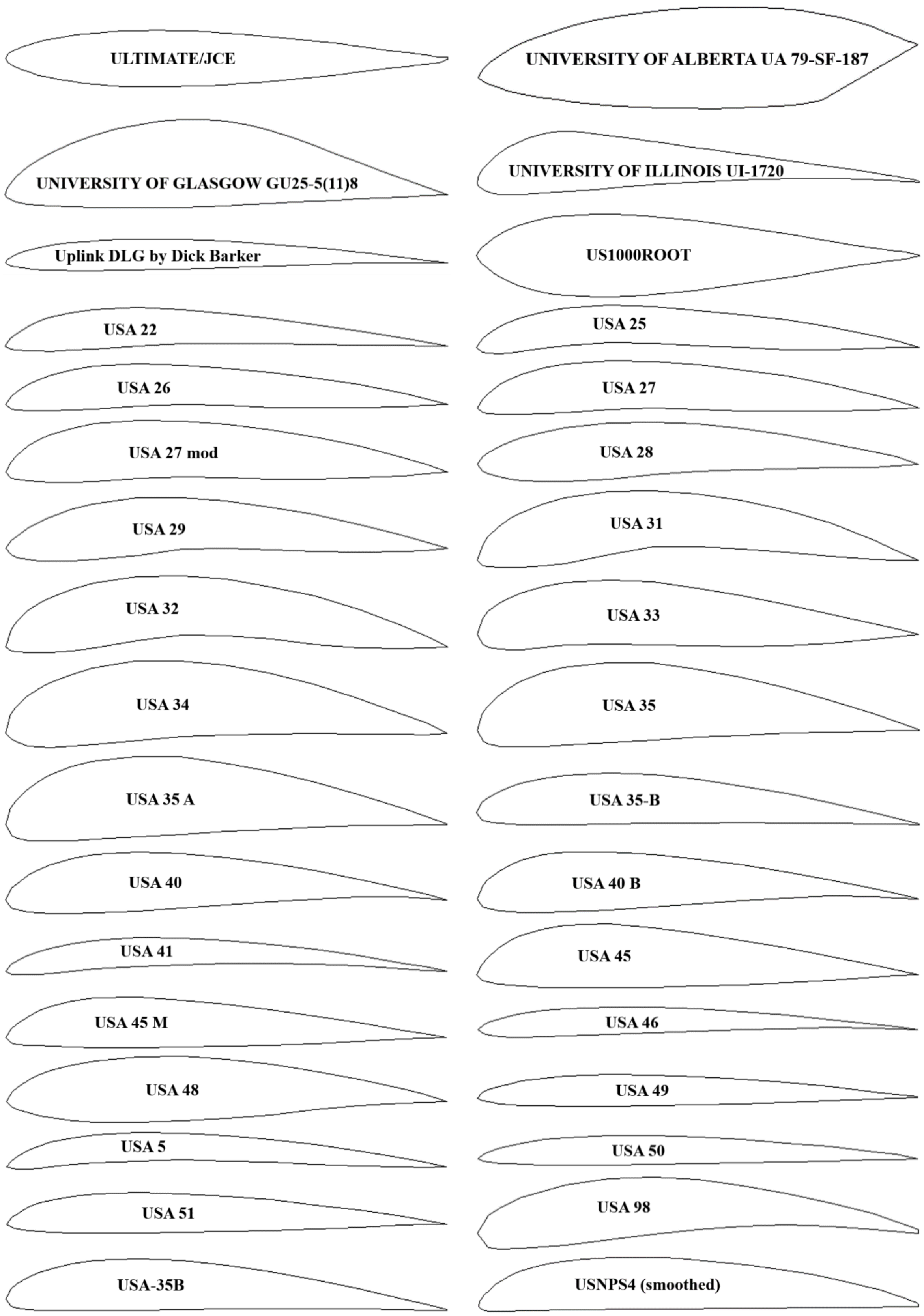
Materials and methods

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 [1-37]. In this work, the airfoils having the names beginning with the letter *U* were adopted. Air flow around the airfoils was carried out at 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
ULTIMATE/JCE	12.85% at 34.2% of the chord	0.05% at 0.0% of the chord	0.8961%	0.5804%
UNIVERSITY OF ALBERTA UA 79-SF-187	29.62% at 67.5% of the chord	5.89% at 100.0% of the chord	0.2016%	10.27%
UNIVERSITY OF GLASGOW GU25-5(11)8	19.99% at 40.0% of the chord	7.13% at 45.0% of the chord	1.3448%	0.0%
UNIVERSITY OF ILLINOIS UI-1720	13.8% at 17.9% of the chord	4.64% at 23.8% of the chord	2.1541%	0.0614%
Uplink DLG by Dick Barker	7.0% at 29.1% of the chord	1.8% at 39.3% of the chord	0.3639%	0.0%
US1000ROOT	18.57% at 27.1% of the chord	0.13% at 0.0% of the chord	0.6962%	0.0096%
USA 22	9.1% at 20.0% of the chord	4.42% at 40.0% of the chord	0.785%	0.1%
USA 25	8.28% at 20.0% of the chord	5.24% at 30.0% of the chord	0.9853%	0.0%
USA 26	9.82% at 20.0% of the chord	4.34% at 40.0% of the chord	1.0195%	0.0%
USA 27	11.07% at 30.0% of the chord	5.1% at 40.0% of the chord	1.128%	0.02%
USA 27 mod	13.29% at 30.0% of the chord	5.1% at 40.0% of the chord	1.5494%	0.024%
USA 28	13.16% at 30.0% of the chord	3.75% at 50.0% of the chord	1.239%	0.0%
USA 29	13.16% at 30.0% of the chord	5.54% at 40.0% of the chord	1.242%	0.0%
USA 31	14.86% at 20.1% of the chord	9.36% at 39.9% of the chord	2.2425%	0.0%
USA 32	14.72% at 20.0% of the chord	9.33% at 40.0% of the chord	2.0712%	0.0%
USA 33	14.19% at 30.0% of the chord	4.86% at 30.0% of the chord	3.4496%	0.0%
USA 34	17.99% at 30.0% of the chord	7.7% at 40.0% of the chord	2.9586%	0.0%
USA 35	18.14% at 30.1% of the chord	6.41% at 40.1% of the chord	4.0949%	0.43%
USA 35 A	18.14% at 30.1% of the chord	6.41% at 40.1% of the chord	4.0949%	0.43%
USA 35-B	11.61% at 30.0% of the chord	5.96% at 30.0% of the chord	1.6642%	0.25%
USA 40	13.32% at 30.0% of the chord	4.19% at 40.0% of the chord	1.987%	0.1%
USA 40 B	13.63% at 20.0% of the chord	4.0% at 40.0% of the chord	2.3536%	0.0%
USA 41	6.6% at 30.0% of the chord	4.49% at 40.0% of the chord	0.7349%	0.0%
USA 45	14.52% at 30.1% of the chord	4.14% at 30.1% of the chord	1.404%	0.0%
USA 45 M	11.63% at 30.0% of the chord	3.32% at 30.0% of the chord	1.1829%	0.0%
USA 46	6.54% at 20.0% of the chord	2.17% at 40.0% of the chord	0.7365%	0.0%
USA 48	14.9% at 30.0% of the chord	2.88% at 40.0% of the chord	1.3037%	0.0%
USA 49	7.25% at 30.0% of the chord	1.73% at 40.0% of the chord	0.6395%	0.23%
USA 5	6.38% at 30.0% of the chord	4.53% at 40.0% of the chord	0.6074%	0.0%
USA 50	7.04% at 30.0% of the chord	1.95% at 40.0% of the chord	0.6436%	0.0%
USA 51	9.33% at 30.0% of the chord	2.57% at 30.0% of the chord	0.7526%	0.0%
USA 98	14.3% at 30.0% of the chord	6.6% at 50.0% of the chord	3.0712%	0.9%
USA-35B	11.61% at 30.0% of the chord	3.19% at 30.0% of the chord	1.6642%	0.25%
USNPS4 (smoothed)	11.94% at 34.2% of the chord	5.02% at 34.2% of the chord	1.0858%	0.7756%
Note: *USA 35-B (U.S. Navy (USA)).*				

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



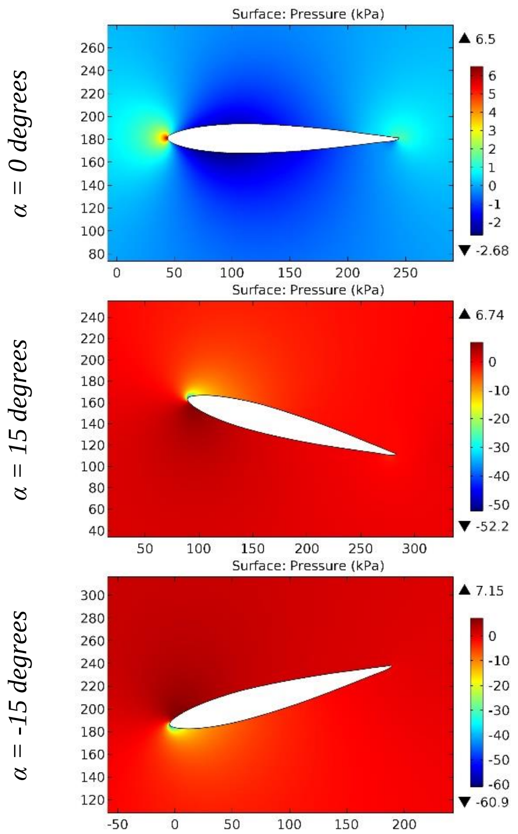


Figure 1. The pressure contours on the surfaces of the ULTIMATE/JCE airfoil.

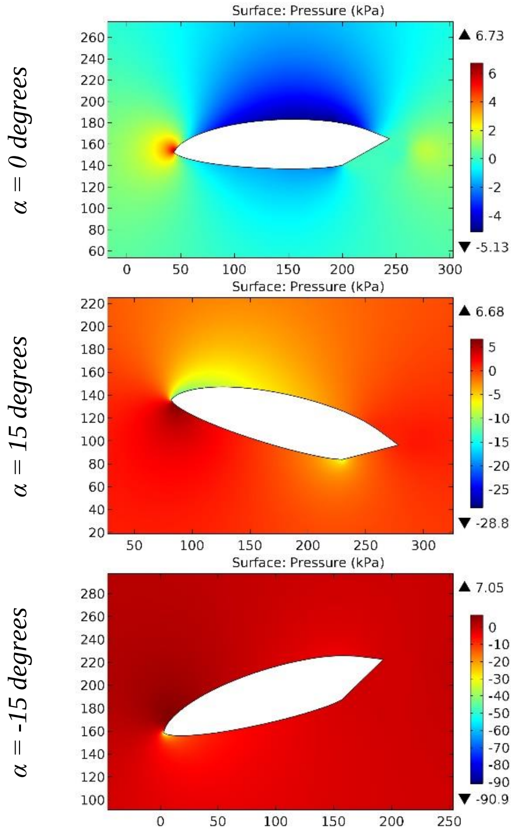


Figure 2. The pressure contours on the surfaces of the UNIVERSITY OF ALBERTA UA 79-SF-187 airfoil.

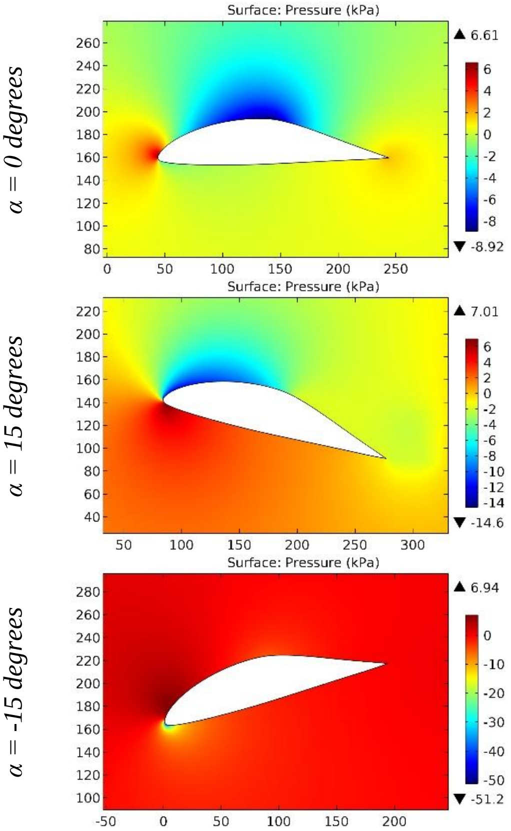


Figure 3. The pressure contours on the surfaces of the UNIVERSITY OF GLASGOW GU25-5(11)8 airfoil.

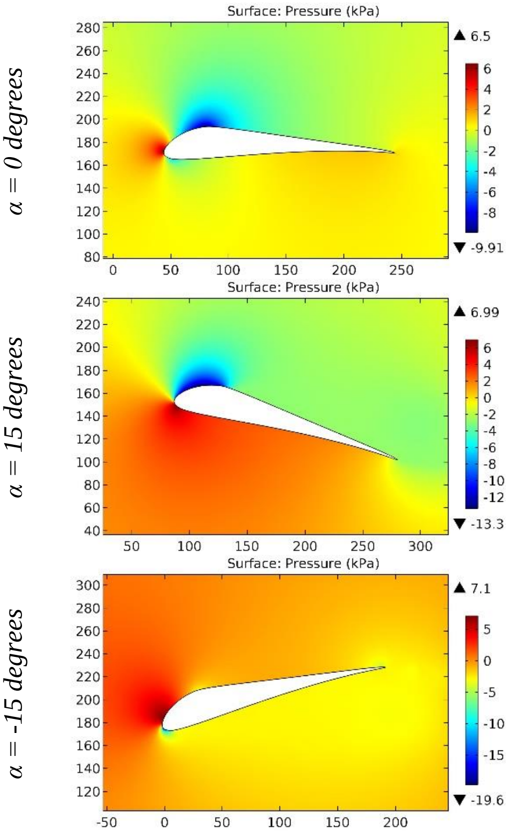


Figure 4. The pressure contours on the surfaces of the UNIVERSITY OF ILLINOIS UI-1720 airfoil.

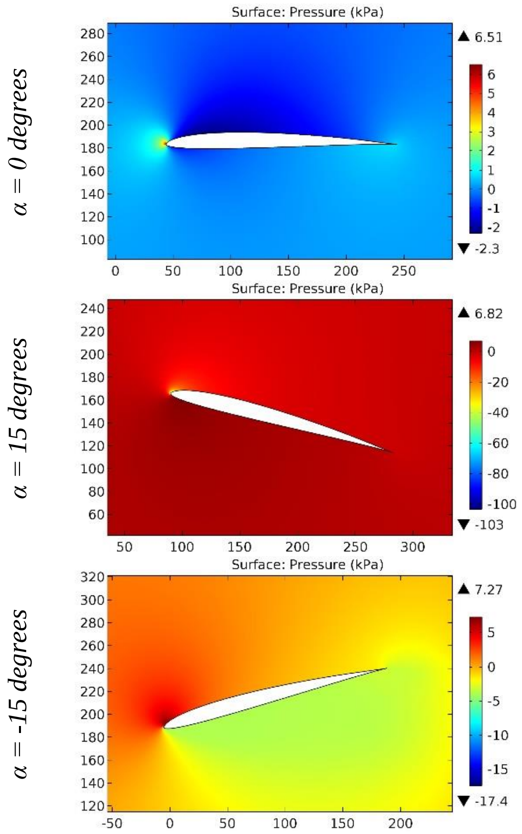


Figure 5. The pressure contours on the surfaces of the Uplink DLG by Dick Barker airfoil.

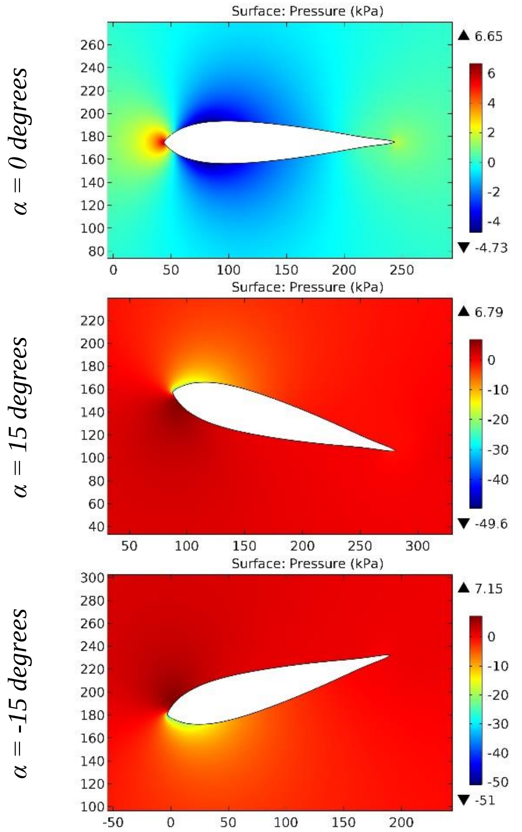


Figure 6. The pressure contours on the surfaces of the US1000ROOT airfoil.

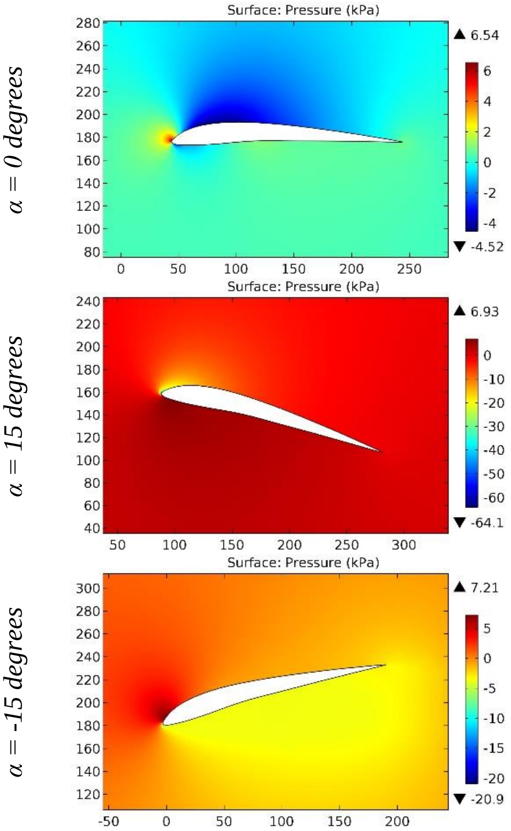


Figure 7. The pressure contours on the surfaces of the USA 22 airfoil.

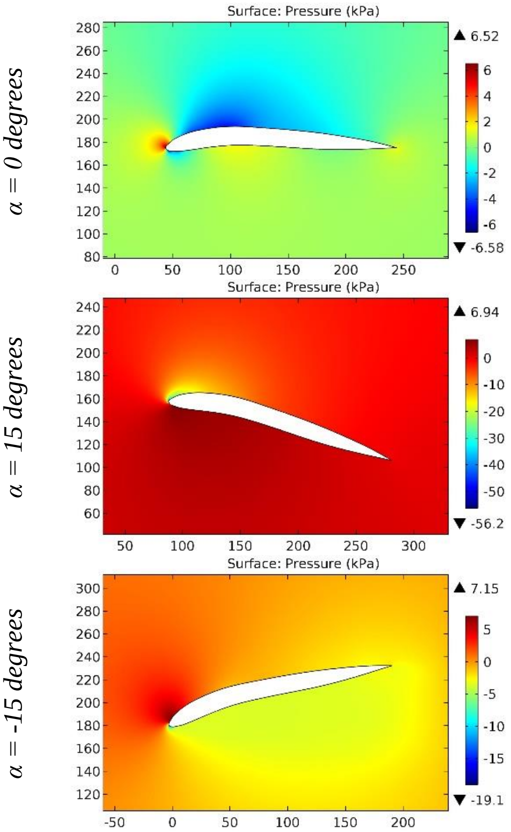


Figure 8. The pressure contours on the surfaces of the USA 25 airfoil.

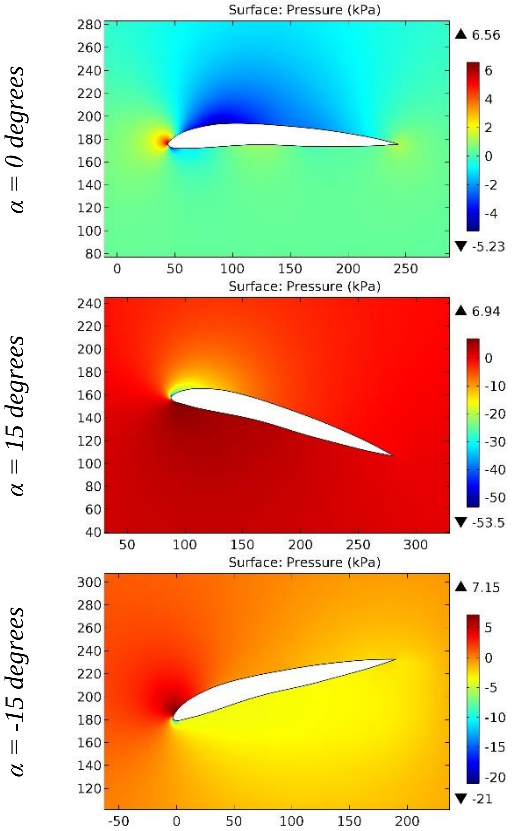


Figure 9. The pressure contours on the surfaces of the USA 26 airfoil.

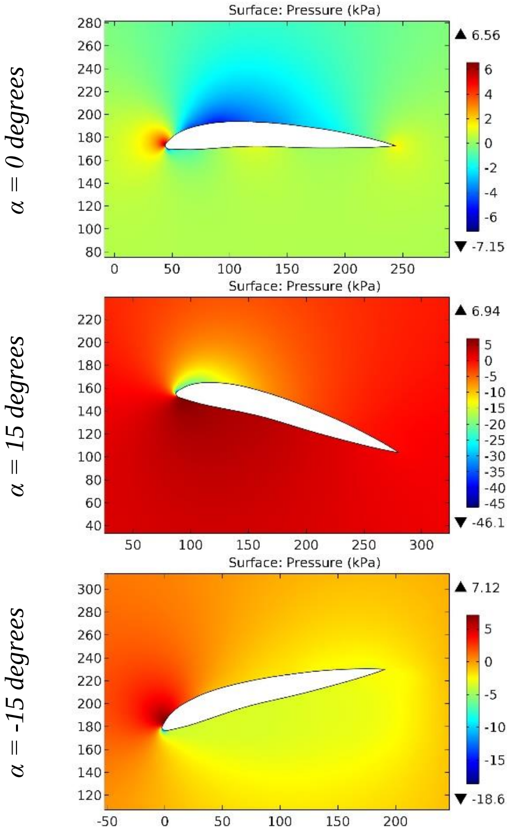


Figure 10. The pressure contours on the surfaces of the USA 27 airfoil.

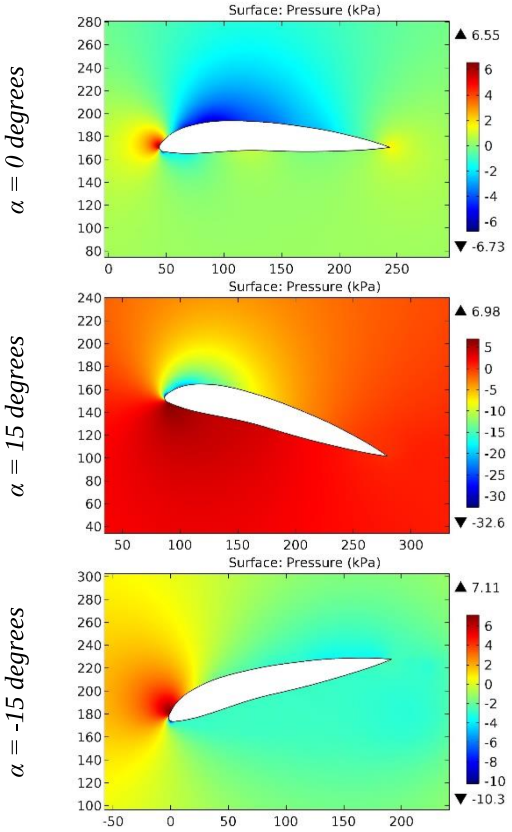


Figure 11. The pressure contours on the surfaces of the USA 27 mod airfoil.

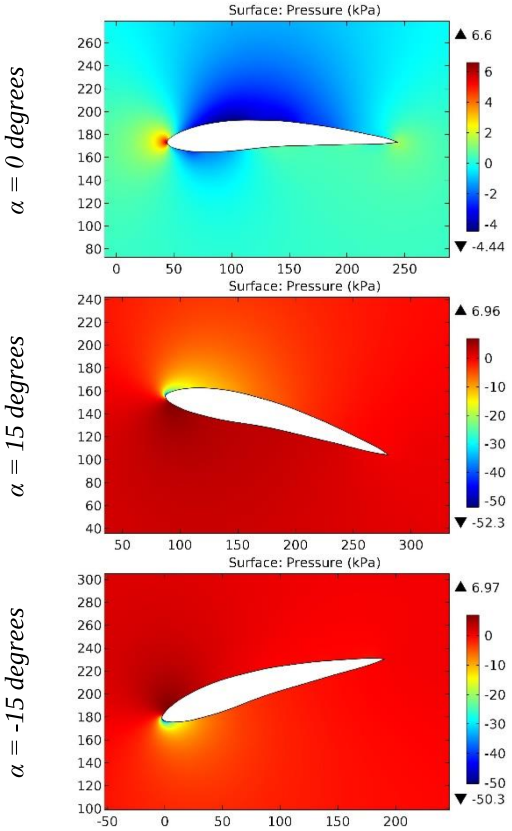


Figure 12. The pressure contours on the surfaces of the USA 28 airfoil.

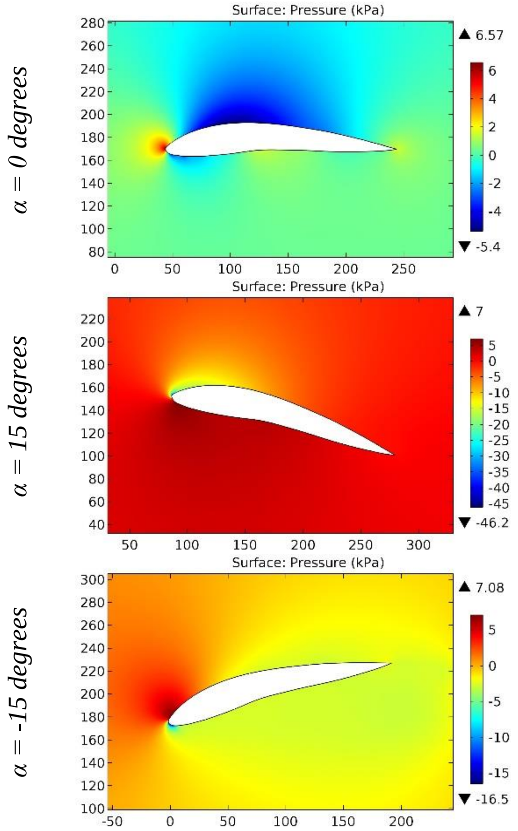


Figure 13. The pressure contours on the surfaces of the USA 29 airfoil.

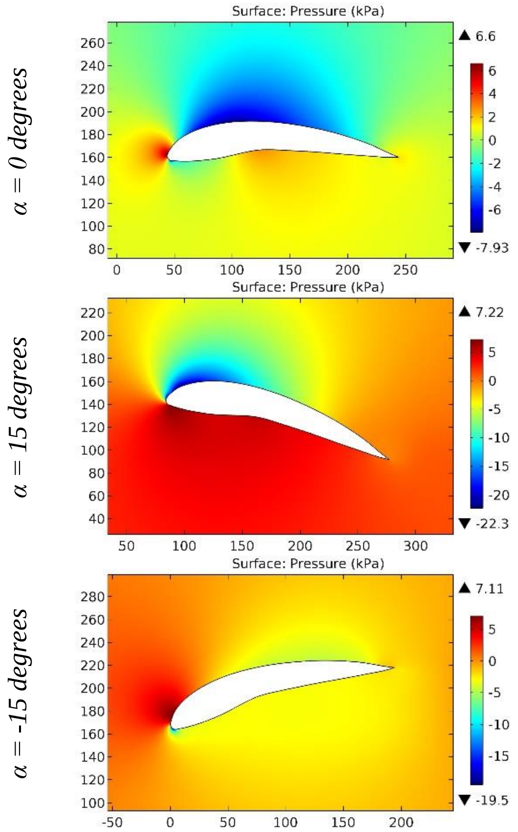


Figure 14. The pressure contours on the surfaces of the USA 31 airfoil.

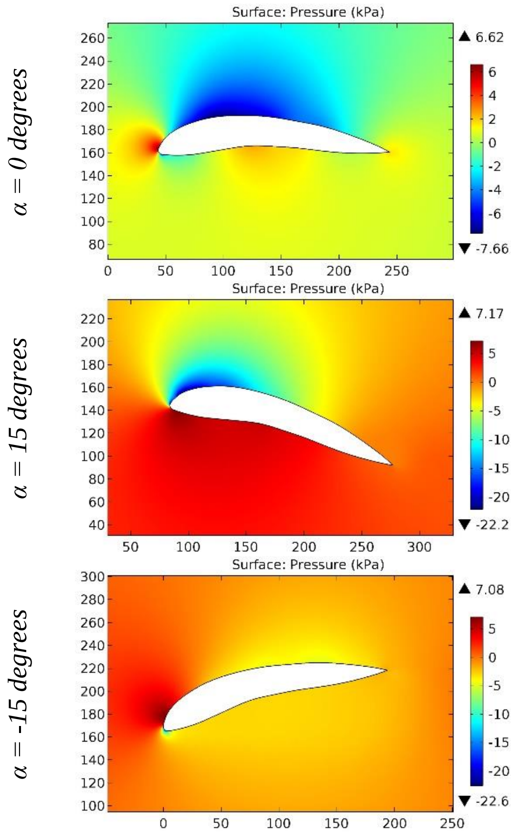


Figure 15. The pressure contours on the surfaces of the USA 32 airfoil.

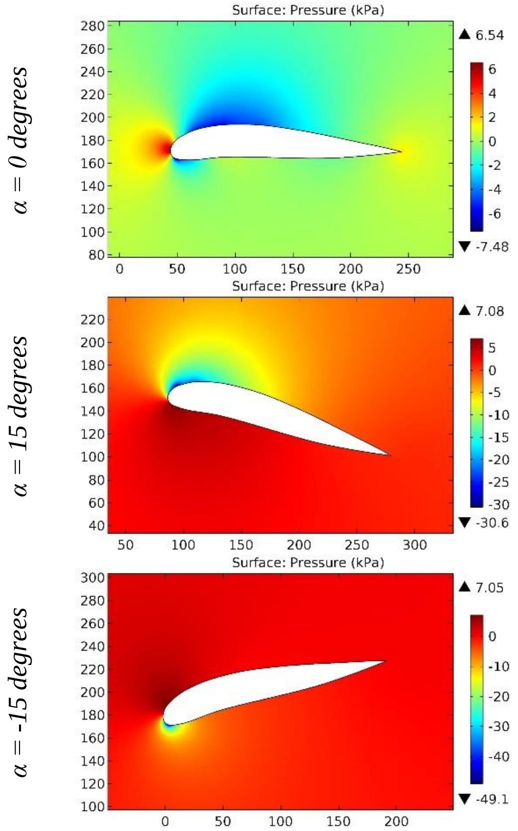


Figure 16. The pressure contours on the surfaces of the USA 33 airfoil.

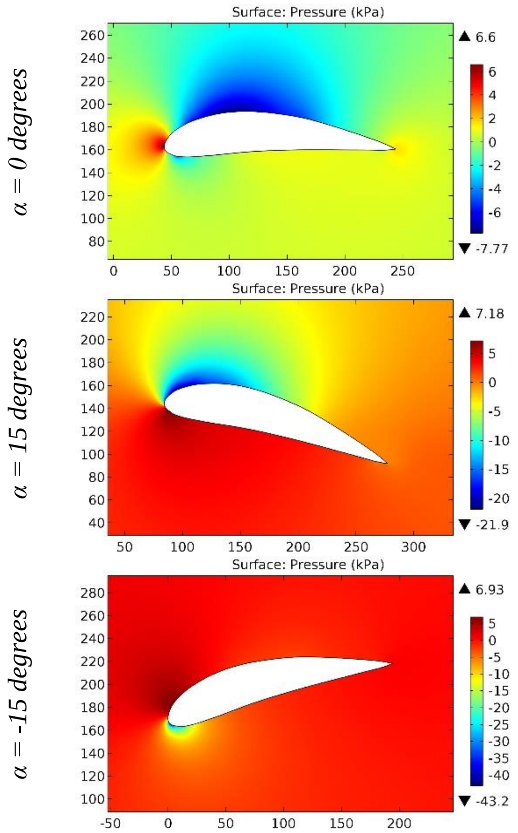


Figure 17. The pressure contours on the surfaces of the USA 34 airfoil.

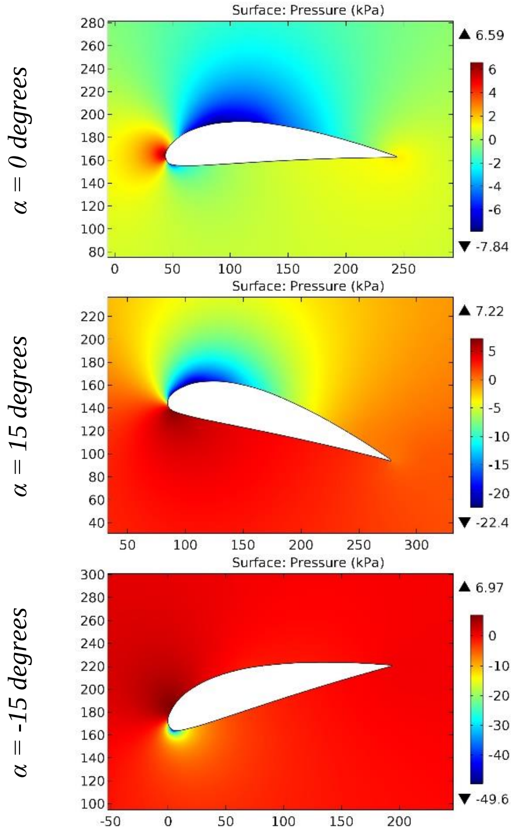


Figure 18. The pressure contours on the surfaces of the USA 35 airfoil.

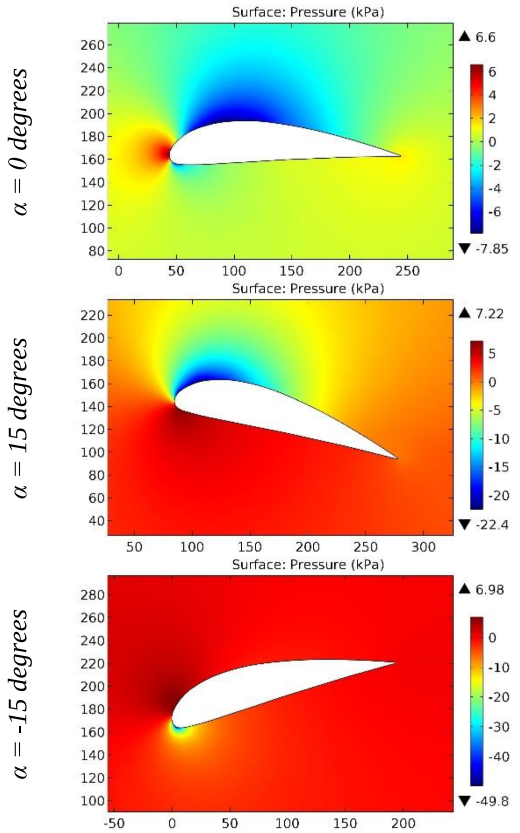


Figure 19. The pressure contours on the surfaces of the USA 35 A airfoil.

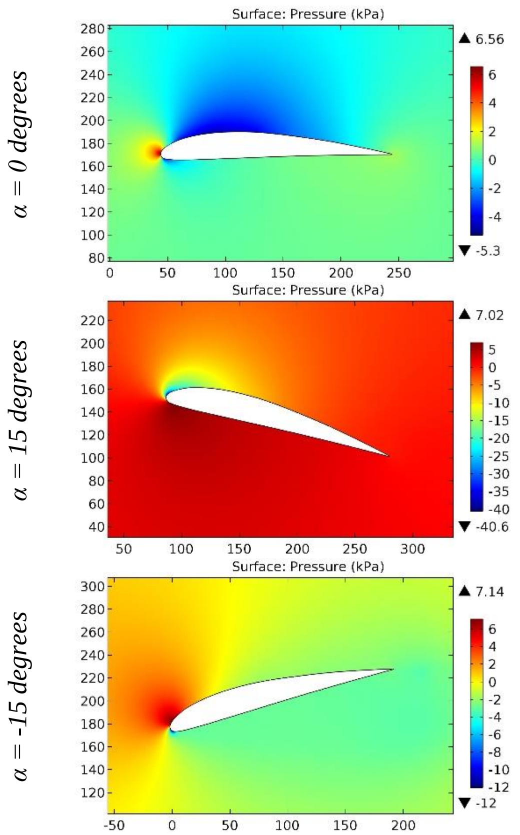


Figure 20. The pressure contours on the surfaces of the USA 35-B airfoil.

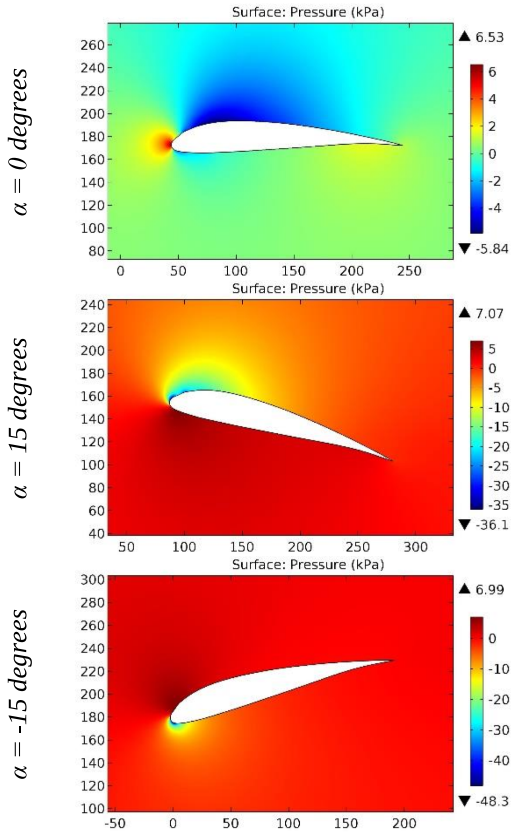


Figure 21. The pressure contours on the surfaces of the USA 40 airfoil.

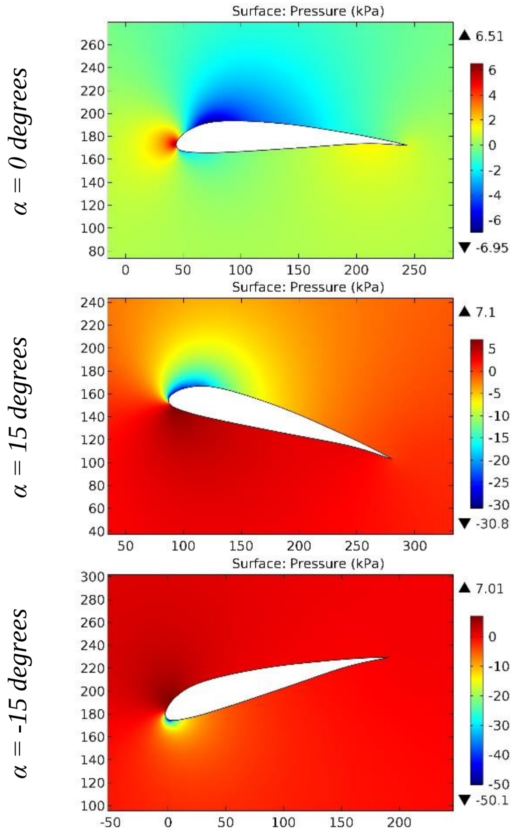


Figure 22. The pressure contours on the surfaces of the USA 40 B airfoil.

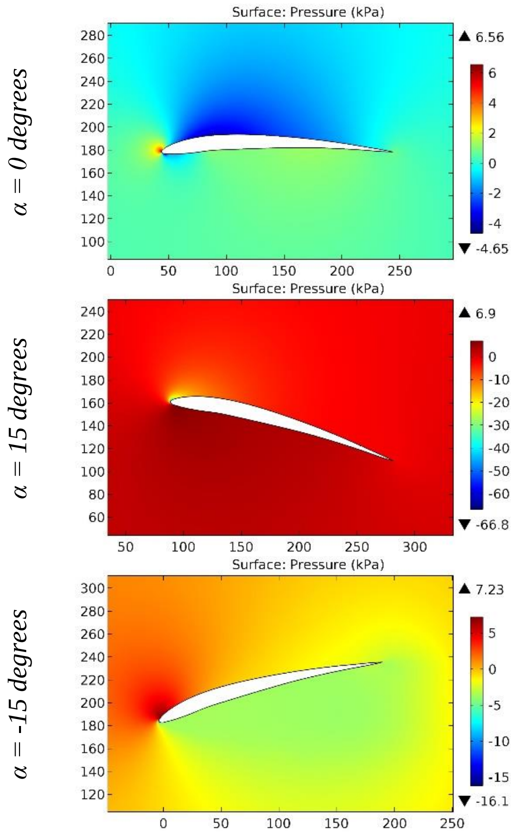


Figure 23. The pressure contours on the surfaces of the USA 41 airfoil.

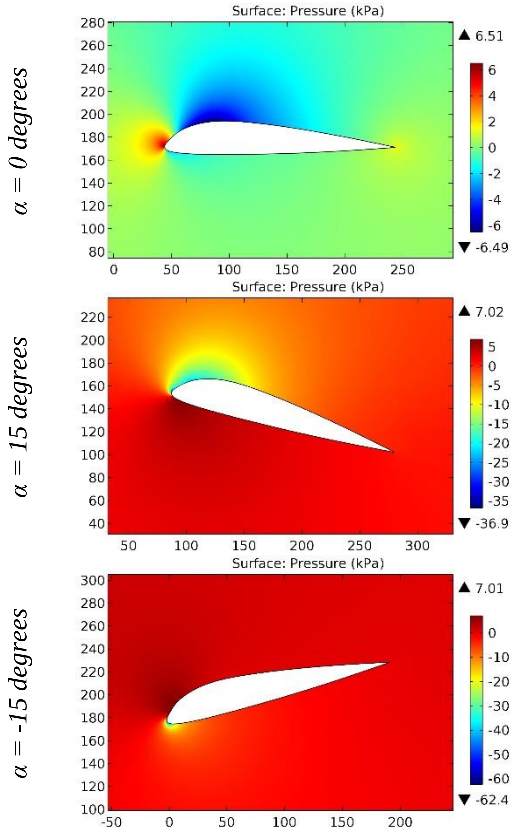


Figure 24. The pressure contours on the surfaces of the USA 45 airfoil.

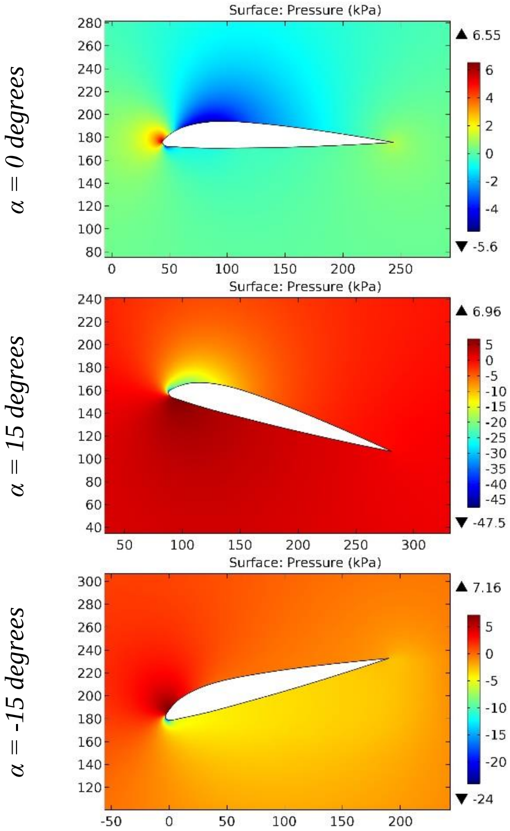


Figure 25. The pressure contours on the surfaces of the USA 45 M airfoil.

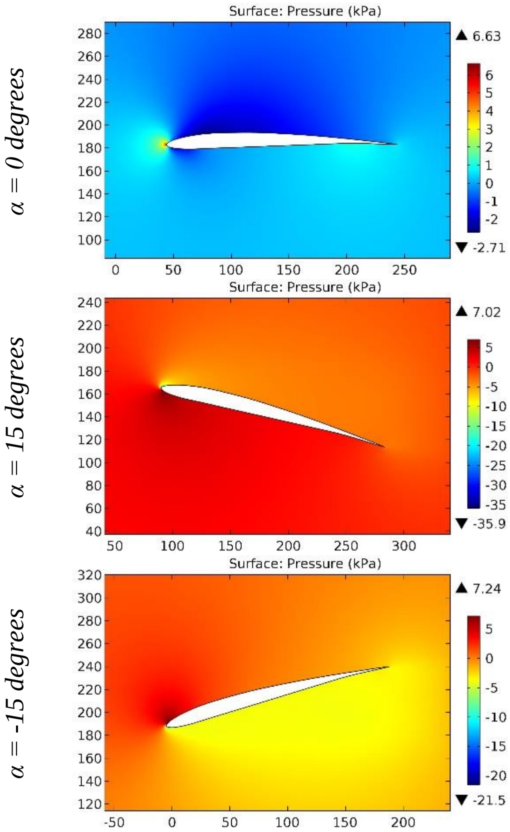


Figure 26. The pressure contours on the surfaces of the USA 46 airfoil.

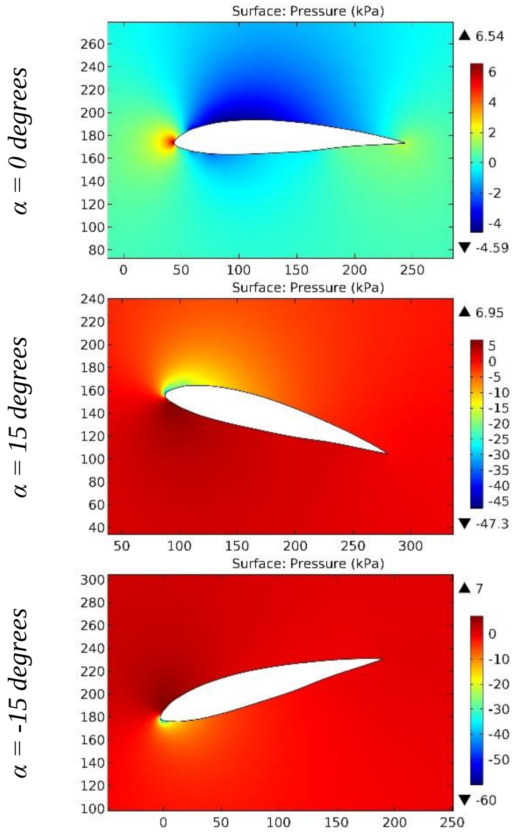


Figure 27. The pressure contours on the surfaces of the USA 48 airfoil.

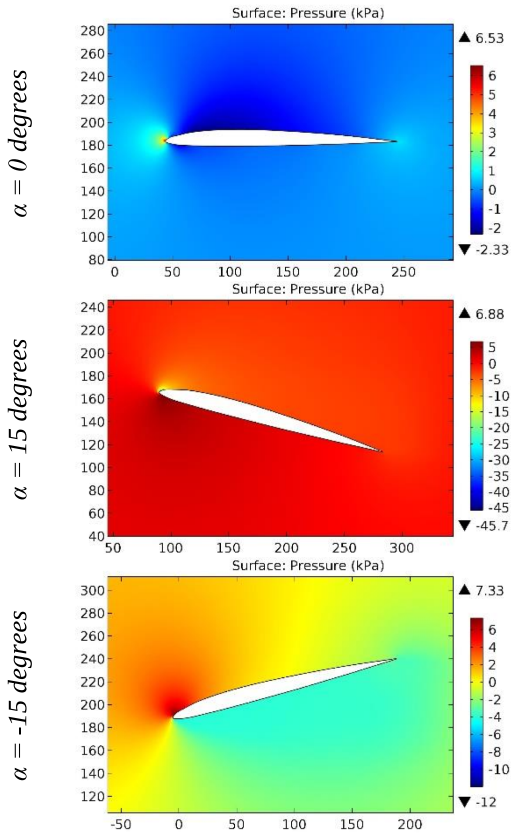


Figure 28. The pressure contours on the surfaces of the USA 49 airfoil.

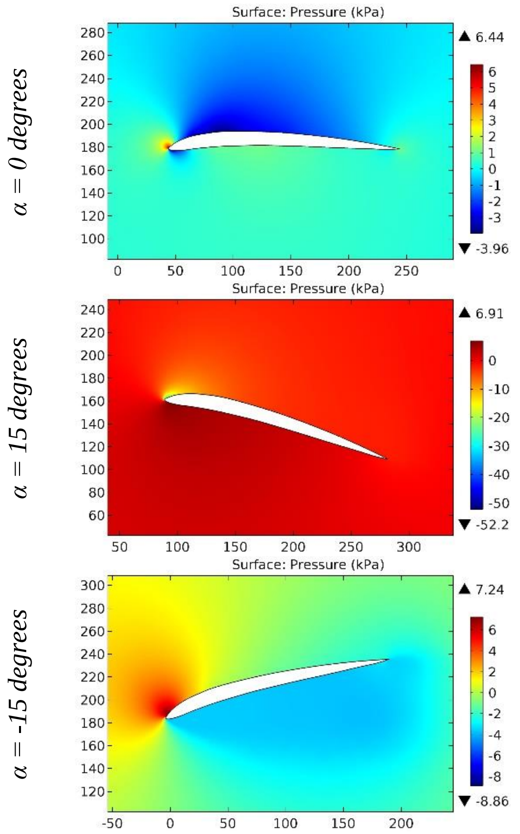


Figure 29. The pressure contours on the surfaces of the USA 5 airfoil.

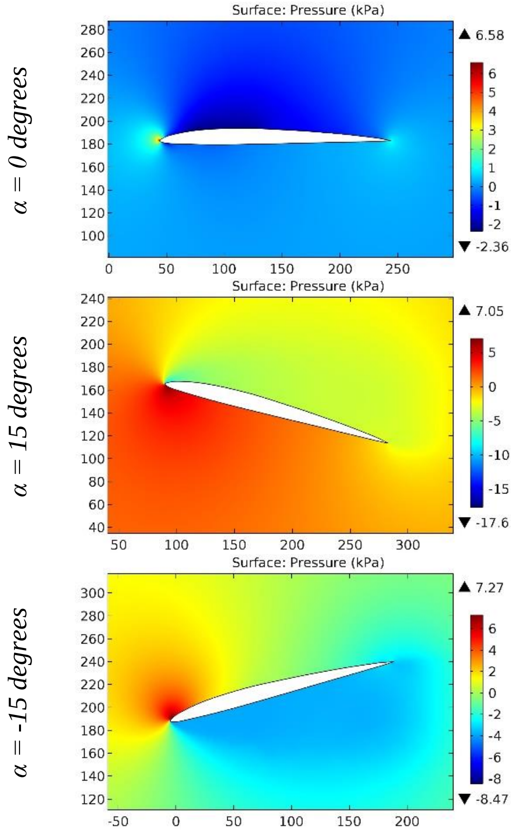


Figure 30. The pressure contours on the surfaces of the USA 50 airfoil.

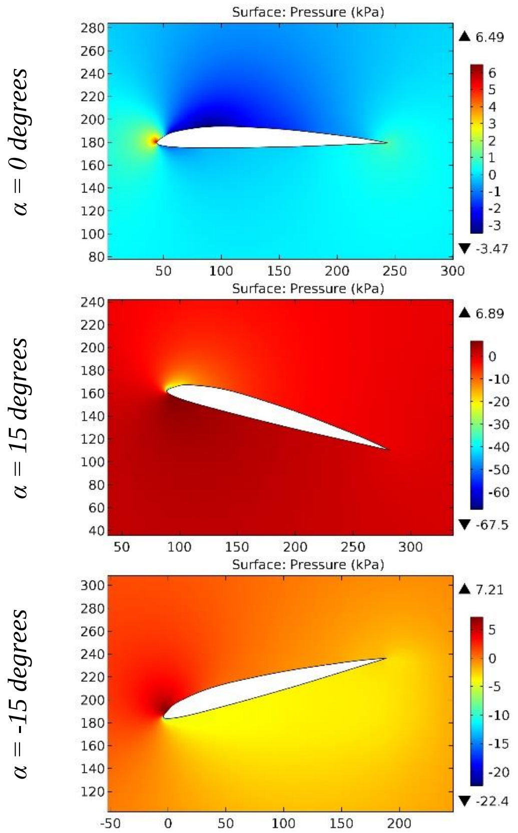


Figure 31. The pressure contours on the surfaces of the USA 51 airfoil.

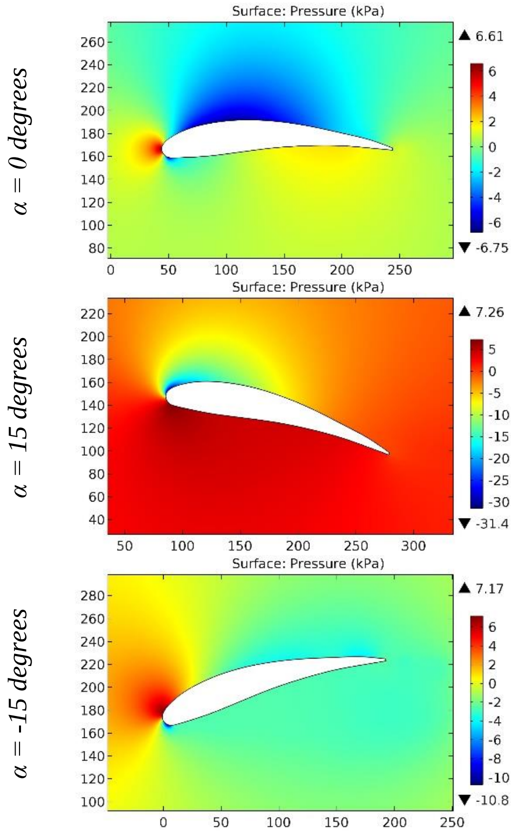


Figure 32. The pressure contours on the surfaces of the USA 98 airfoil.

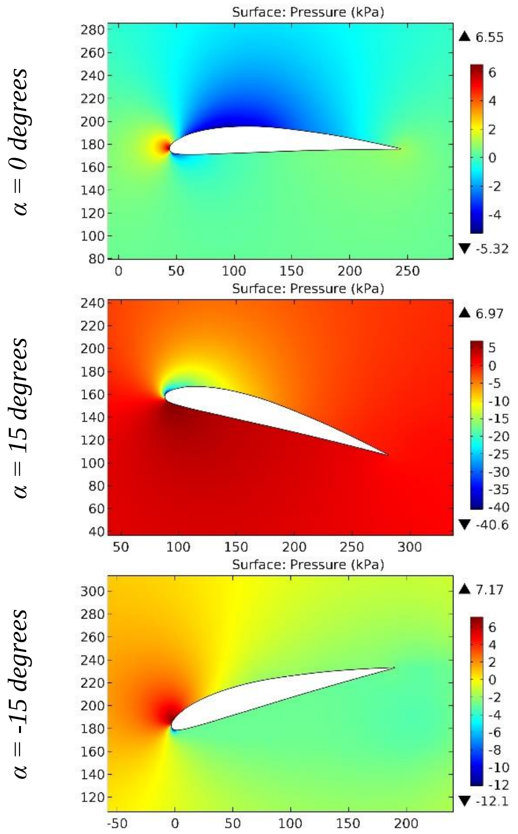


Figure 33. The pressure contours on the surfaces of the USA-35B airfoil.

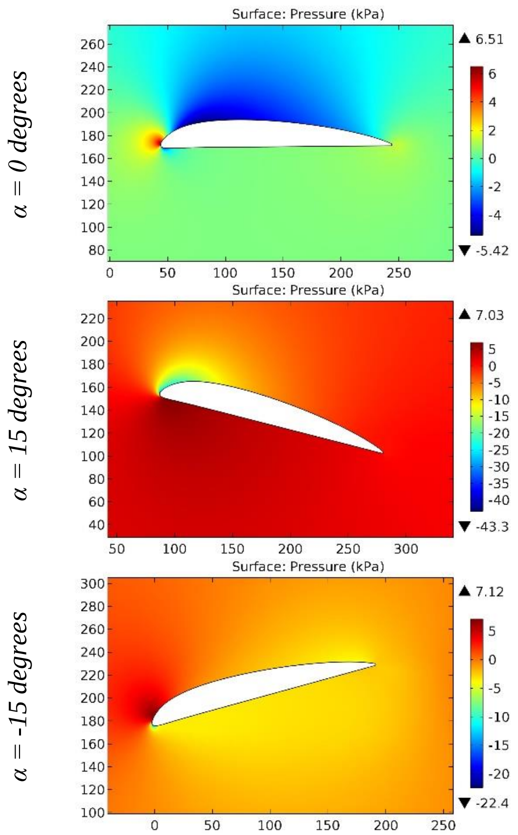


Figure 34. The pressure contours on the surfaces of the USNPS4 (smoothed) airfoil.

Results and discussion

The calculated pressure contours on the surfaces of the airfoils at different angles of attack are presented in the Figs. 1-34. 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.

34 airfoils of the USA, UNIVERSITY and other types were subject to consideration. All airfoils are asymmetrical.

The UNIVERSITY OF ALBERTA UA 79-SF-187 airfoil has the maximum thickness. The minimum thickness is specified for the USA 5 airfoil. The maximum camber of 9.36% is determined for the USA 31 airfoil.

A minimum camber of 0.05% is specified for the ULTIMATE/JCE airfoil. The largest leading edge radius was observed for the USA 35 and USA 35 A airfoils, and the minimum radius was observed for the UNIVERSITY OF ALBERTA UA 79-SF-187 airfoil. The greatest thickening of the trailing edge is made in the UNIVERSITY OF ALBERTA UA 79-SF-187 airfoil. Most airfoils do not have a trailing edge thickening.

Let us consider the aerodynamic characteristics of the airfoils described above.

The ULTIMATE/JCE airfoil is subjected to almost the same intensity of pressure distribution on the leading edge both during climb and descent of the airplane, due to minimal camber. But the amount of drag when climb is less than when descent of the airplane.

The configuration of the UNIVERSITY OF ALBERTA UA 79-SF-187 airfoil during the airplane maneuvers leads to a greater spread in the distribution of negative pressure on the leading edge. When an airplane descends, the pressure on the leading edge is approximately 3 times greater than when it climbs.

The USA 5 airfoil, when the airplane climb, has a greater lift force due to the difference in pressure on the upper and lower surfaces. The pressure difference on the upper and lower surfaces is much smaller as the airplane descent.

The USA 31 airfoil, which has maximum camber in the cross section, is subject to negligible pressures acting on the surfaces and edges of the wing. A convex upper surface contributes to the formation of negative pressure on it at angles of attack of 0 and 15 degrees, and a negative angle of attack causes positive pressure on this surface.

For the USA 35 and USA 35 A airfoils, when the airplane climb, a pressure difference arises on the upper and lower surfaces, which is approximately two times smaller than when descent.

Conclusion

Depending on the geometry of the airplane wing, airfoils can be subjected to maximum drag, both during climb and descent. In particular cases, the positive effect of the camber magnitude and the small thickness of the airfoils in the cross section on the aerodynamic characteristics of the airplane wings was noted. The greatest pressure difference on the wing surfaces is the UNIVERSITY OF ALBERTA UA 79-SF-187 model from the above-considered airfoils.

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