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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

Andrey Karasyov
Vladimir Industrial College
Student, Russian Federation

Veronika Khlebnikova
Vladimir Industrial College
Student, Russian Federation

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Vladimir Industrial College
Student, Russian Federation

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Dmitriy Netsvetaev
Vladimir Industrial College
Student, Russian Federation

Andrey Volvyankin
Vladimir Industrial College
Student, Russian Federation

REFERENCE DATA OF PRESSURE DISTRIBUTION ON THE SURFACES OF AIRFOILS HAVING THE NAMES BEGINNING WITH THE LETTER N (THE FIRST PART)

Abstract: *The results of the computer calculation of air flow around the airfoils having the names beginning with the letter N 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: *the airfoil, the angle of attack, pressure, the surface.*

Language: *English*

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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 [1-29]. In this work, the airfoils having the names beginning with the letter *N* 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
N 11	10.94% at 30.0% of the chord	5.81% at 30.0% of the chord	1.1658%	0.2%
N 22	12.37% at 30.0% of the chord	6.24% at 30.0% of the chord	1.4944%	0.4%
N 60	12.37% at 30.0% of the chord	6.22% at 30.0% of the chord	1.3634%	0.4%
N 60 R	12.37% at 30.0% of the chord	6.22% at 30.0% of the chord	1.3634%	0.4%
N 9	8.46% at 30.0% of the chord	4.23% at 30.0% of the chord	0.8619%	0.28%
N-10	11.22% at 30.0% of the chord	5.63% at 30.0% of the chord	1.159%	0.34%
N-12	10.46% at 30.0% of the chord	0.16% at 15.0% of the chord	1.0389%	0.0%
N-13	11.8% at 30.0% of the chord	0.11% at 95.0% of the chord	1.0996%	0.0%
N-14	11.48% at 30.0% of the chord	0.05% at 20.0% of the chord	1.2666%	0.0%
N16006PR	6.0% at 50.0% of the chord	0.0% at 0.0% of the chord	0.716%	0.12%
N16009PR	9.0% at 50.0% of the chord	0.0% at 0.0% of the chord	0.7351%	0.18%
N16012PR	12.0% at 50.0% of the chord	0.0% at 0.0% of the chord	0.863%	0.24%
N16015PR	15.0% at 50.0% of the chord	0.0% at 0.0% of the chord	1.1201%	0.3%
N16018PR	18.0% at 50.0% of the chord	0.0% at 0.0% of the chord	1.4975%	0.36%
N16021PR	21.0% at 50.0% of the chord	0.0% at 0.0% of the chord	1.9829%	0.42%
N-22P	12.3% at 30.0% of the chord	6.25% at 30.0% of the chord	1.5091%	0.0%
N2311275	12.01% at 30.0% of the chord	1.99% at 15.0% of the chord	1.5022%	0.26%
N-24	17.02% at 30.0% of the chord	8.61% at 30.0% of the chord	2.6364%	0.0%
N631-012	12.0% at 35.0% of the chord	0.0% at 0.0% of the chord	0.7847%	0.0%
N631-212	12.0% at 35.1% of the chord	1.1% at 50.0% of the chord	0.8224%	0.0%
N631A012	11.99% at 35.0% of the chord	0.0% at 0.0% of the chord	0.7627%	0.05%
N631A412	11.99% at 35.0% of the chord	2.21% at 50.0% of the chord	0.81%	0.0%
N631A512	11.99% at 35.0% of the chord	2.76% at 50.0% of the chord	0.8086%	0.0%
N631A612	11.99% at 35.0% of the chord	3.31% at 50.0% of the chord	0.8068%	0.0%
N632-215	15.0% at 35.1% of the chord	1.1% at 50.0% of the chord	1.299%	0.0%
N632-415	15.0% at 35.1% of the chord	2.21% at 50.0% of the chord	1.3216%	0.0%
N632-615	14.99% at 35.2% of the chord	3.31% at 50.0% of the chord	1.3124%	0.0%
N63A-010	9.99% at 35.0% of the chord	0.0% at 0.0% of the chord	0.5058%	0.042%
N641A012	11.99% at 40.0% of the chord	0.0% at 0.0% of the chord	0.741%	0.05%
N651-012	11.99% at 40.0% of the chord	0.0% at 0.0% of the chord	0.6745%	0.0%
N652-015	15.0% at 40.0% of the chord	0.0% at 0.0% of the chord	1.0637%	0.0%
N-7	6.65% at 30.0% of the chord	1.66% at 30.0% of the chord	0.5913%	0.0%
NA0006T	6.0% at 30.0% of the chord	0.0% at 0.0% of the chord	0.7174%	0.0%
NA0012T	12.0% at 30.0% of the chord	0.0% at 0.0% of the chord	0.839%	0.0%
NA0018T	18.0% at 30.0% of the chord	0.0% at 0.0% of the chord	2.1417%	0.0%
NA010-34	10.0% at 40.0% of the chord	0.0% at 0.0% of the chord	0.7304%	0.2%
NA012-63	12.0% at 30.0% of the chord	0.0% at 0.0% of the chord	1.4603%	0.24%
NA012-64	12.0% at 40.0% of the chord	0.0% at 0.0% of the chord	1.3344%	0.24%
NA012-B	12.0% at 25.0% of the chord	0.0% at 0.0% of the chord	3.0995%	0.24%
NA10	10.0% at 35.0% of the chord	3.5% at 50.0% of the chord	0.5245%	0.0%
NA23009	9.01% at 30.0% of the chord	1.84% at 15.0% of the chord	0.9446%	0.2%
NA23012	0.0% at 0.0% of the chord	1.76% at 20.0% of the chord	1.4742%	0.0%
NA23012F	12.01% at 30.0% of the chord	1.85% at 15.0% of the chord	2.7107%	0.26%
NA23112	12.01% at 30.0% of the chord	1.99% at 15.0% of the chord	1.5022%	0.26%
NA2R1-12	12.0% at 30.0% of the chord	1.98% at 30.0% of the chord	1.4436%	0.0%
NA2R2-12	12.0% at 30.0% of the chord	2.0% at 30.0% of the chord	1.4473%	0.0%
NA5	10.0% at 35.0% of the chord	5.0% at 50.0% of the chord	0.6476%	0.0%
NA6	10.0% at 35.0% of the chord	3.5% at 50.0% of the chord	0.5656%	0.042%
NA63-009	8.89% at 40.0% of the chord	0.0% at 0.0% of the chord	0.4147%	0.0%
NA63-010	10.0% at 35.0% of the chord	0.0% at 0.0% of the chord	0.5248%	0.0%
NA63-206	6.0% at 35.0% of the chord	1.1% at 50.0% of the chord	0.2159%	0.0%

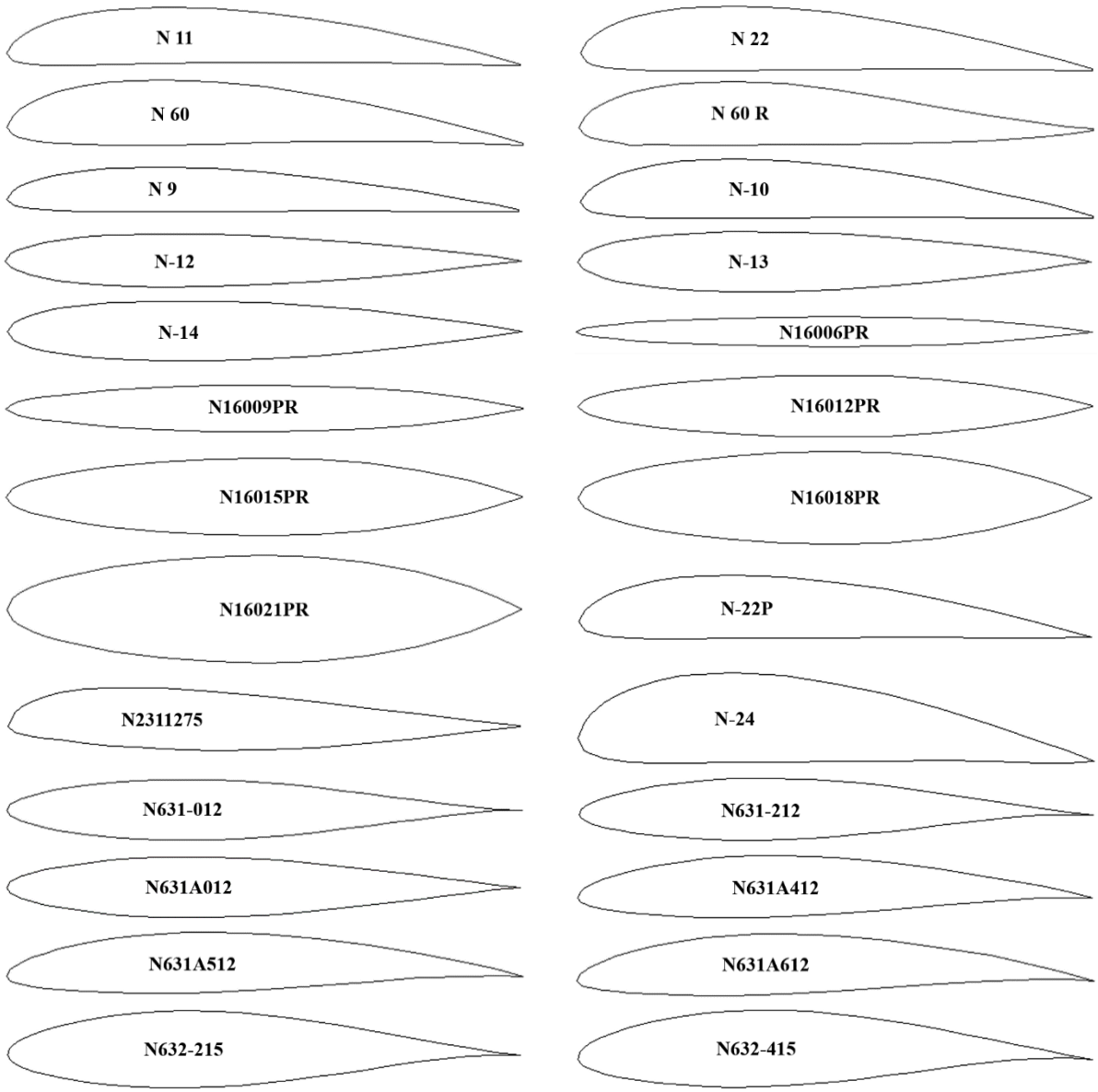
NA63-209	9.0% at 35.0% of the chord	1.1% at 50.0% of the chord	0.4296%	0.0%
NA63-210	10.0% at 35.0% of the chord	1.1% at 50.0% of the chord	0.5473%	0.0%
NA63A006	5.97% at 40.0% of the chord	0.0% at 0.0% of the chord	0.7136%	0.026%
NA63A410	9.99% at 35.0% of the chord	2.21% at 50.0% of the chord	0.5753%	0.042%
NA63A411	10.99% at 35.0% of the chord	2.21% at 50.0% of the chord	0.6814%	0.046%
NA63A413	12.99% at 35.0% of the chord	2.21% at 50.0% of the chord	0.9539%	0.054%
NA63A414	13.99% at 35.0% of the chord	2.21% at 50.0% of the chord	1.1128%	0.058%
NA63A510	9.99% at 35.0% of the chord	2.76% at 50.0% of the chord	0.5729%	0.042%
NA63A511	10.99% at 35.0% of the chord	2.76% at 50.0% of the chord	0.6797%	0.046%
NA63A513	12.99% at 35.0% of the chord	2.76% at 50.0% of the chord	0.9528%	0.054%
NA63A514	13.99% at 35.0% of the chord	2.76% at 50.0% of the chord	1.1118%	0.058%
NA63A610	9.99% at 35.0% of the chord	3.31% at 50.0% of the chord	0.5707%	0.042%
NA63A611	10.99% at 35.0% of the chord	3.31% at 50.0% of the chord	0.6777%	0.046%
NA63A613	12.99% at 35.0% of the chord	3.31% at 50.0% of the chord	0.9511%	0.054%
NA63A614	13.99% at 35.0% of the chord	3.31% at 50.0% of the chord	1.1101%	0.058%
NA64-006	5.98% at 40.0% of the chord	0.0% at 0.0% of the chord	0.7135%	0.0%
NA64-009	8.98% at 40.0% of the chord	0.0% at 0.0% of the chord	0.4021%	0.0%
NA64-010	9.98% at 40.0% of the chord	0.0% at 0.0% of the chord	0.5116%	0.0%
NA641012	11.96% at 40.0% of the chord	0.0% at 0.0% of the chord	0.7718%	0.0%
NA641112	9.97% at 40.0% of the chord	1.1% at 50.0% of the chord	0.5768%	0.0%
NA64A010	9.99% at 40.0% of the chord	0.0% at 0.0% of the chord	0.4887%	0.042%
NA65-009	8.99% at 40.0% of the chord	0.0% at 75.0% of the chord	0.3556%	0.0%
NA65-010	9.99% at 40.0% of the chord	0.0% at 0.0% of the chord	0.4447%	0.0%
NA66-018	18.0% at 45.0% of the chord	0.0% at 87.6% of the chord	1.7563%	0.0%
NA7	10.0% at 35.0% of the chord	3.0% at 50.0% of the chord	0.6647%	0.0%
NA8	10.0% at 35.0% of the chord	3.5% at 50.0% of the chord	0.539%	0.0%
NA9	10.0% at 35.0% of the chord	3.5% at 50.0% of the chord	0.5656%	0.042%
NACA 0006	6.0% at 29.7% of the chord	0.0% at 0.0% of the chord	0.4896%	0.126%
NACA 0007	7.0% at 29.7% of the chord	0.0% at 0.0% of the chord	0.6024%	0.147%
NACA 0008	8.0% at 29.7% of the chord	0.0% at 0.0% of the chord	0.7413%	0.168%
NACA 0009	9.0% at 29.7% of the chord	0.0% at 0.0% of the chord	0.9051%	0.189%
NACA 0010	10.0% at 29.7% of the chord	0.0% at 0.0% of the chord	1.0931%	0.21%
NACA 0011	11.0% at 29.7% of the chord	0.0% at 0.0% of the chord	1.3045%	0.231%
NACA 0012	12.0% at 30.0% of the chord	0.0% at 0.0% of the chord	1.4936%	0.252%
NACA 0013	13.0% at 29.7% of the chord	0.0% at 0.0% of the chord	1.795%	0.273%
NACA 0014	14.0% at 29.7% of the chord	0.0% at 0.0% of the chord	2.0736%	0.294%
NACA 0015	15.0% at 29.7% of the chord	0.0% at 0.0% of the chord	2.3742%	0.315%
NACA 0015 by profile	15.0% at 29.7% of the chord	0.0% at 0.0% of the chord	2.3742%	0.315%
NACA 0016	16.0% at 29.7% of the chord	0.0% at 0.0% of the chord	2.6964%	0.336%
NACA 0016- 30-20	16.0% at 19.8% of the chord	0.0% at 0.0% of the chord	4.0255%	0.336%
NACA 0016- 30-25	16.0% at 24.7% of the chord	0.0% at 0.0% of the chord	3.2235%	0.336%
NACA 0016- Mod,	16.0% at 9.9% of the chord	0.0% at 0.0% of the chord	8.0508%	0.336%
NACA 0016- Mod,30-20	16.0% at 19.8% of the chord	0.0% at 0.0% of the chord	4.023%	0.336%
NACA 0016- Mod,40-30	16.0% at 22.3% of the chord	0.0% at 0.0% of the chord	3.578%	0.336%
NACA 0016- Mod,40-32	16.0% at 23.7% of the chord	0.0% at 0.0% of the chord	3.3562%	0.336%
NACA 0016- Mod,40-35	16.0% at 26.0% of the chord	0.0% at 0.0% of the chord	3.0721%	0.336%
NACA 0018	18.0% at 29.7% of the chord	0.0% at 0.0% of the chord	3.4054%	0.378%
NACA 0018- Mod,40-30	18.0% at 22.3% of the chord	0.0% at 0.0% of the chord	4.5312%	0.378%
NACA 0018- Mod,40-32	18.0% at 23.7% of the chord	0.0% at 0.0% of the chord	4.2464%	0.378%
NACA 0018- Mod,40-35	18.0% at 26.0% of the chord	0.0% at 0.0% of the chord	3.8849%	0.378%
NACA 0020	20.0% at 29.7% of the chord	0.0% at 0.0% of the chord	4.2002%	0.42%
NACA 11-H-09	8.97% at 39.8% of the chord	4.51% at 30.0% of the chord	0.5329%	0.0%
NACA 1412	11.99% at 30.1% of the chord	1.0% at 40.0% of the chord	1.3141%	0.245%
NACA 16018	18.0% at 49.6% of the chord	0.0% at 0.0% of the chord	1.5688%	0.36%
NACA 1-H-15	14.72% at 40.0% of the chord	5.5% at 40.0% of the chord	1.4307%	0.0%
NACA 2 R 12	12.0% at 30.0% of the chord	1.98% at 30.0% of the chord	1.4436%	0.0%
NACA 2 R1 12	12.0% at 30.0% of the chord	1.98% at 30.0% of the chord	1.4436%	0.0%
NACA 2,5411	11.0% at 29.8% of the chord	2.5% at 39.6% of the chord	1.2891%	0.0%
NACA 23012 12%	12.0% at 29.5% of the chord	1.83% at 13.0% of the chord	1.5162%	0.252%
NACA 23016	15.99% at 30.4% of the chord	1.22% at 14.9% of the chord	2.6427%	0.3356%
NACA 2409-34	9.0% at 40.2% of the chord	2.0% at 40.2% of the chord	0.3842%	0.1796%
NACA 2410	10.01% at 29.8% of the chord	1.93% at 41.0% of the chord	1.097%	0.2096%
NACA 2412	12.01% at 29.9% of the chord	1.92% at 41.7% of the chord	1.5475%	0.2514%
NACA 2413	13.01% at 29.9% of the chord	1.91% at 41.7% of the chord	1.8071%	0.2724%
NACA 2414	14.0% at 29.8% of the chord	2.0% at 39.6% of the chord	2.0428%	0.294%
NACA 2414- Mod,	14.0% at 29.8% of the chord	0.19% at 4.7% of the chord	2.0818%	0.294%
NACA 2415	15.01% at 29.9% of the chord	1.9% at 41.8% of the chord	2.3917%	0.3144%
NACA 2-H-15	14.72% at 40.0% of the chord	4.5% at 40.0% of the chord	1.5204%	0.0%
NACA 4415bis	15.02% at 29.4% of the chord	3.69% at 42.5% of the chord	2.3979%	0.3124%
NACA 4-H-12,4	12.76% at 40.0% of the chord	4.44% at 40.0% of the chord	1.2809%	0.0%

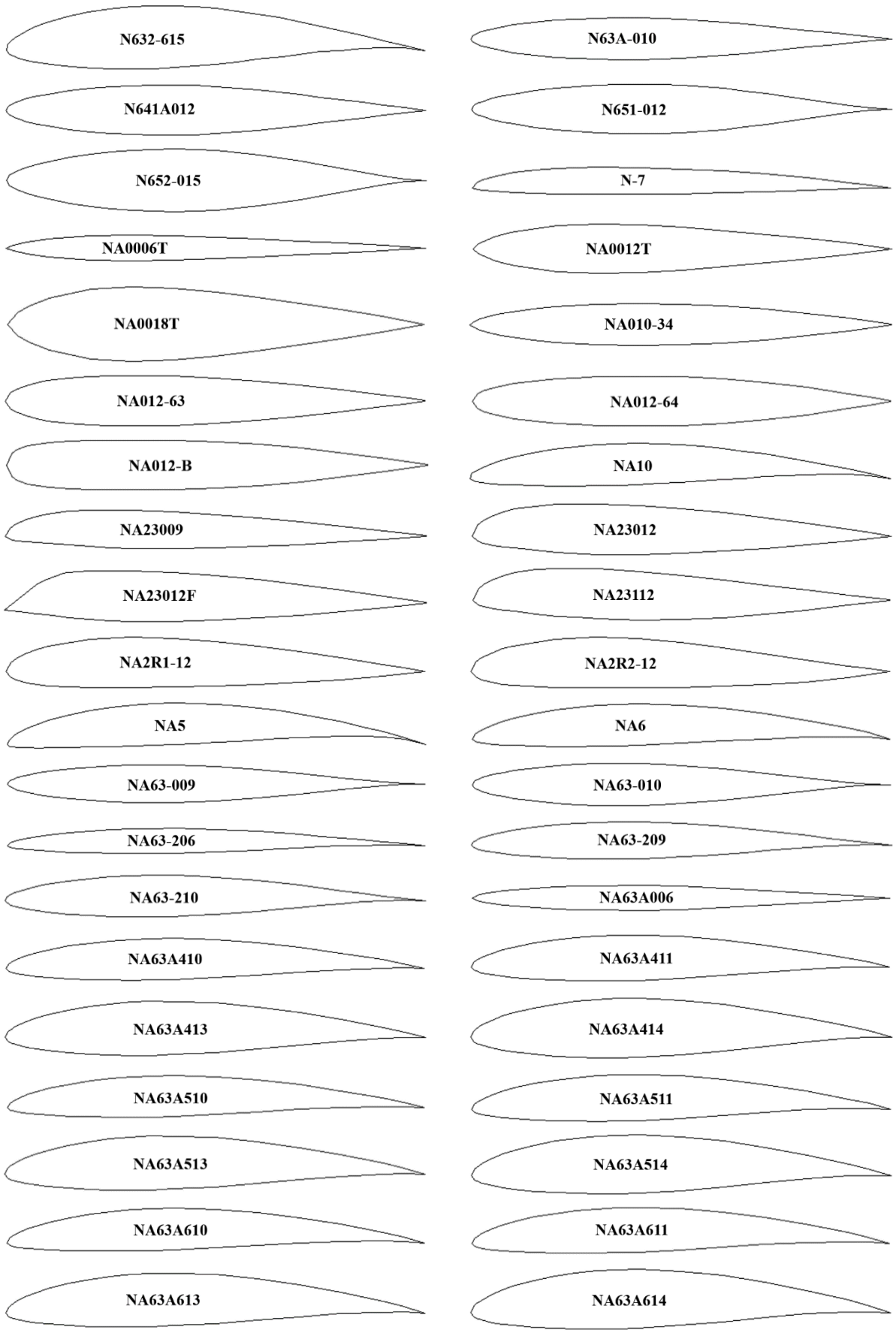
NACA 5-H-10	9.9% at 40.0% of the chord	2.25% at 40.0% of the chord	0.7581%	0.0%
NACA 5-H-15	15.42% at 40.0% of the chord	2.92% at 30.0% of the chord	1.2092%	0.0%
NACA 5-H-20	19.9% at 40.0% of the chord	4.45% at 40.0% of the chord	2.3803%	0.0%
NACA 63(2)-215 MOD B	15.04% at 30.0% of the chord	1.49% at 10.0% of the chord	1.3861%	0.0%
NACA 63012A	11.99% at 35.0% of the chord	0.0% at 0.0% of the chord	0.7627%	0.05%
NACA 63-015A	14.99% at 35.0% of the chord	0.0% at 0.0% of the chord	1.2413%	0.064%
NACA 63-018	18.0% at 35.0% of the chord	0.0% at 0.0% of the chord	1.7538%	0.0%
NACA 63-210	10.0% at 35.0% of the chord	1.12% at 59.0% of the chord	0.5473%	0.0%
NACA 63-212	12.0% at 35.1% of the chord	1.1% at 50.0% of the chord	0.8497%	0.0%
NACA 63-215	15.0% at 35.1% of the chord	1.1% at 50.0% of the chord	1.299%	0.0%
NACA 63-412	15.0% at 35.1% of the chord	2.21% at 50.0% of the chord	1.3216%	0.0%
NACA 63A010	9.99% at 35.0% of the chord	0.0% at 0.0% of the chord	0.5058%	0.042%
NACA 63A018	18.0% at 35.0% of the chord	0.0% at 0.0% of the chord	1.7538%	0.0%
NACA 63A612	12.0% at 36.3% of the chord	3.81% at 54.6% of the chord	0.9518%	0.05%
NACA 64(1)-212	11.96% at 40.0% of the chord	1.1% at 50.0% of the chord	0.8087%	0.0%
NACA 64(1)-212 MOD A	11.96% at 41.1% of the chord	2.45% at 21.4% of the chord	3.0097%	0.0%
NACA 64(1)-212 MOD B	12.05% at 35.1% of the chord	1.49% at 10.1% of the chord	1.3903%	0.0%
NACA 64-008A	8.0% at 40.0% of the chord	0.0% at 0.0% of the chord	0.298%	0.036%
NACA 64-012A	11.99% at 40.0% of the chord	0.0% at 0.0% of the chord	0.741%	0.05%
NACA 6409	9.03% at 29.4% of the chord	5.87% at 41.0% of the chord	0.9439%	0.1854%
NACA 64-108	7.98% at 40.0% of the chord	0.55% at 50.0% of the chord	0.3126%	0.0%
NACA 6411	11.03% at 29.5% of the chord	5.77% at 41.0% of the chord	1.3743%	0.2266%
NACA 64-110	9.98% at 40.0% of the chord	0.55% at 50.0% of the chord	0.5231%	0.0%
NACA 6412	12.01% at 30.1% of the chord	6.0% at 39.6% of the chord	1.5164%	0.124%
NACA 6413	13.04% at 29.6% of the chord	5.73% at 41.8% of the chord	1.8582%	0.2678%
NACA 642-015	14.96% at 35.0% of the chord	0.0% at 0.0% of the chord	1.253%	0.0%
NACA 642-015A	14.97% at 40.0% of the chord	0.0% at 0.0% of the chord	1.2181%	0.064%
NACA 64-215	14.96% at 35.1% of the chord	1.1% at 50.0% of the chord	1.3084%	0.0%
NACA 64A-010 10,0%	9.99% at 40.0% of the chord	0.0% at 0.0% of the chord	0.6322%	0.0%
NACA 64A018	17.96% at 35.0% of the chord	0.0% at 0.0% of the chord	1.8207%	0.0%
NACA 65019	18.91% at 30.3% of the chord	5.31% at 26.5% of the chord	4.1584%	0.3956%
NACA 65-019	19.0% at 40.0% of the chord	0.0% at 0.0% of the chord	1.7477%	0.0%
NACA 66,2-(1,8)12 A=,6 P-51 TIP	12.0% at 45.0% of the chord	1.33% at 47.5% of the chord	0.8501%	0.0%
NACA 66,2-(1,8)15,5 A=,6 P-51 ROOT	15.5% at 45.0% of the chord	1.33% at 47.5% of the chord	1.3498%	0.0%
NACA 66,2-(1.8)12 A=.6	12.0% at 45.0% of the chord	1.33% at 47.5% of the chord	0.8504%	0.0%
NACA 66,2-(1.8)15.5 A=.6	15.5% at 45.0% of the chord	1.33% at 47.5% of the chord	1.3499%	0.0%
NACA 66-018	18.0% at 45.0% of the chord	0.0% at 87.6% of the chord	1.7563%	0.0%
NACA 66-021	21.0% at 45.0% of the chord	0.0% at 0.0% of the chord	2.1032%	0.0%

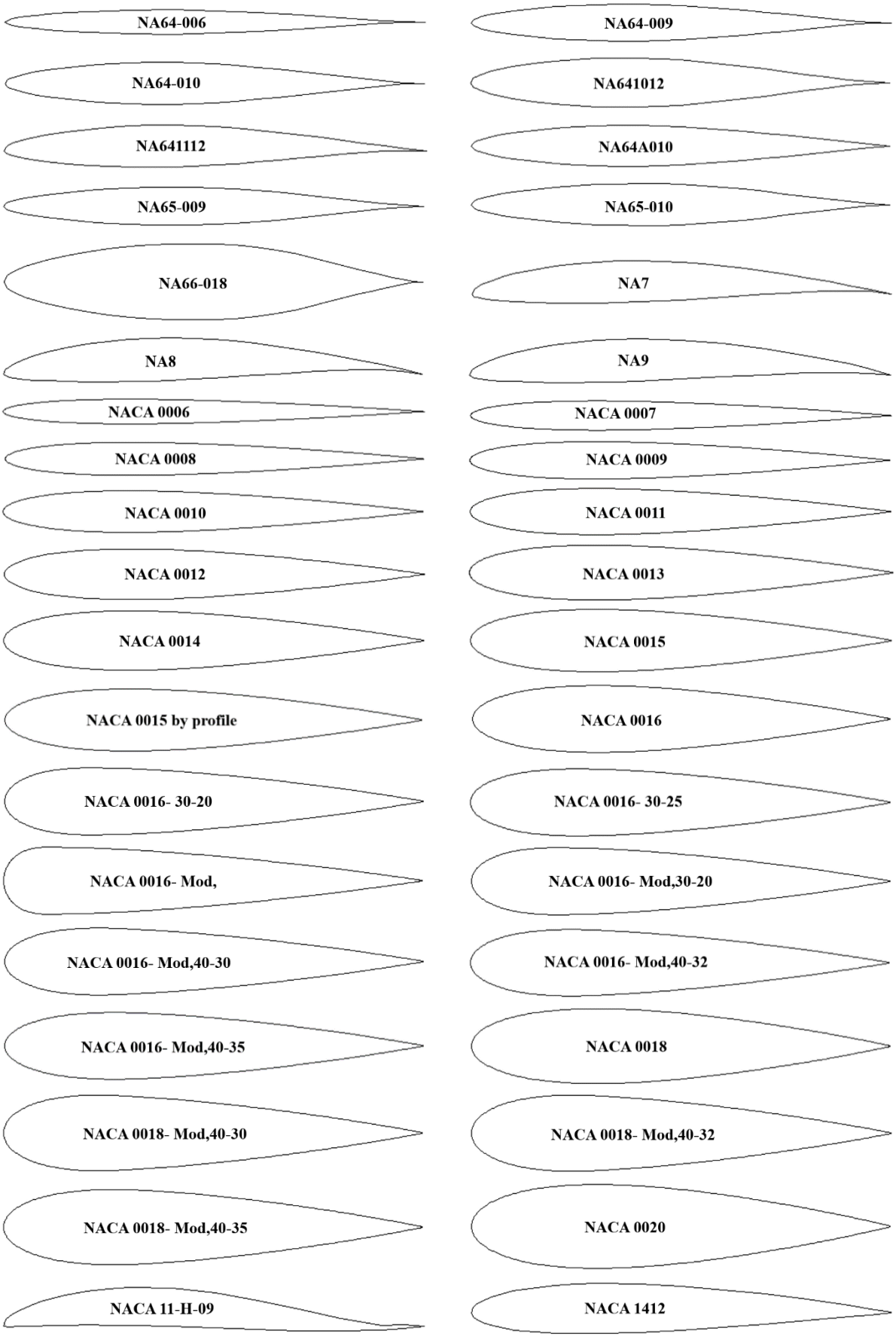
Note:
N 11 (U.S. Navy (USA));
N 22 (U.S. Navy (USA));
N 60 (U.S. Navy (USA));
N 60 R (U.S. Navy (USA));
N 9 (U.S. Navy (USA));
NACA 0006 (Generato da Profili);
NACA 0007 (Generato da Profili);
NACA 0008 (Generato da Profili);
NACA 0009 (Generato da Profili);
NACA 0010 (Generato da Profili);
NACA 0011 (Generato da Profili);
NACA 0013 (Generato da Profili);
NACA 0014 (Generato da Profili);
NACA 0015 (Generato da Profili);
NACA 0015 by profile (Generato da Profili);
NACA 0016 (Generato da Profili);
NACA 0016- 30-20 (Generato da Profili - Mod.);
NACA 0016- 30-25 (Generato da Profili - Mod.);
NACA 0016- Mod, (Generato da Profili - Mod.);
NACA 0016- Mod,30-20 (Generato da Profili - Mod.);
NACA 0016- Mod,40-30 (Generato da Profili - Mod.);
NACA 0016- Mod,40-32 (Generato da Profili - Mod.);
NACA 0016- Mod,40-35 (Generato da Profili - Mod.);
NACA 0018 (Generato da Profili);
NACA 0018- Mod,40-30 (Generato da Profili - Mod.);
NACA 0018- Mod,40-32 (Generato da Profili - Mod.);
NACA 0018- Mod,40-35 (Generato da Profili - Mod.);
NACA 0020 (Generato da Profili);
NACA 16018 (Generato da Profili);
NACA 2 R 12 (USA);

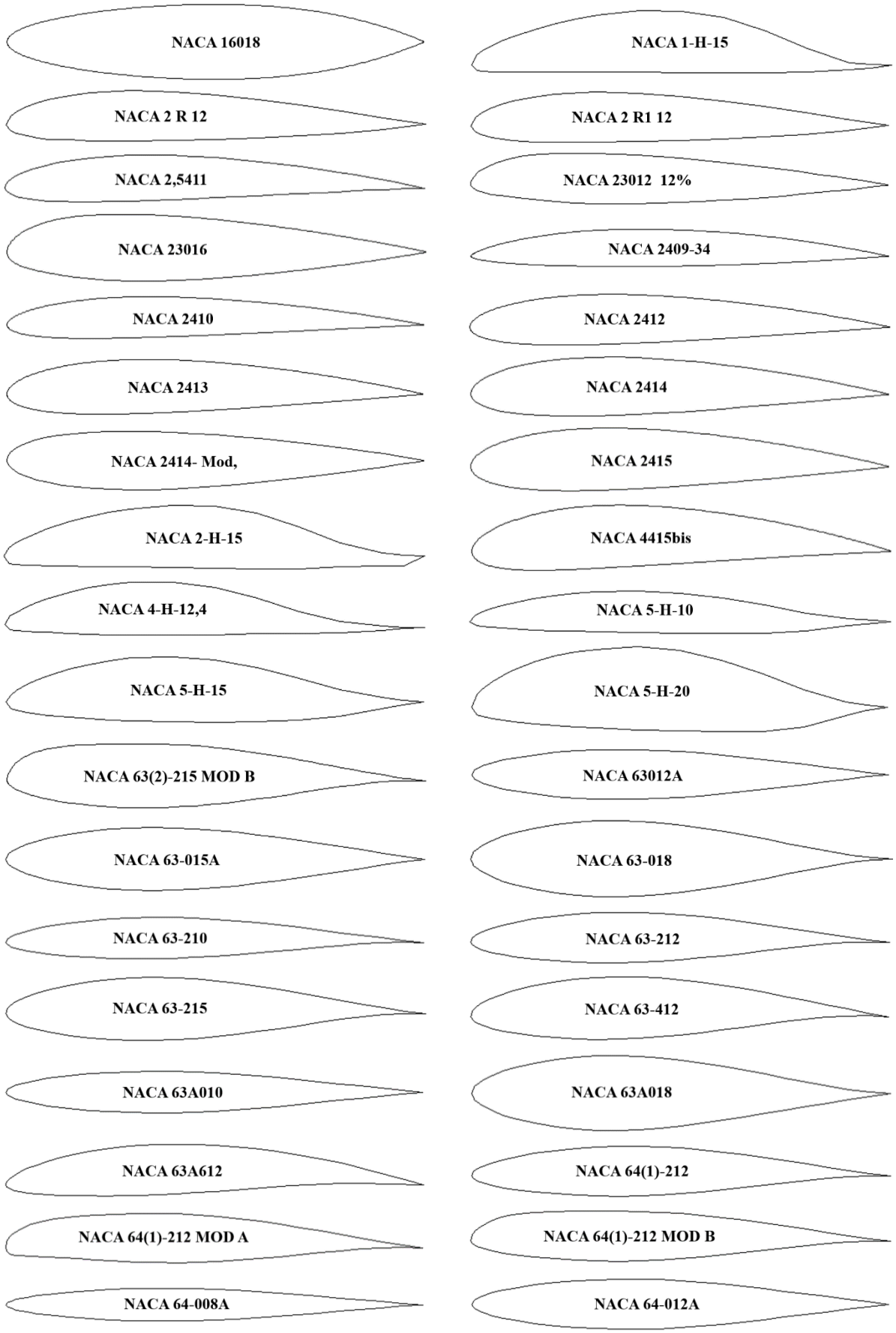
NACA 2 R1 12 (USA);
NACA 23016 (Generato da Profili);
NACA 2409-34 (Generato da Profili);
NACA 2410 (Generato da Profili);
NACA 2412 (Generato da Profili);
NACA 2413 (Generato da Profili);
NACA 2414- Mod, (- Mod.);
NACA 2415 (Generato da Profili);
NACA 4415bis (Generato da Profili);
NACA 4-H-12,4 (USA);
NACA 63-018 (Generato da Profili);
NACA 63A018 (Generato da Profili);
NACA 63A612 (By Naca.exe D. LEDNICER);
NACA 6409 (Generato da Profili);
NACA 6411 (Generato da Profili);
NACA 6413 (Generato da Profili);
NACA 64A018 (Generato da Profili);
NACA 65019 (Generato da Profili);
NACA 65-019 (Generato da Profili);
NACA 66,2-(1.8)12 A=.6 (P-51 TIP AIRFOIL);
NACA 66,2-(1.8)15.5 A=.6 (P-51 ROOT AIRFOIL).

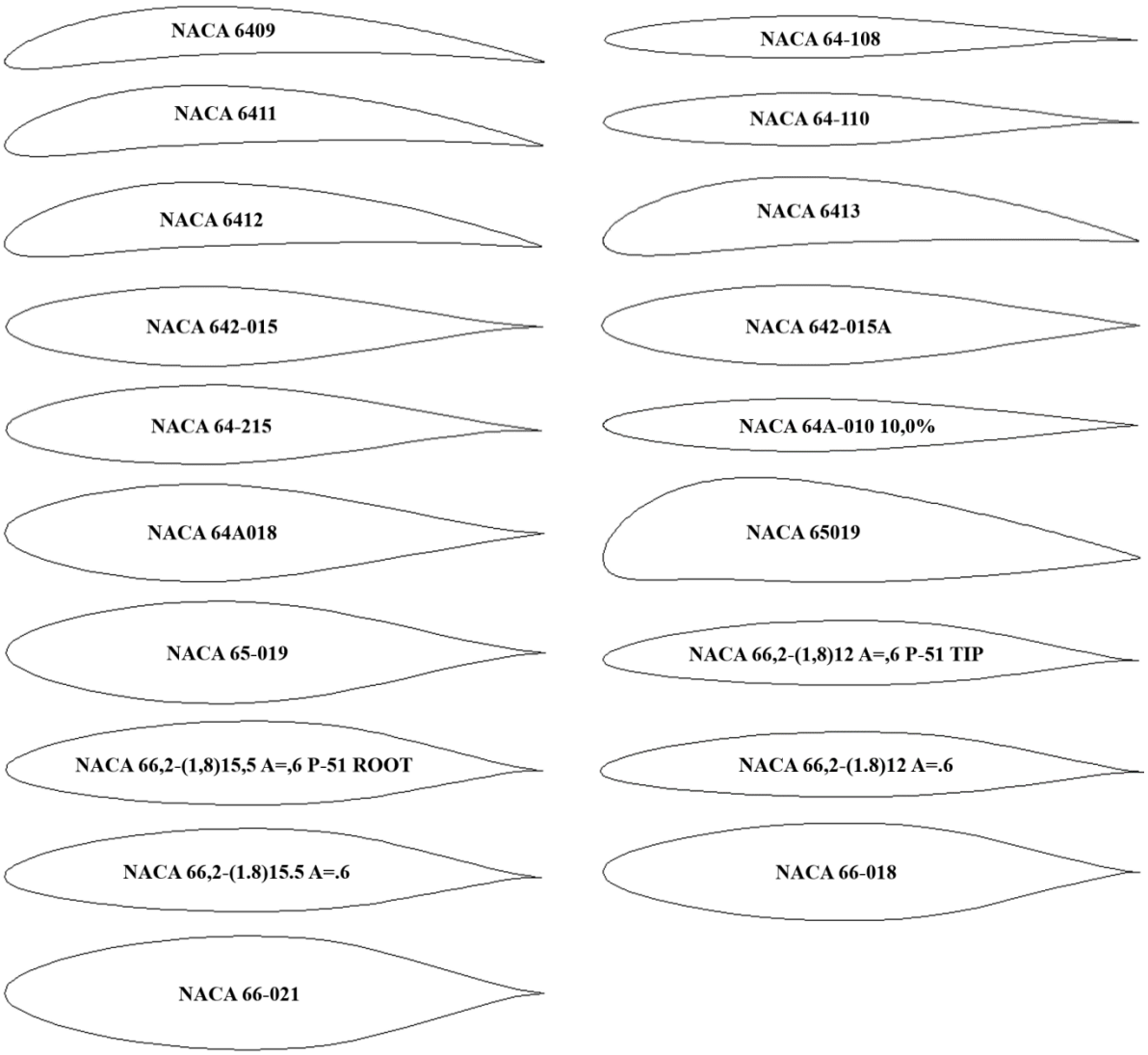
Table 2. The geometric shapes of the airfoils in the cross section.




N632-615
N63A-010
N641A012
N651-012
N652-015
N-7
NA0006T
NA0012T
NA0018T
NA010-34
NA012-63
NA012-64
NA012-B
NA10
NA23009
NA23012
NA23012F
NA23112
NA2R1-12
NA2R2-12
NA5
NA6
NA63-009
NA63-010
NA63-206
NA63-209
NA63-210
NA63A006
NA63A410
NA63A411
NA63A413
NA63A414
NA63A510
NA63A511
NA63A513
NA63A514
NA63A610
NA63A611
NA63A613
NA63A614


NA64-006
NA64-009
NA64-010
NA641012
NA641112
NA64A010
NA65-009
NA65-010
NA66-018
NA7
NA8
NA9
NACA 0006
NACA 0007
NACA 0008
NACA 0009
NACA 0010
NACA 0011
NACA 0012
NACA 0013
NACA 0014
NACA 0015
NACA 0015 by profile
NACA 0016
NACA 0016- 30-20
NACA 0016- 30-25
NACA 0016- Mod,
NACA 0016- Mod,30-20
NACA 0016- Mod,40-30
NACA 0016- Mod,40-32
NACA 0016- Mod,40-35
NACA 0018
NACA 0018- Mod,40-30
NACA 0018- Mod,40-32
NACA 0018- Mod,40-35
NACA 0020
NACA 11-H-09
NACA 1412


NACA 16018
NACA 1-H-15
NACA 2 R 12
NACA 2 R1 12
NACA 2,5411
NACA 23012 12%
NACA 23016
NACA 2409-34
NACA 2410
NACA 2412
NACA 2413
NACA 2414
NACA 2414- Mod,
NACA 2415
NACA 2-H-15
NACA 4415bis
NACA 4-H-12,4
NACA 5-H-10
NACA 5-H-15
NACA 5-H-20
NACA 63(2)-215 MOD B
NACA 63012A
NACA 63-015A
NACA 63-018
NACA 63-210
NACA 63-212
NACA 63-215
NACA 63-412
NACA 63A010
NACA 63A018
NACA 63A612
NACA 64(1)-212
NACA 64(1)-212 MOD A
NACA 64(1)-212 MOD B
NACA 64-008A
NACA 64-012A



Results and discussion

The calculated pressure contours on the surfaces of the airfoils at different angles of attack are presented in the Figs. 1-159. 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.

159 airfoils of the airplane wings were considered. The studied airfoils were both asymmetrical and symmetrical (for example, N16006PR, N631-012, NA0006T, NA010-34, NA012-B, NA63A006, NACA 0006, NACA 0015 by profile, NACA 0016-Mod, NACA 63012A, NACA 642-015, NACA 64A-010 10,0% and other airfoils).

The rational geometry of the airfoil of the airplane wing allows for high lift and low drag coefficient. The geometry analysis allows you to select a number of airfoils for a detailed assessment of the aerodynamic characteristics of the airplane wings. The maximum thickness along the chord is observed for N16021PR (21.0%) and NACA 66-021 (21.0%), the minimum thickness along the chord is observed for NA63A006 (5.97%) from the considered airfoils. The airfoils of the airplane wings with the camber have the better aerodynamic characteristics. The camber of the N-24 airfoil is 8.61%, and the camber of all symmetrical airfoils is 0.0% relative to the length of the chord, which is the largest and smallest ratios among all the studied airfoils, respectively. Increasing the radius of the leading edge of the airfoil increases drag. The largest and smallest leading edge radii are 8.0508% and 0.2159% for the NACA 0016-Mod and NA63-206 airfoils, respectively. The minimum thickness of the trailing edge of some airfoils is 0.0%. The maximum thickness of the trailing edge (0.42%) is determined for the N16021PR and NACA 0020 airfoils.

Consideration of the calculation results for each airfoil will lead to a significant increase in the volume of the article. Therefore, let us consider in detail the change in pressure on the surfaces of several proposed airfoils under conditions of changing the angle of attack: N 60 R, N2311275, NA0006T, NA012-B,

NA23012F, NACA 0016-Mod, NACA 11-H-09, NACA 16018, NACA 2-H-15 and NACA 65019.

The N 60 R airfoil is characterized by an increase in the value of negative pressure on the leading edge at a negative angle of attack and an increase in the area of negative pressure on the leading edge and the upper surface.

The opposite pattern is observed when the N2311275 airfoil flows around the air in the conditions of the airplane maneuvers. At the same time, the contact surfaces of the airplane wing are subjected to less pressure, compared with the N 60 R airfoil. The difference in maximum pressures during the climb and descent of the airplane is no more than 15%.

The value of positive pressure on the contact surfaces of the NA0006T airfoil practically does not change at zero, positive and negative angles of attack. The pressure difference during the climb and descent of the airplane is minimal. This indicates a slight lifting force of the airplane wing. Thus, this airfoil is rationally used for high-speed horizontal flights.

Due to the fact that the NA012-B airfoil is symmetrical, negative pressure on the leading edge has the same value at angles of attack of 15 and -15 degrees. The large radius of the leading edge leads to some reduction in drag.

Due to the specific shape of the upper surface of the NA23012F airfoil, pressure varies significantly depending on the angle of attack. Negative pressure is formed on this surface at a positive angle of attack, and positive pressure is formed at a negative angle of attack.

During horizontal flight of the airplane with the wing having the NACA 0016-Mod airfoil in the cross section, zones of maximum negative pressure on the upper and lower surfaces are formed in the thickening area. As with most symmetrical airfoils, maximum negative pressure develops during maneuvers on the leading edge.

The convex upper surface of the NACA 11-H-09 airfoil ensures the formation of pressure of the smaller value during the airplane descent. The pressure difference on the surfaces during the airplane climb changes by 8 times, which indicates a good lifting force of the wing.

The NACA 16018 airfoil of the barrel shape forms a positive pressure on the leading and trailing edges. Under the conditions of symmetry of the airfoil, negative pressure decreases slightly in the value during the airplane descent.

The NACA 2-H-15 airfoil at an angle of attack of 0 degrees from the convex surface is subjected to both positive and negative pressures. The lifting force of the airfoil is low.

The configuration of the NACA 65019 airfoil leads to an increase in negative pressure on the leading edge at a negative angle of attack. The lifting force of the airplane wing is low during the climb.

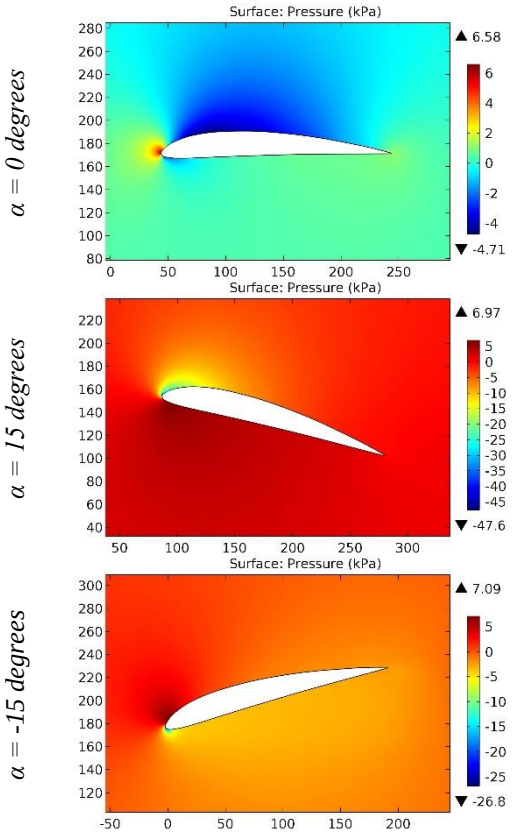


Figure 1. The pressure contours on the surfaces of the N 11 airfoil.

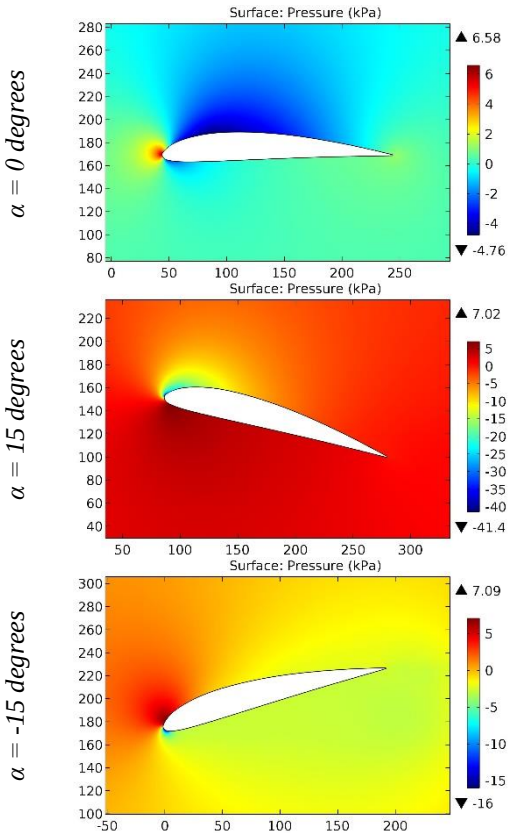


Figure 2. The pressure contours on the surfaces of the N 22 airfoil.

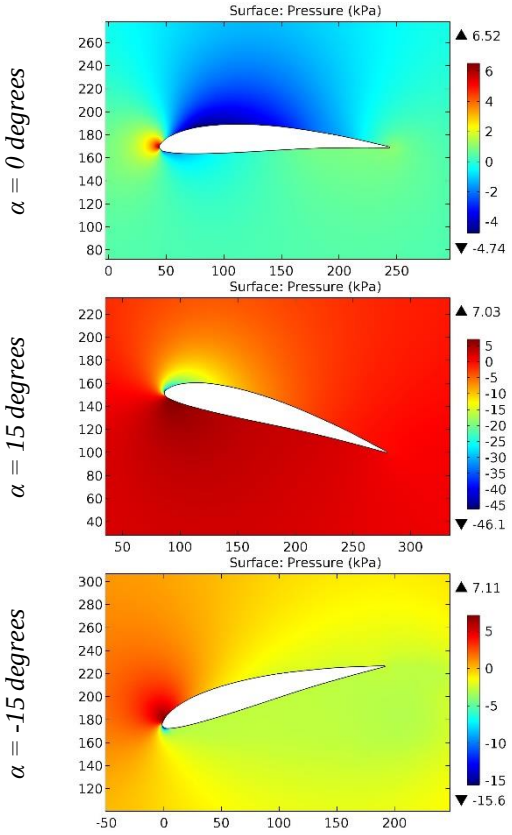


Figure 3. The pressure contours on the surfaces of the N 60 airfoil.

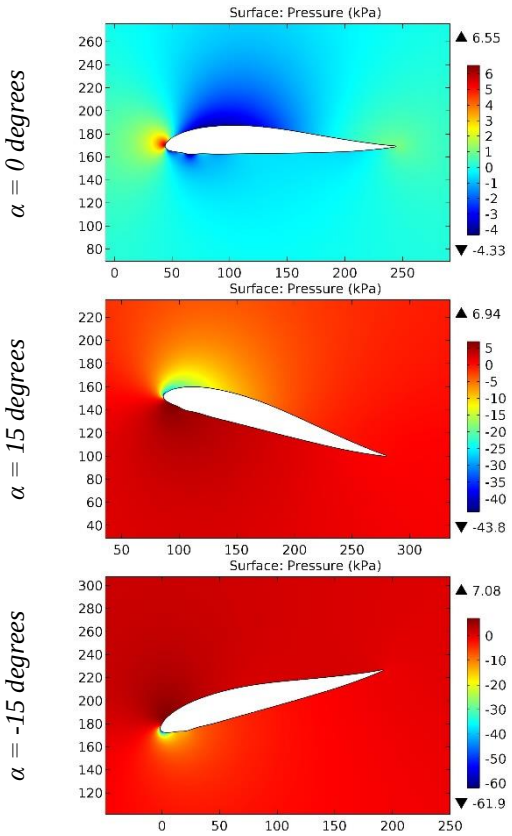


Figure 4. The pressure contours on the surfaces of the N 60 R airfoil.

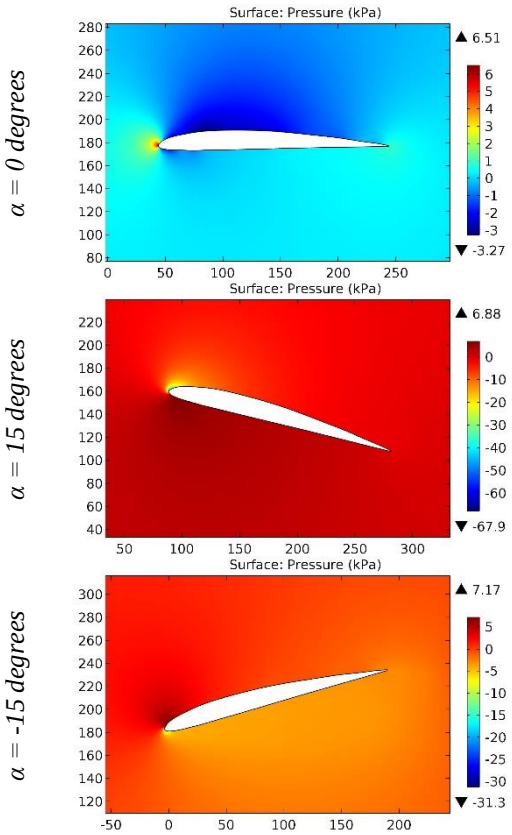


Figure 5. The pressure contours on the surfaces of the N 9 airfoil.

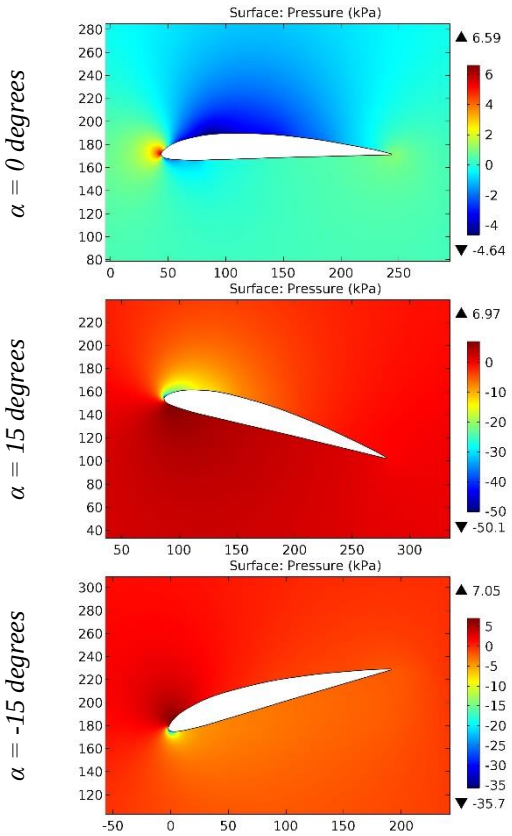


Figure 6. The pressure contours on the surfaces of the N-10 airfoil.

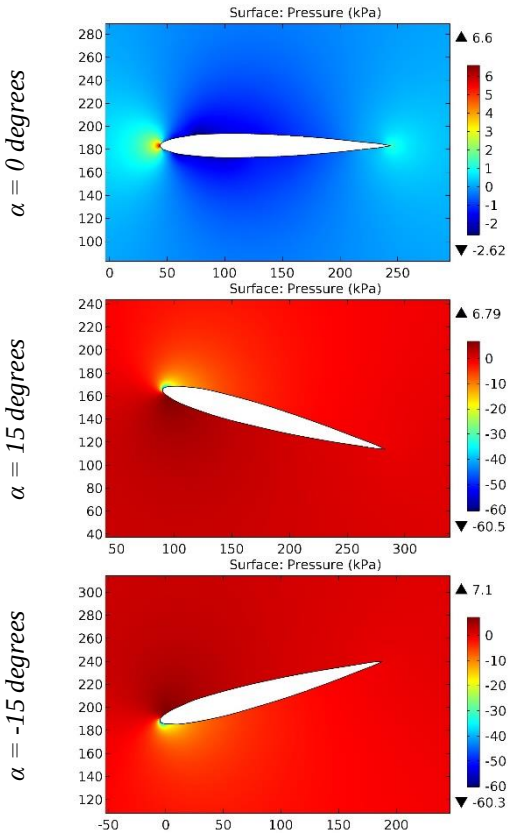


Figure 7. The pressure contours on the surfaces of the N-12 airfoil.

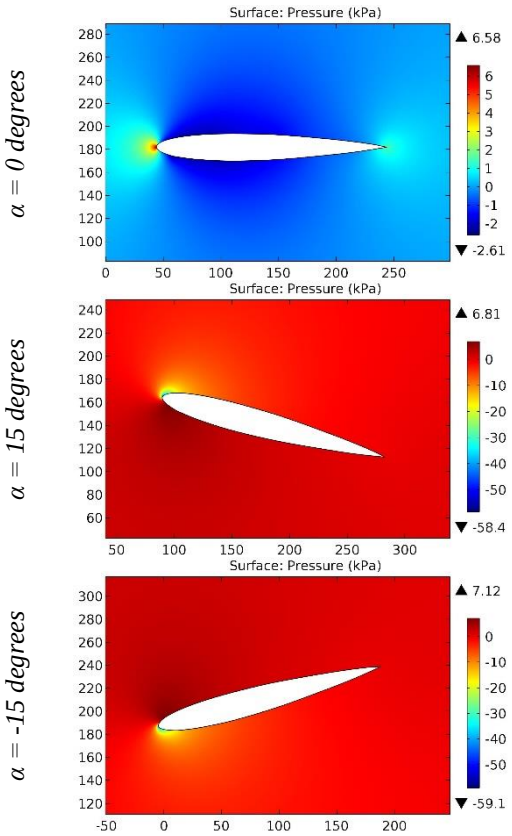


Figure 8. The pressure contours on the surfaces of the N-13 airfoil.

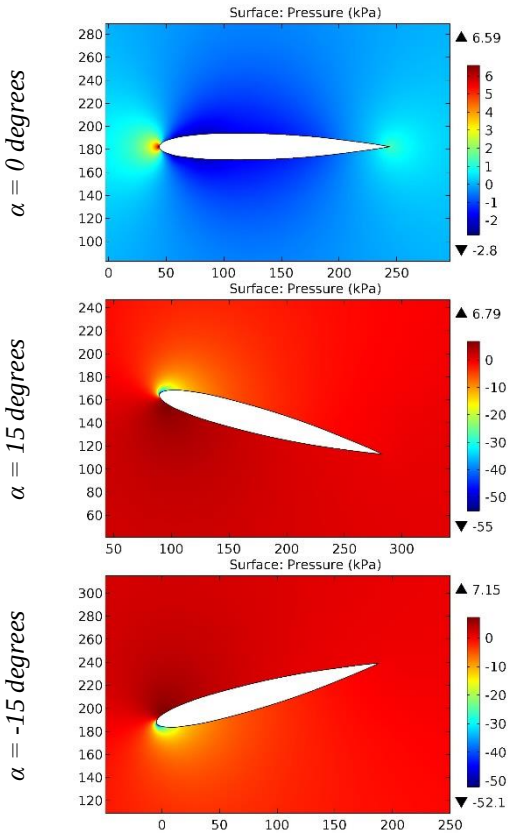


Figure 9. The pressure contours on the surfaces of the N-14 airfoil.

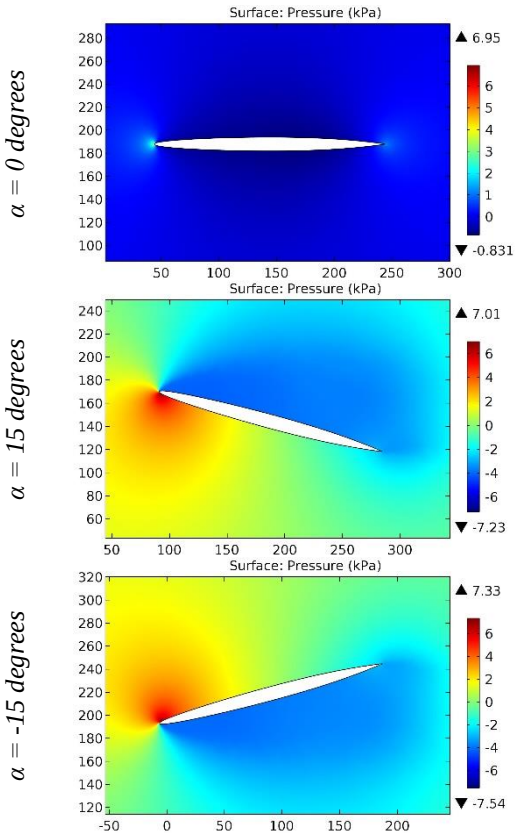


Figure 10. The pressure contours on the surfaces of the N16006PR airfoil.

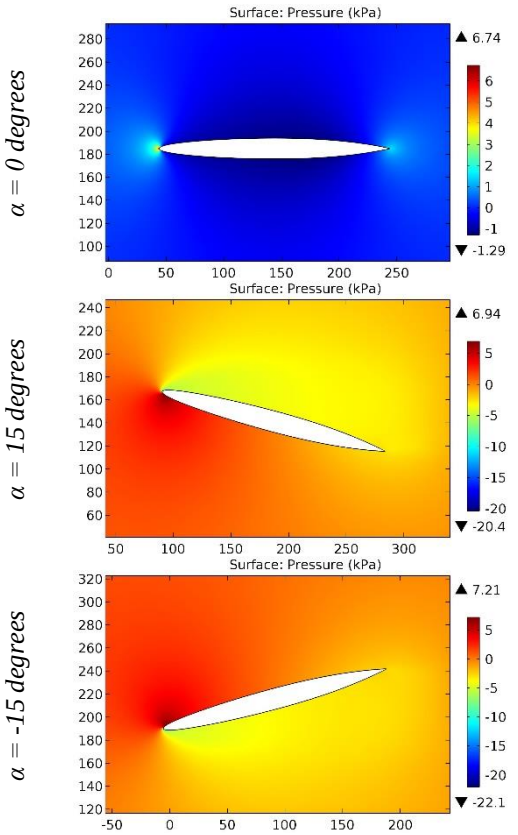


Figure 11. The pressure contours on the surfaces of the N16009PR airfoil.

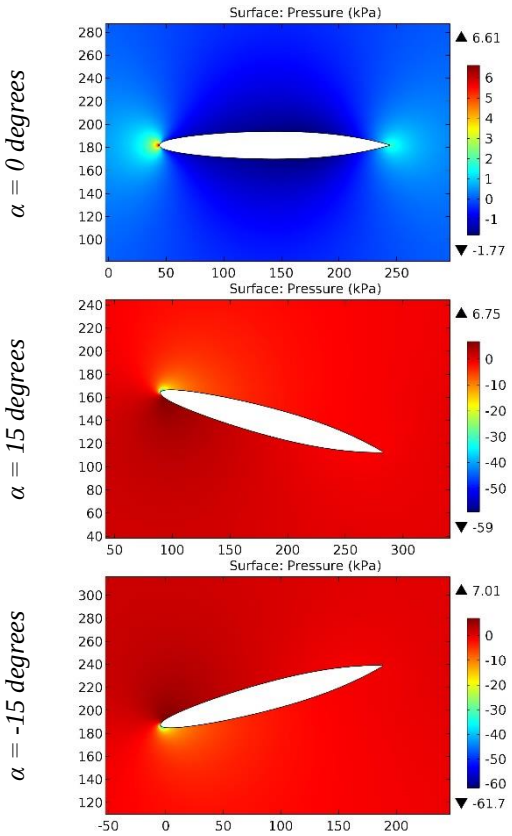


Figure 12. The pressure contours on the surfaces of the N16012PR airfoil.

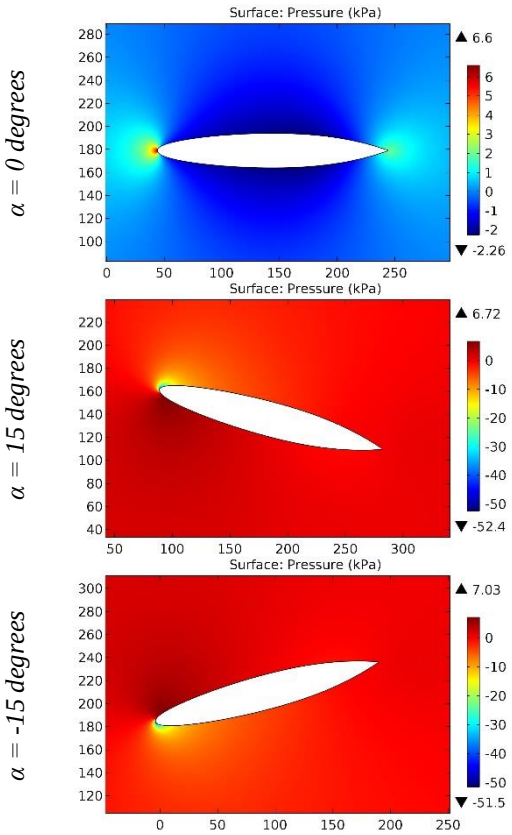


Figure 13. The pressure contours on the surfaces of the N16015PR airfoil.

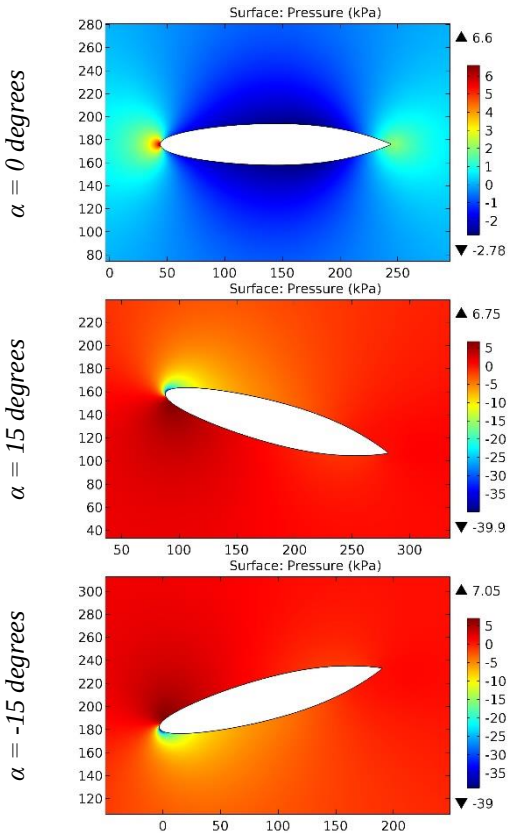


Figure 14. The pressure contours on the surfaces of the N16018PR airfoil.

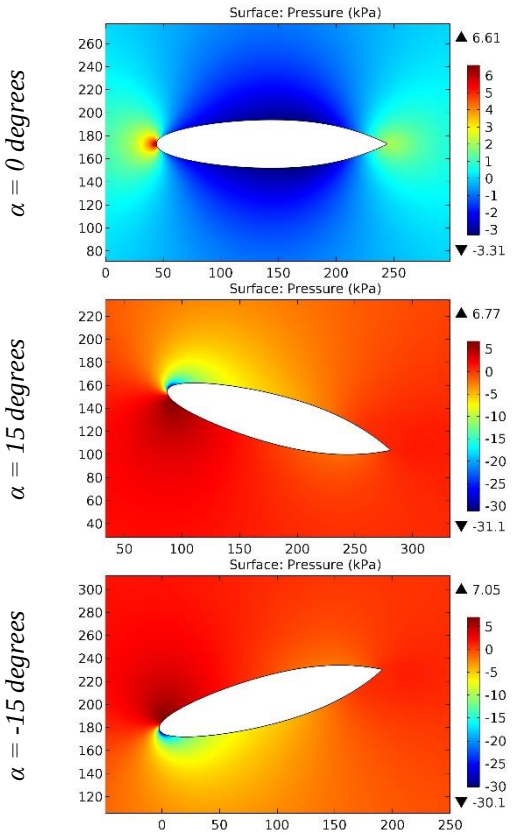


Figure 15. The pressure contours on the surfaces of the N16021PR airfoil.

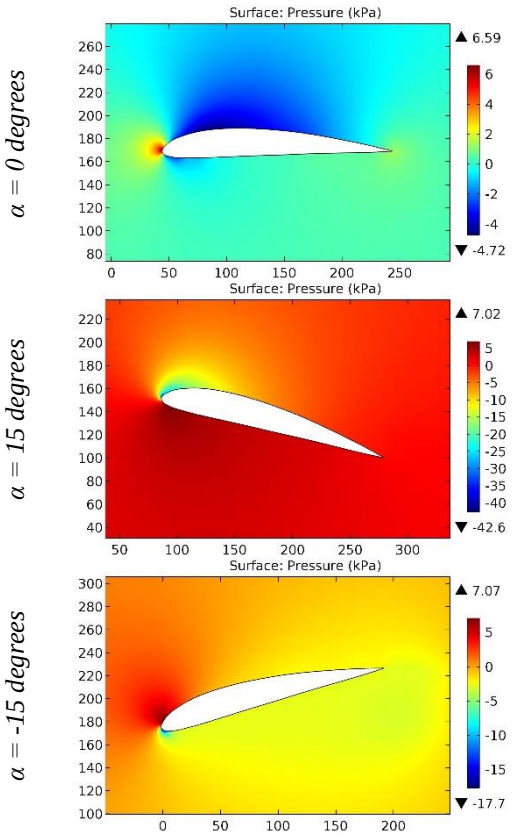


Figure 16. The pressure contours on the surfaces of the N-22P airfoil.

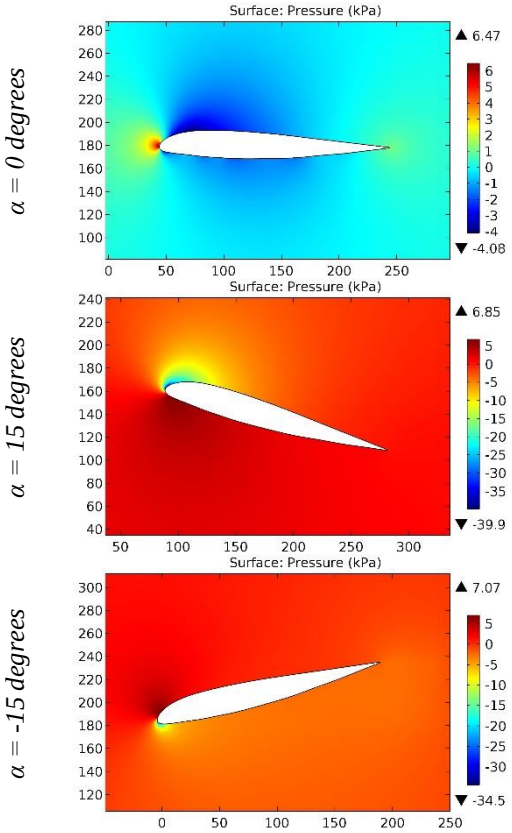


Figure 17. The pressure contours on the surfaces of the N2311275 airfoil.

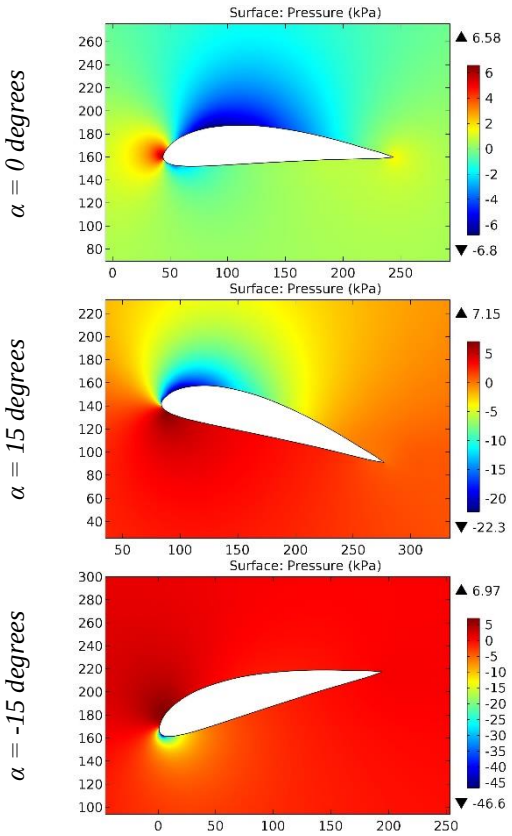


Figure 18. The pressure contours on the surfaces of the N-24 airfoil.

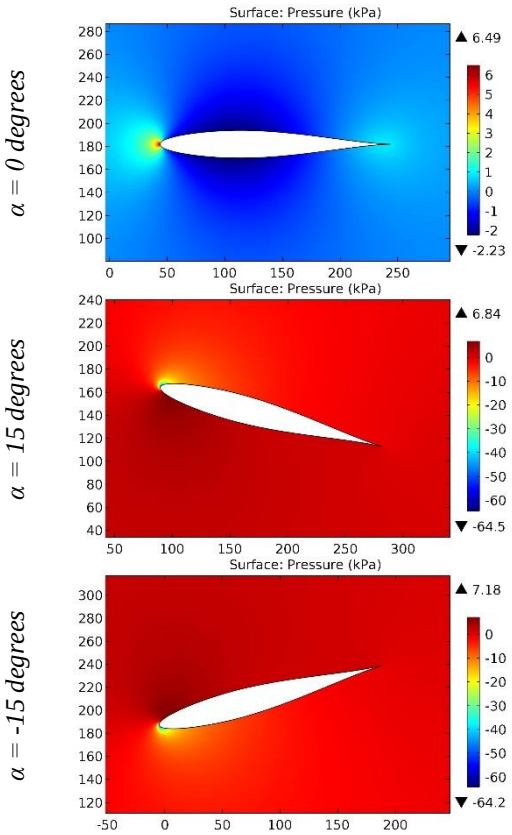


Figure 19. The pressure contours on the surfaces of the N631-012 airfoil.

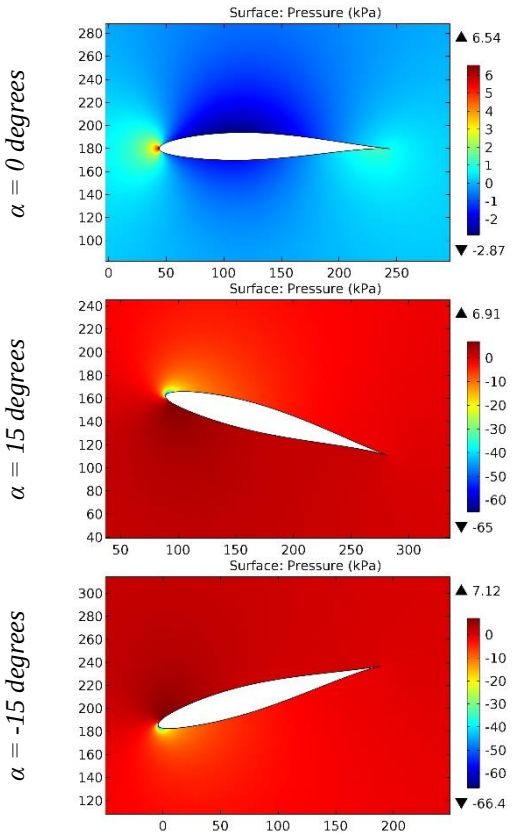


Figure 20. The pressure contours on the surfaces of the N631-212 airfoil.

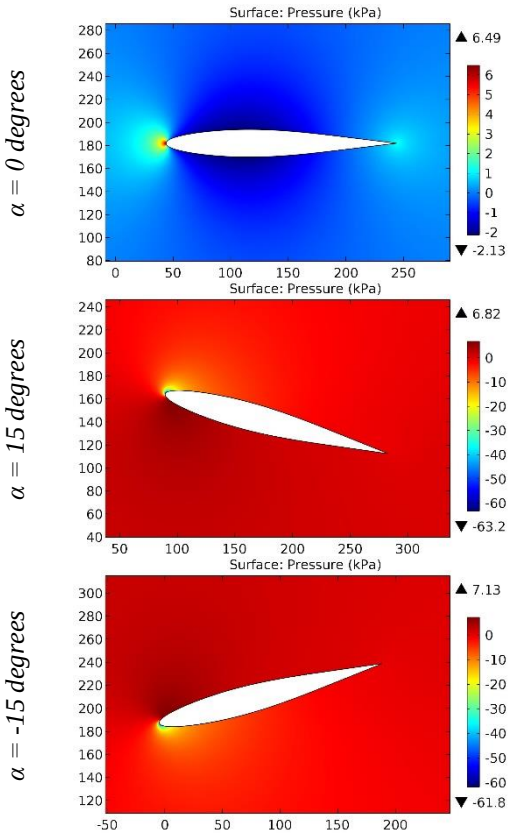


Figure 21. The pressure contours on the surfaces of the N631A012 airfoil.

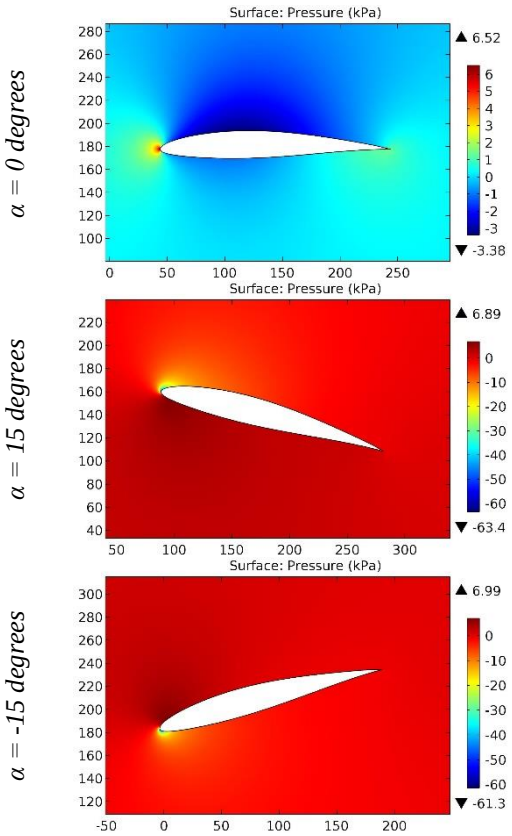


Figure 22. The pressure contours on the surfaces of the N631A412 airfoil.

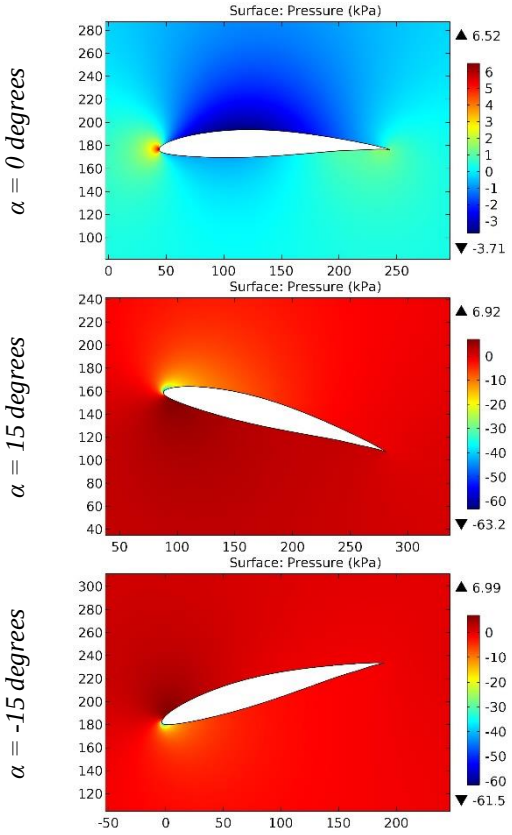


Figure 23. The pressure contours on the surfaces of the N631A512 airfoil.

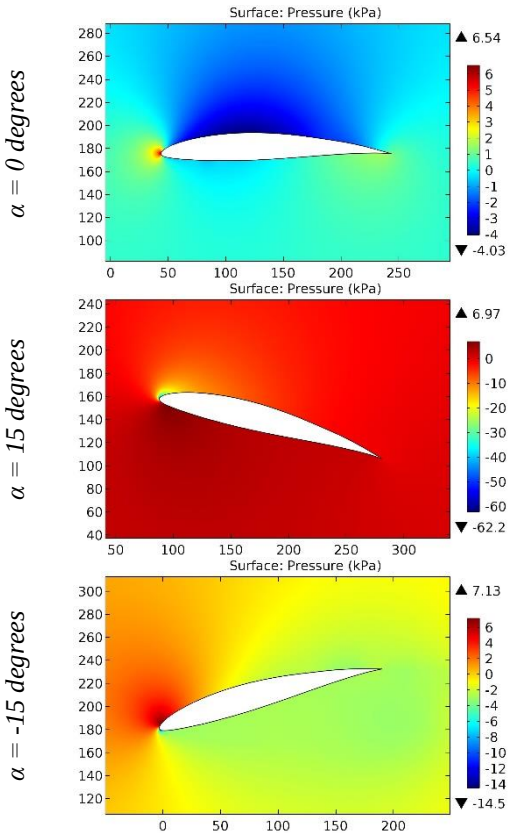


Figure 24. The pressure contours on the surfaces of the N631A612 airfoil.

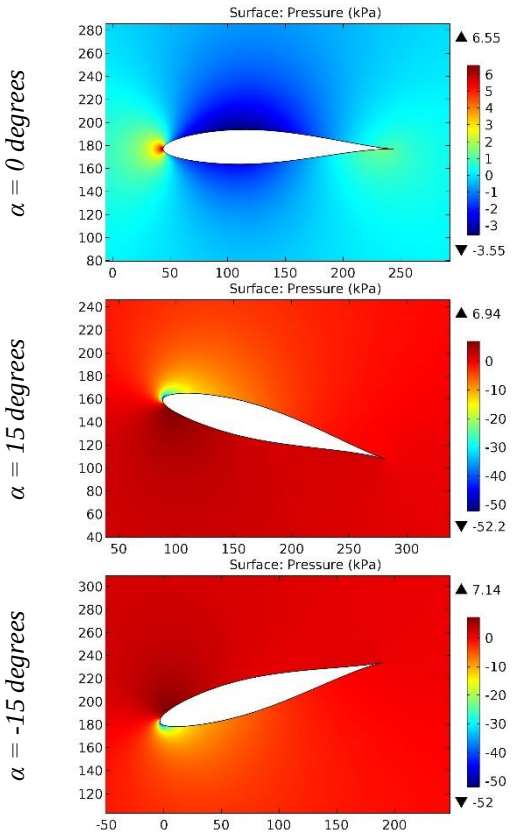


Figure 25. The pressure contours on the surfaces of the N632-215 airfoil.

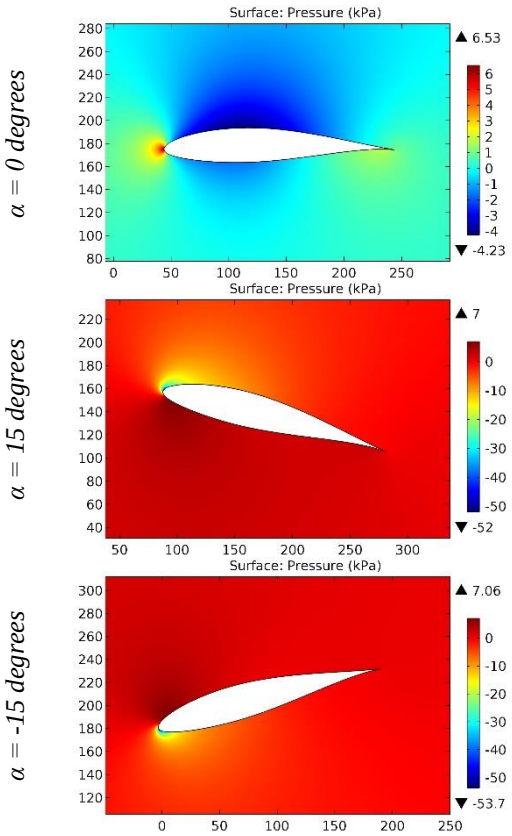


Figure 26. The pressure contours on the surfaces of the N632-415 airfoil.

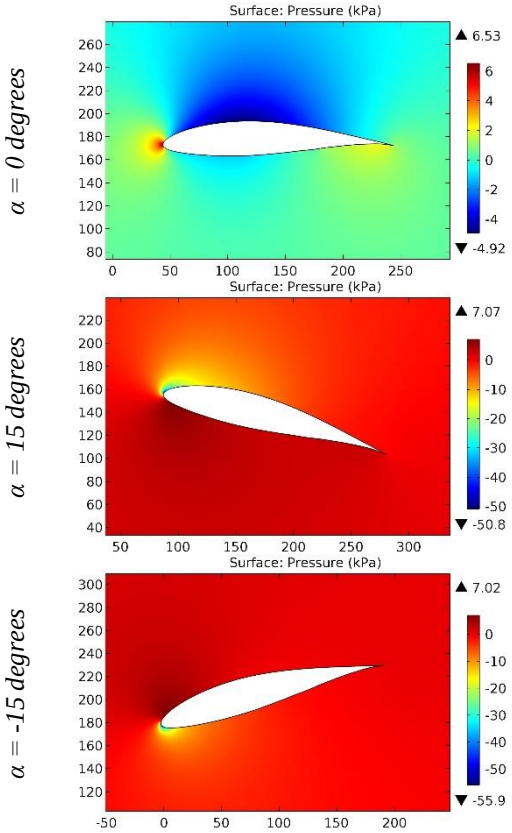


Figure 27. The pressure contours on the surfaces of the N632-615 airfoil.

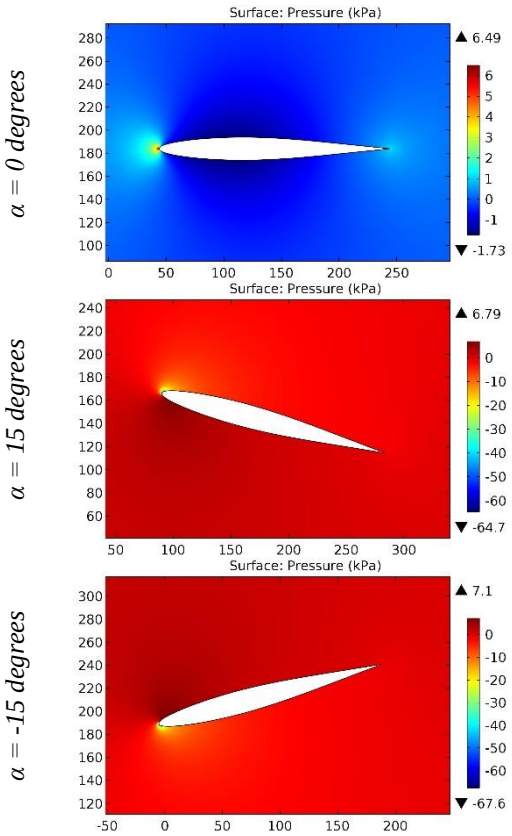


Figure 28. The pressure contours on the surfaces of the N63A-010 airfoil.

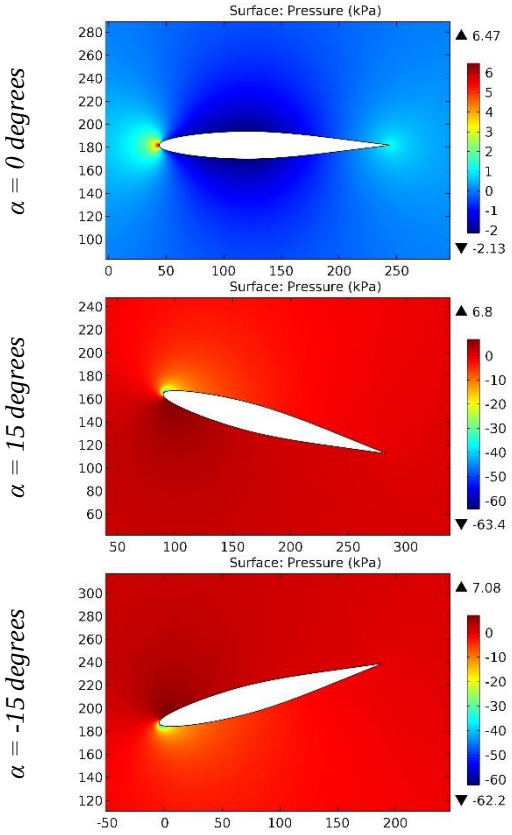


Figure 29. The pressure contours on the surfaces of the N641A012 airfoil.

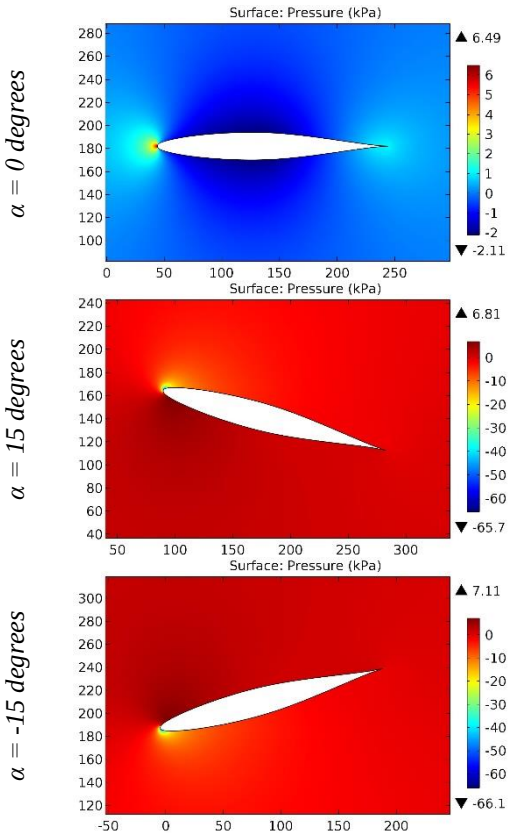


Figure 30. The pressure contours on the surfaces of the N651-012 airfoil.

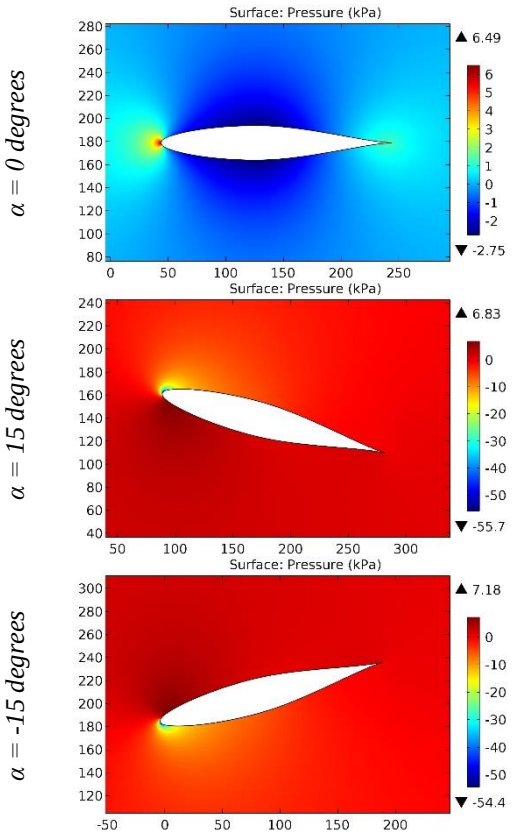


Figure 31. The pressure contours on the surfaces of the N652-015 airfoil.

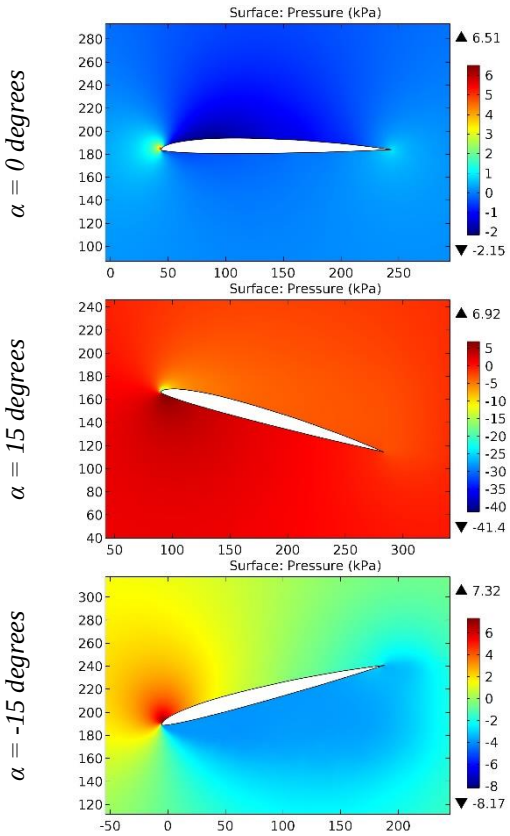


Figure 32. The pressure contours on the surfaces of the N-7 airfoil.

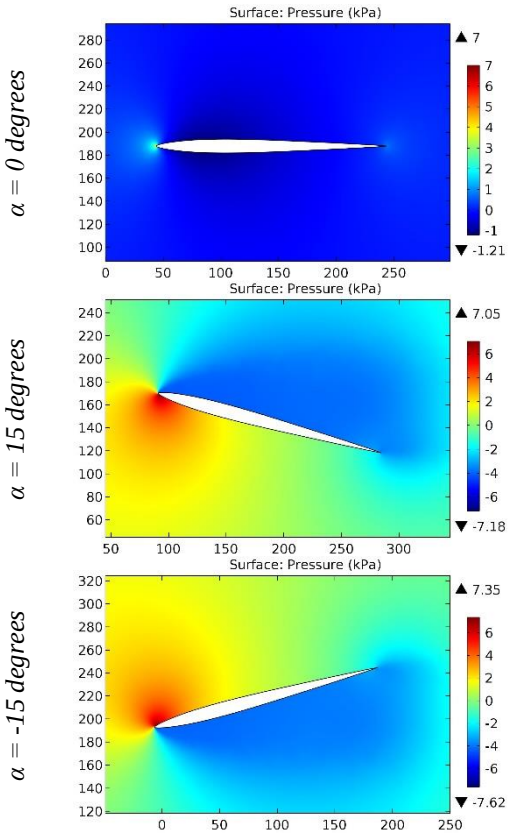


Figure 33. The pressure contours on the surfaces of the NA0006T airfoil.

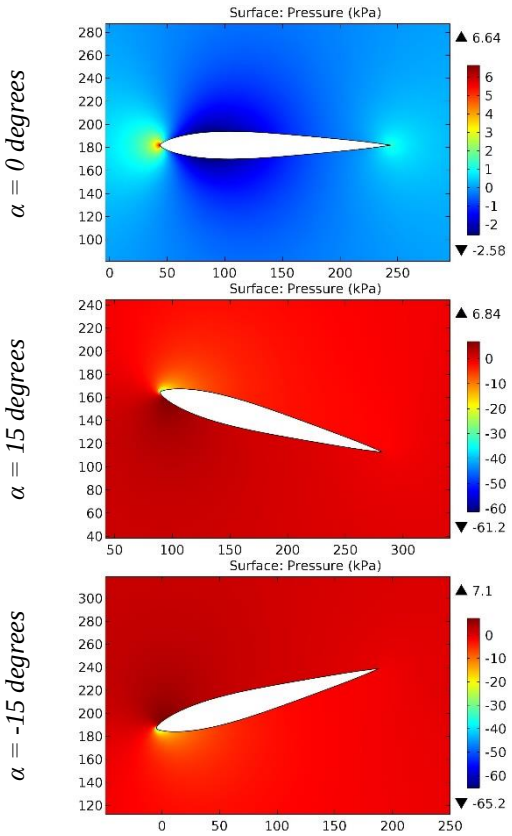


Figure 34. The pressure contours on the surfaces of the NA0012T airfoil.

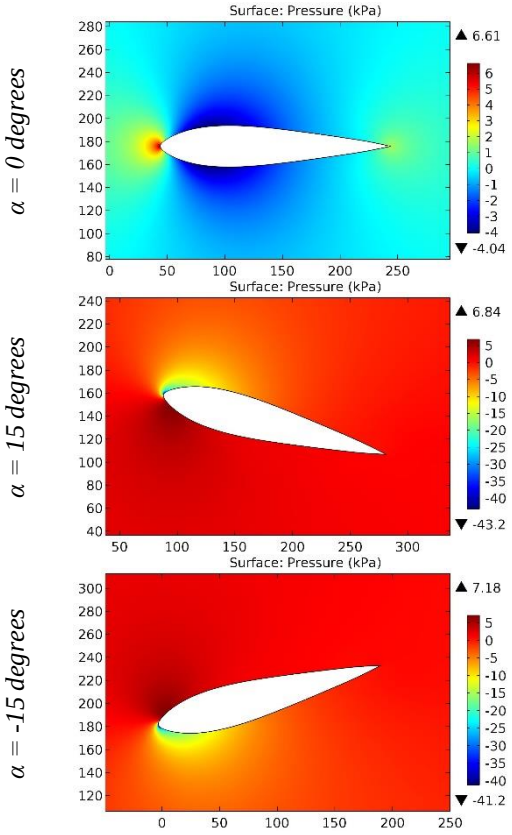


Figure 35. The pressure contours on the surfaces of the NA0018T airfoil.

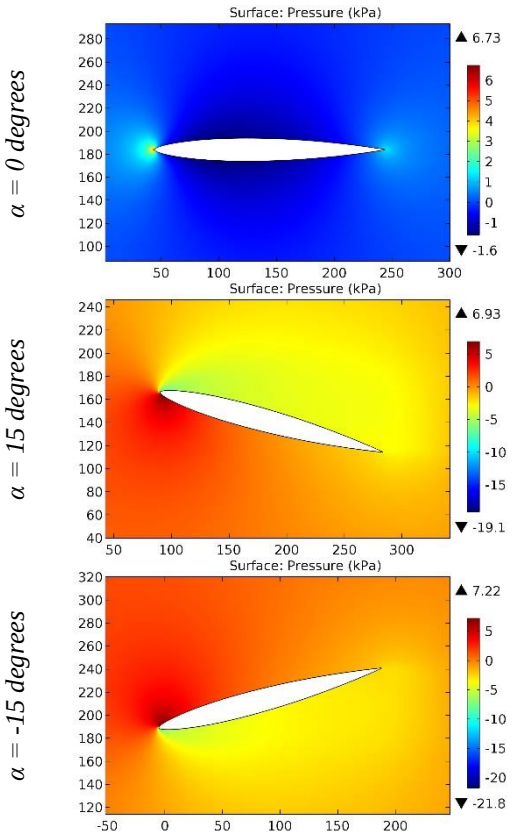


Figure 36. The pressure contours on the surfaces of the NA010-34 airfoil.

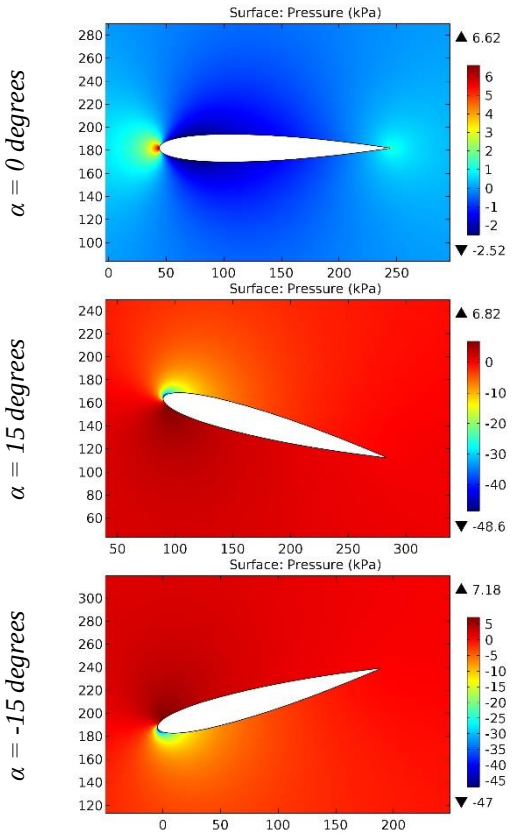


Figure 37. The pressure contours on the surfaces of the NA012-63 airfoil.

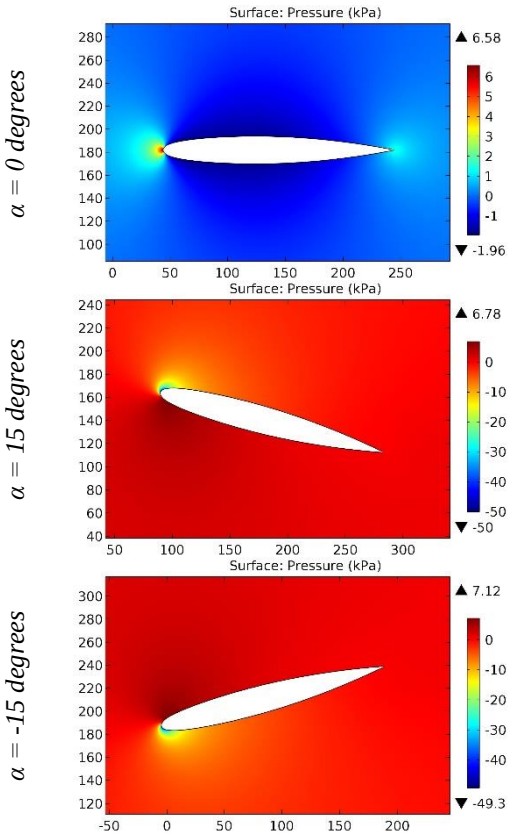


Figure 38. The pressure contours on the surfaces of the NA012-64 airfoil.

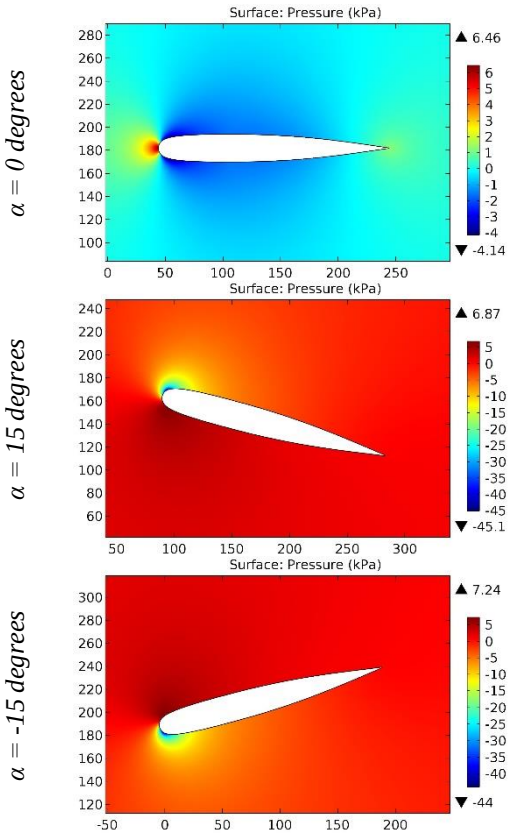


Figure 39. The pressure contours on the surfaces of the NA012-B airfoil.

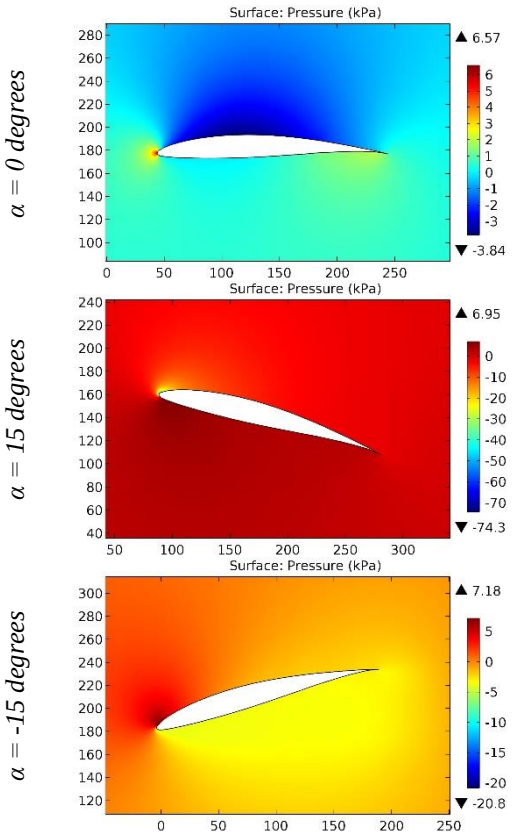


Figure 40. The pressure contours on the surfaces of the NA10 airfoil.

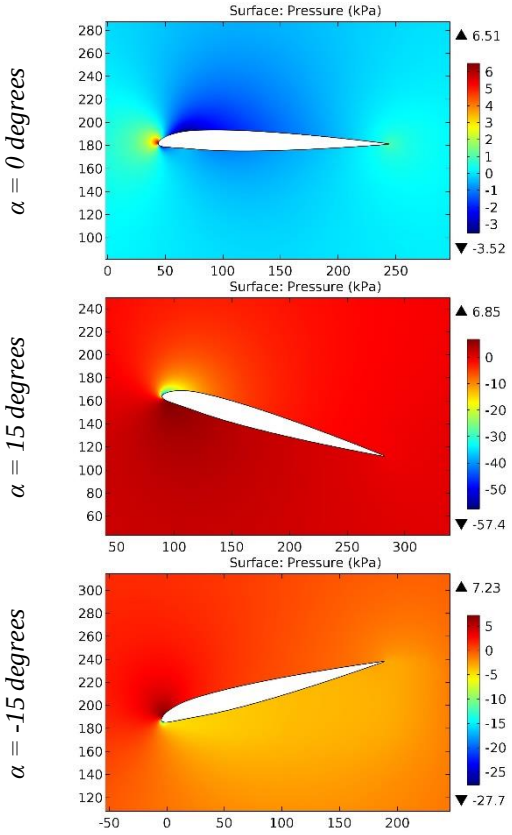


Figure 41. The pressure contours on the surfaces of the NA23009 airfoil.

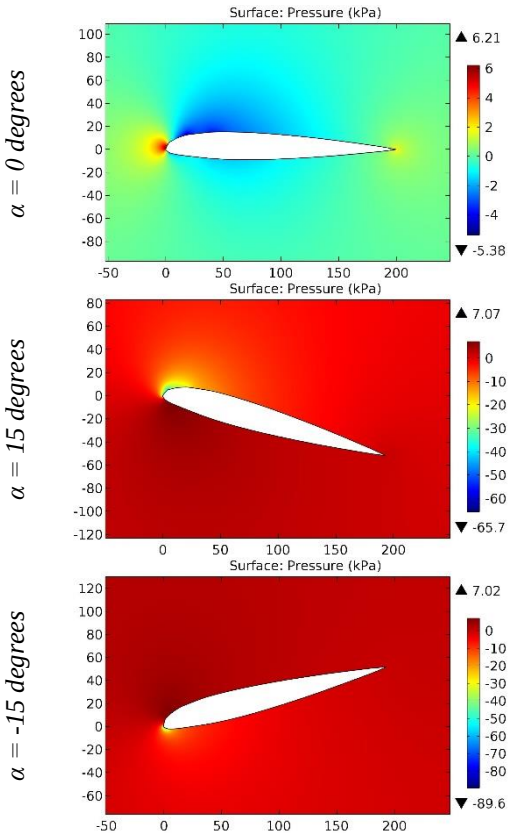


Figure 42. The pressure contours on the surfaces of the NA23012 airfoil.

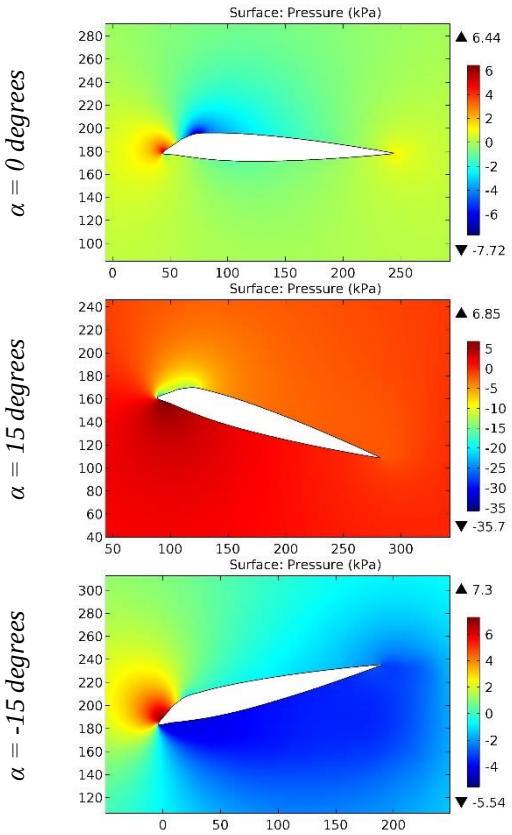


Figure 43. The pressure contours on the surfaces of the NA23012F airfoil.

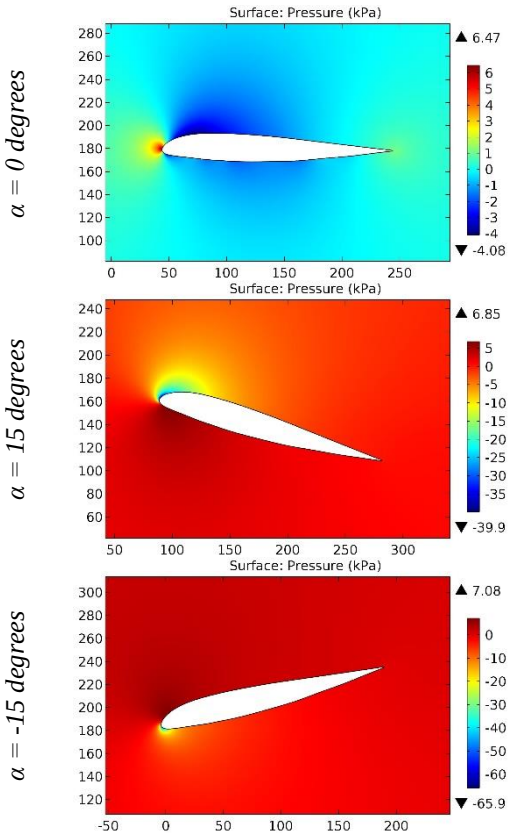


Figure 44. The pressure contours on the surfaces of the NA23112 airfoil.

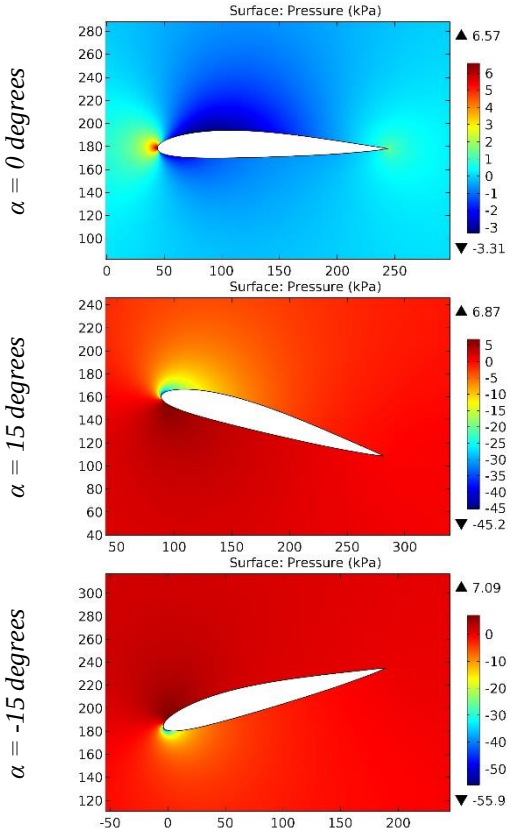


Figure 45. The pressure contours on the surfaces of the NA2R1-12 airfoil.

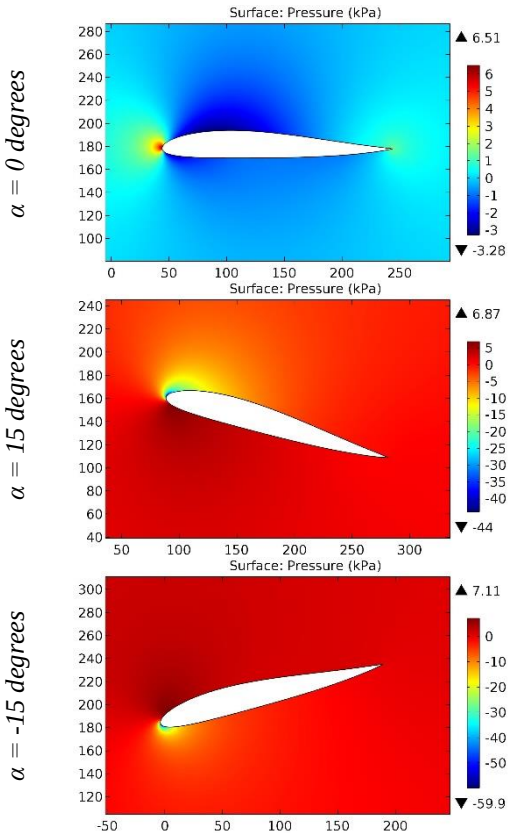


Figure 46. The pressure contours on the surfaces of the NA2R2-12 airfoil.

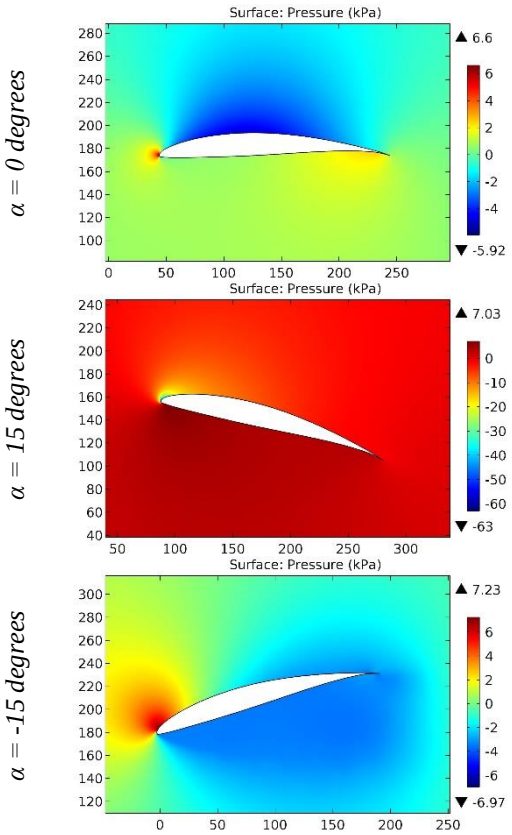


Figure 47. The pressure contours on the surfaces of the NA5 airfoil.

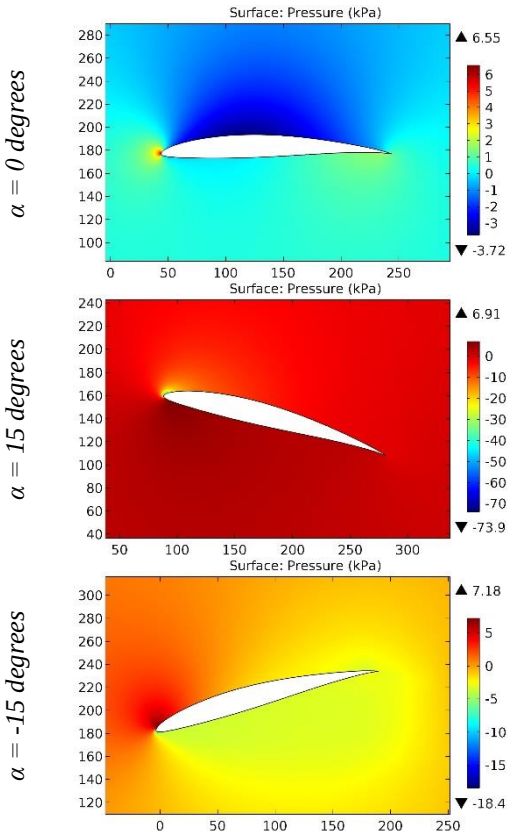


Figure 48. The pressure contours on the surfaces of the NA6 airfoil.

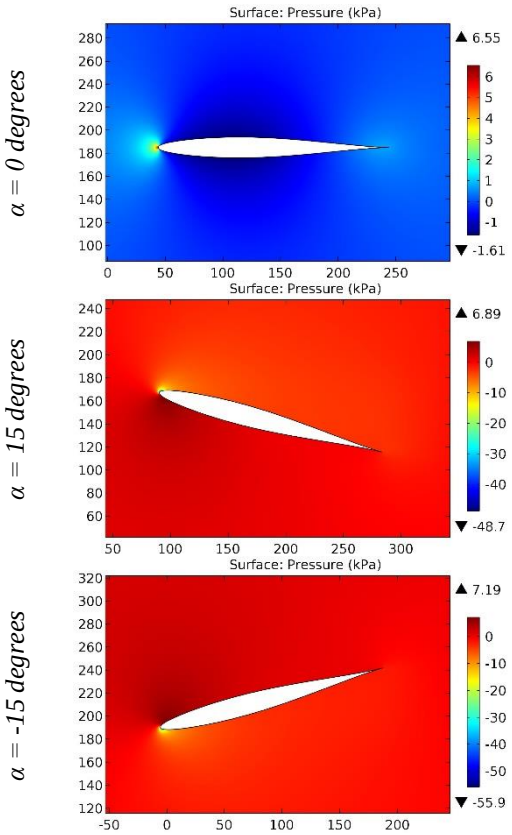


Figure 49. The pressure contours on the surfaces of the NA63-009 airfoil.

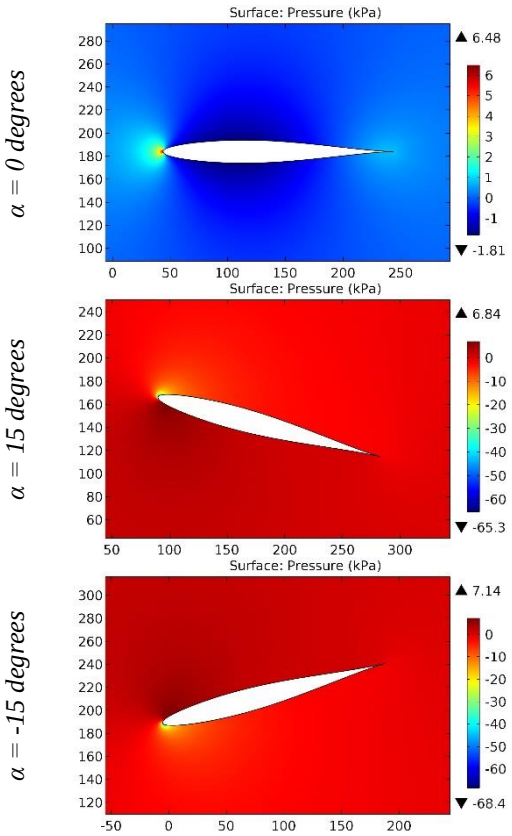


Figure 50. The pressure contours on the surfaces of the NA63-010 airfoil.

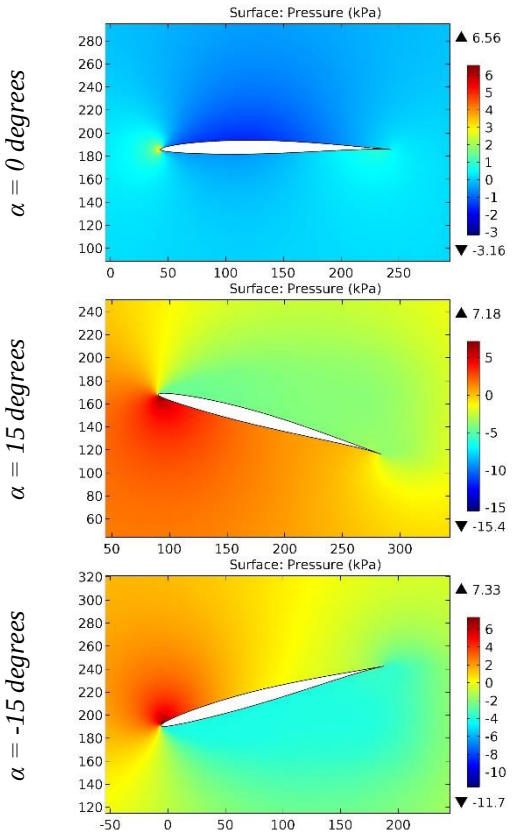


Figure 51. The pressure contours on the surfaces of the NA63-206 airfoil.

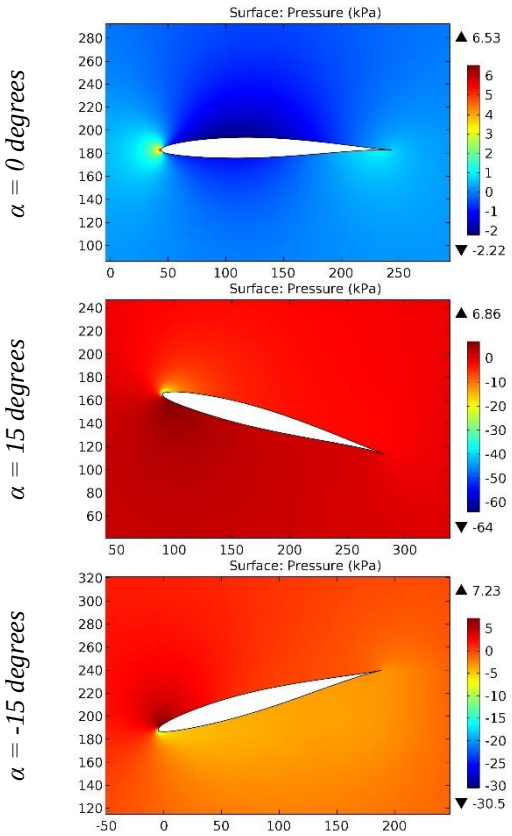


Figure 52. The pressure contours on the surfaces of the NA63-209 airfoil.

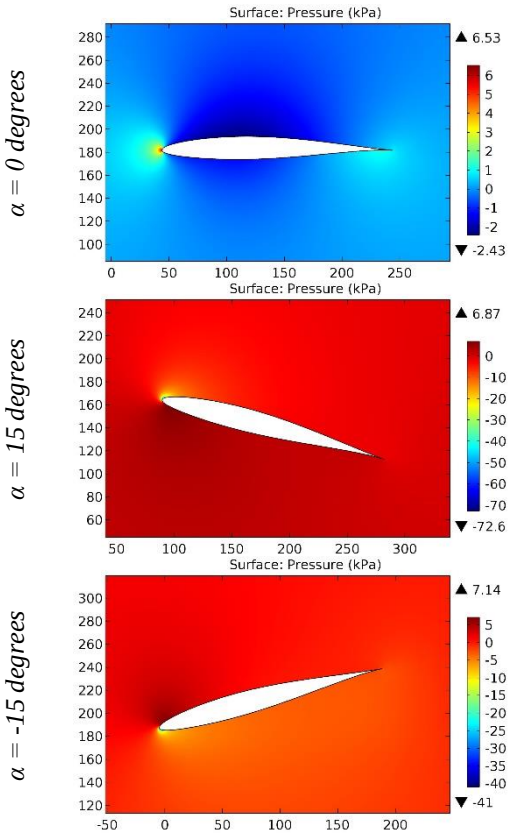


Figure 53. The pressure contours on the surfaces of the NA63-210 airfoil.

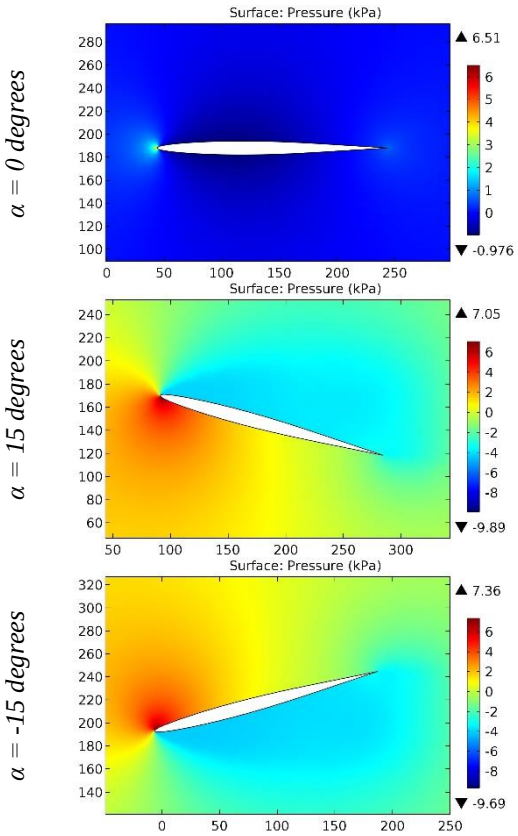


Figure 54. The pressure contours on the surfaces of the NA63A006 airfoil.

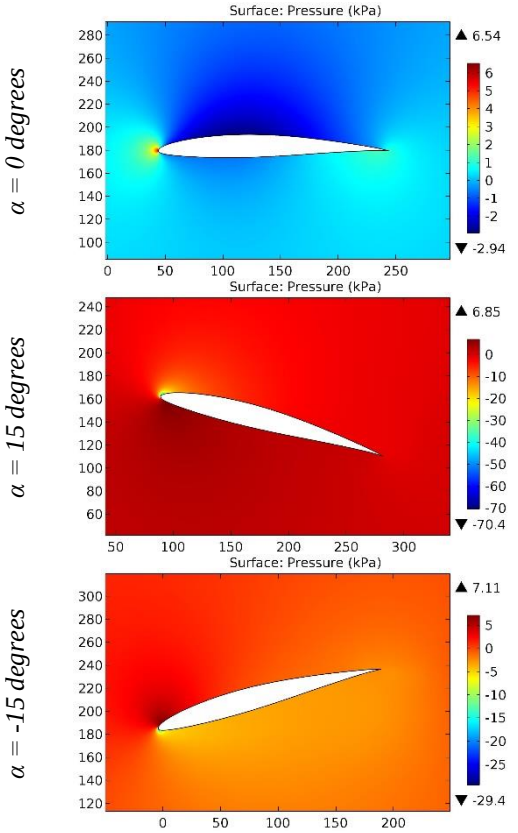


Figure 55. The pressure contours on the surfaces of the NA63A410 airfoil.

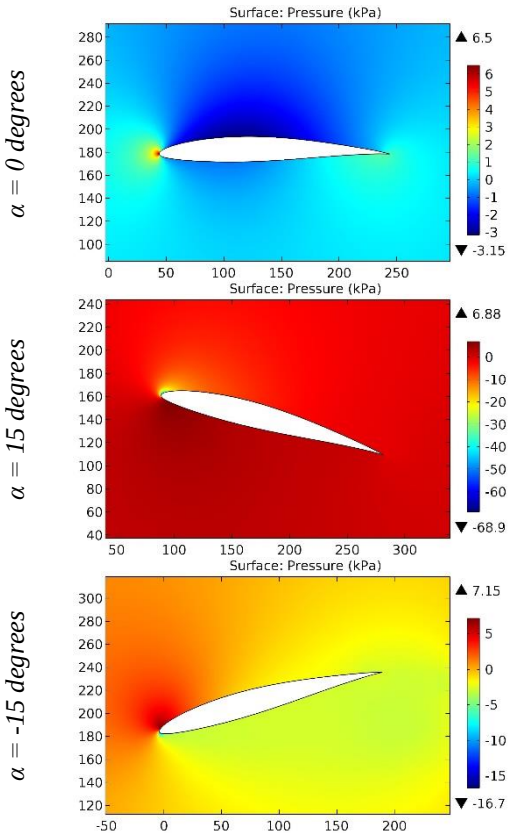


Figure 56. The pressure contours on the surfaces of the NA63A411 airfoil.

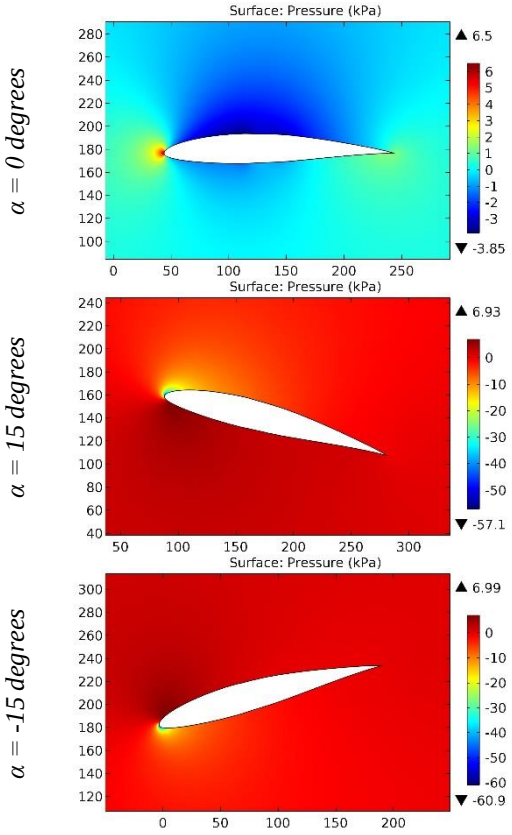


Figure 57. The pressure contours on the surfaces of the NA63A413 airfoil.

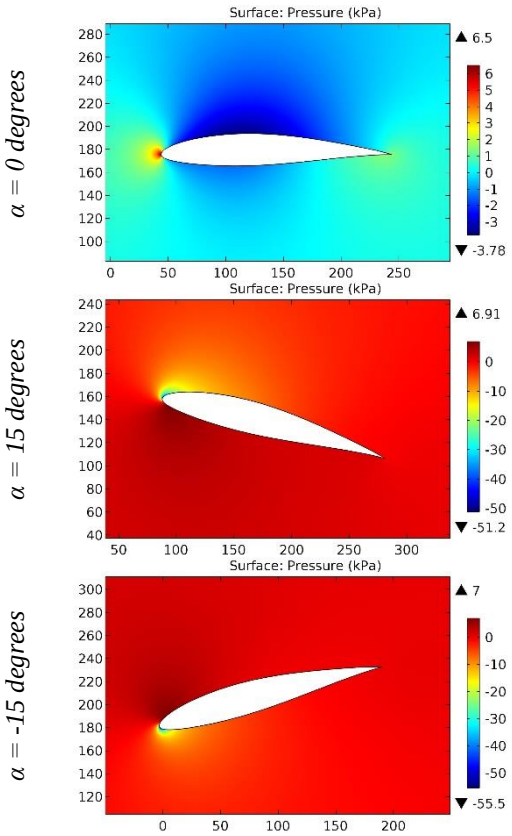


Figure 58. The pressure contours on the surfaces of the NA63A414 airfoil.

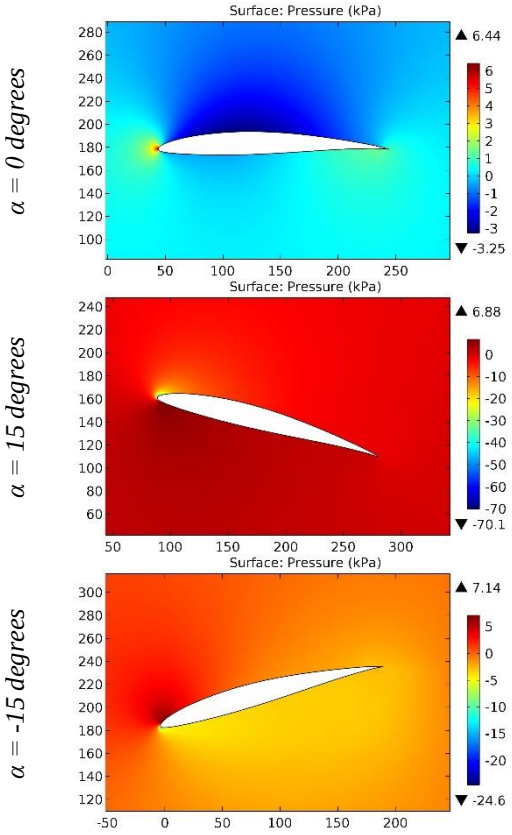


Figure 59. The pressure contours on the surfaces of the NA63A510 airfoil.

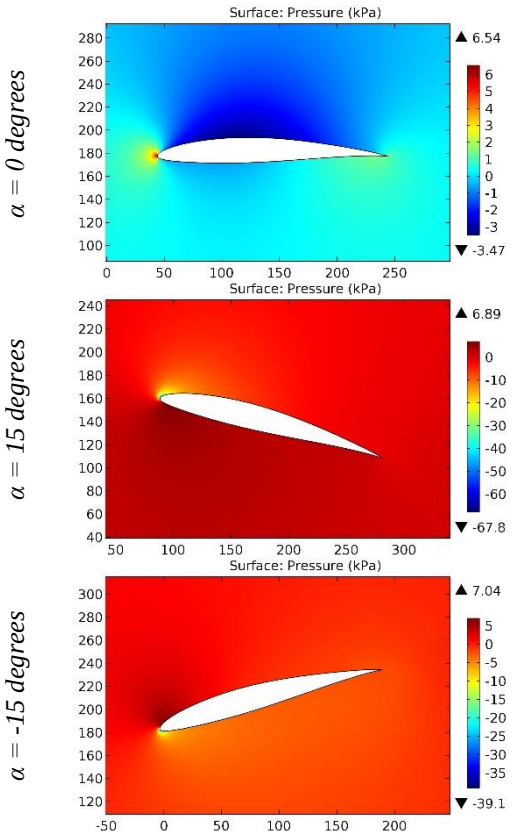


Figure 60. The pressure contours on the surfaces of the NA63A511 airfoil.

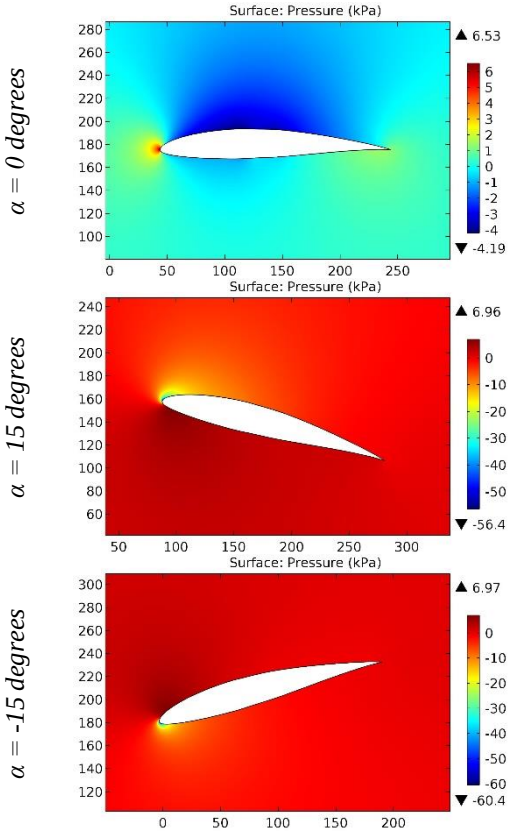


Figure 61. The pressure contours on the surfaces of the NA63A513 airfoil.

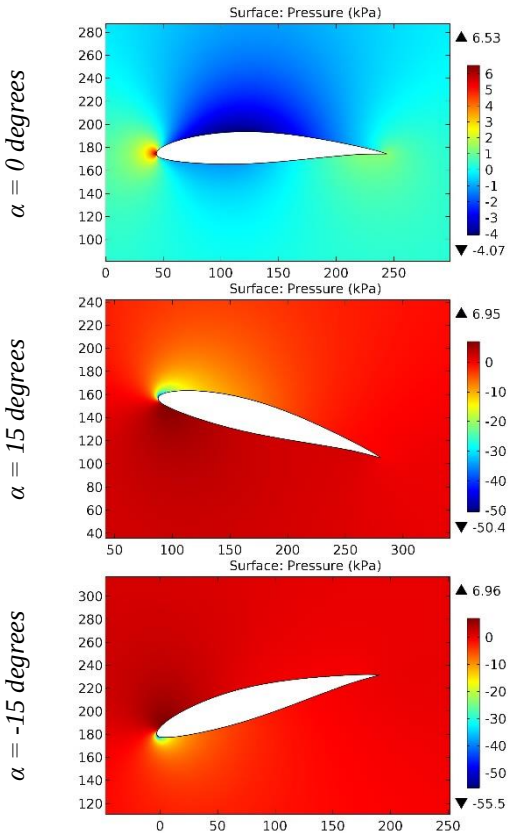


Figure 62. The pressure contours on the surfaces of the NA63A514 airfoil.

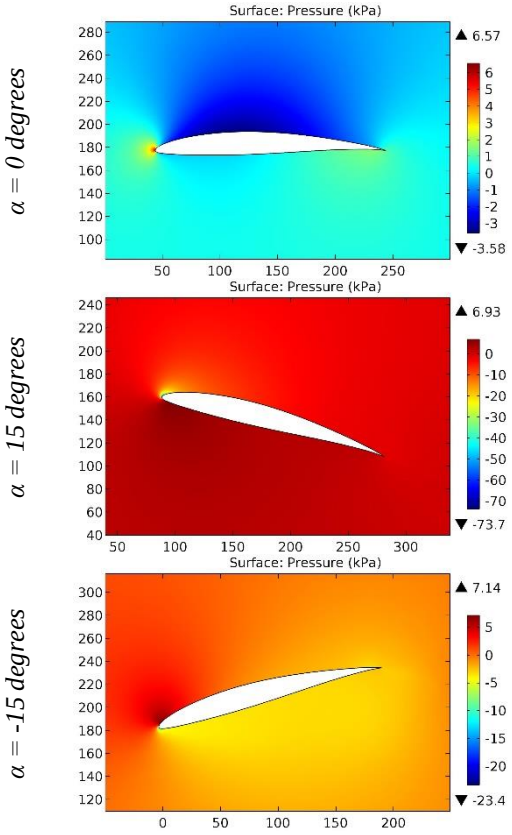


Figure 63. The pressure contours on the surfaces of the NA63A610 airfoil.

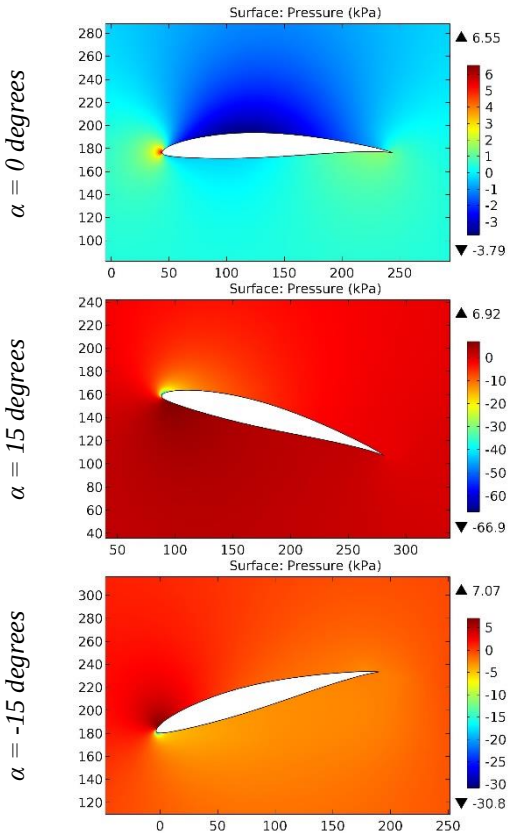


Figure 64. The pressure contours on the surfaces of the NA63A611 airfoil.

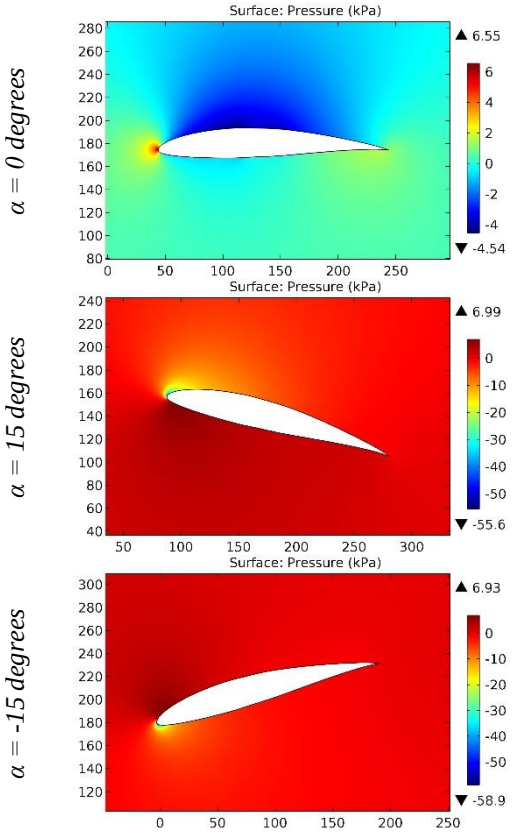


Figure 65. The pressure contours on the surfaces of the NA63A613 airfoil.

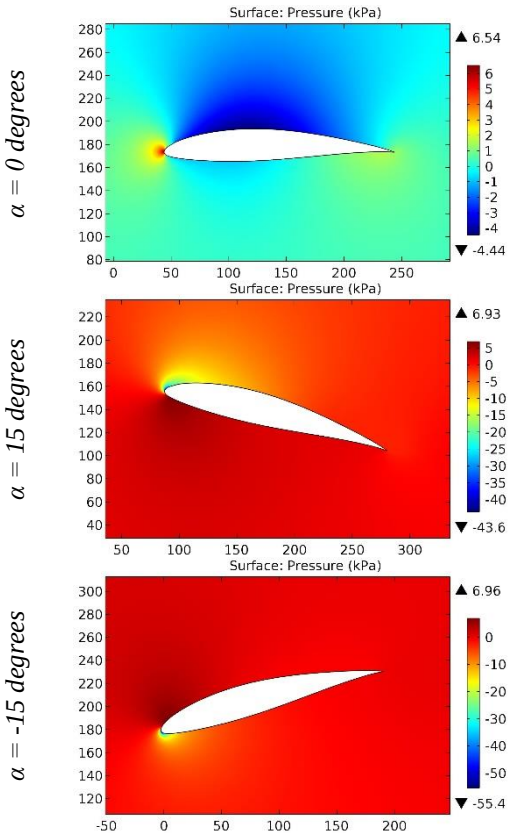


Figure 66. The pressure contours on the surfaces of the NA63A614 airfoil.

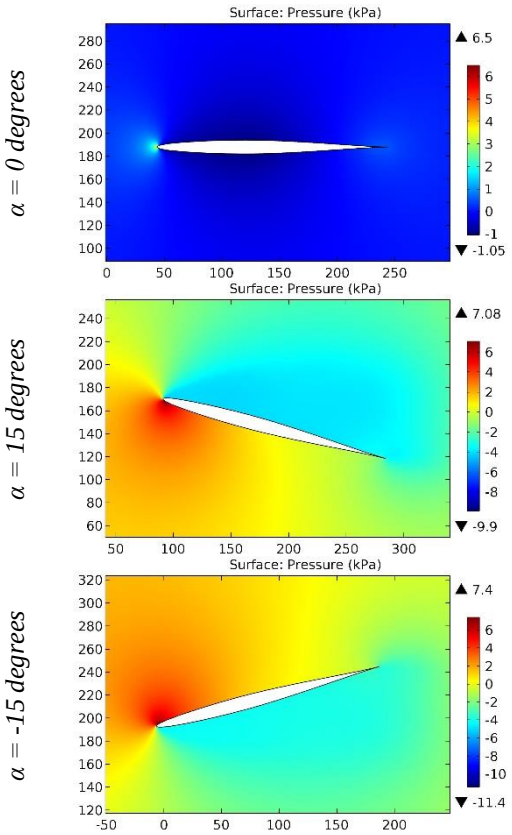


Figure 67. The pressure contours on the surfaces of the NA64-006 airfoil.

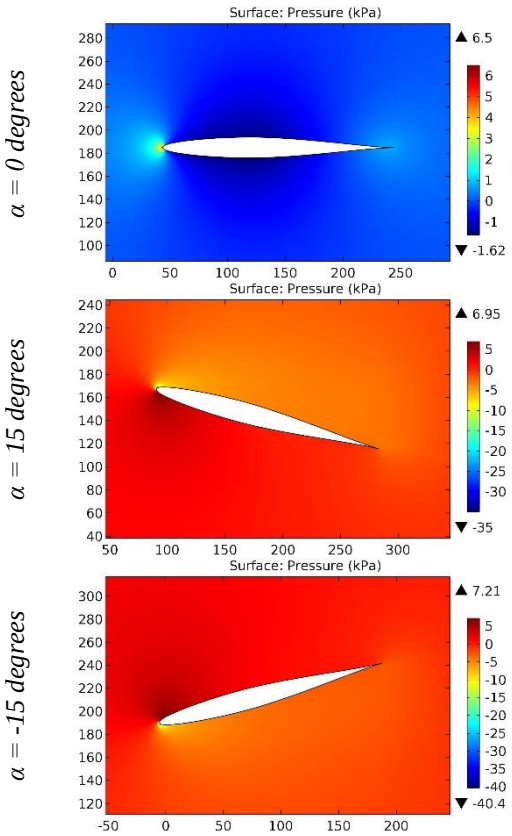


Figure 68. The pressure contours on the surfaces of the NA64-009 airfoil.

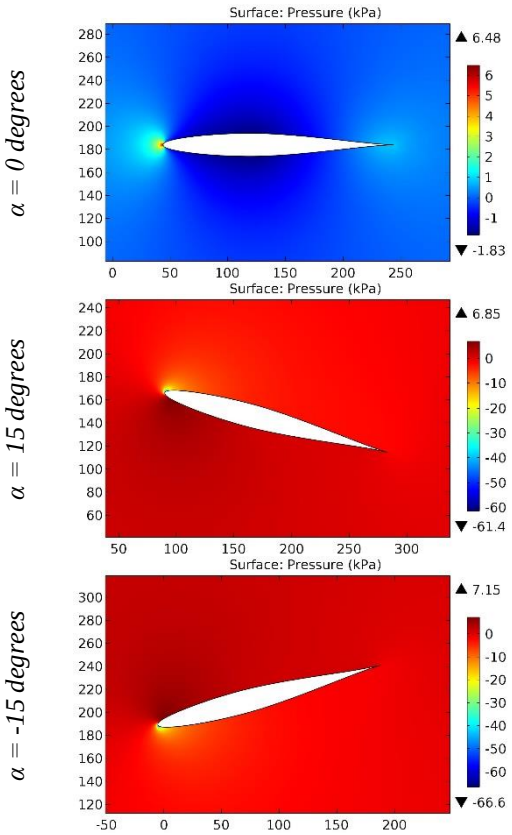


Figure 69. The pressure contours on the surfaces of the NA64-010 airfoil.

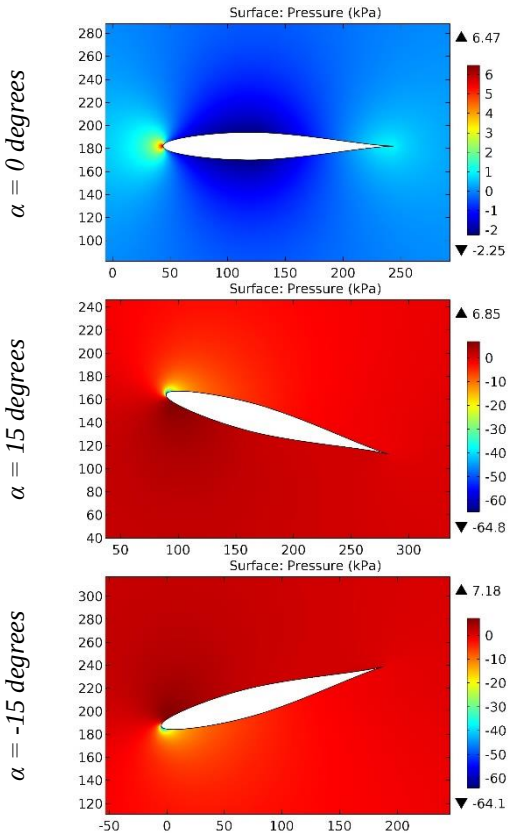


Figure 70. The pressure contours on the surfaces of the NA641012 airfoil.

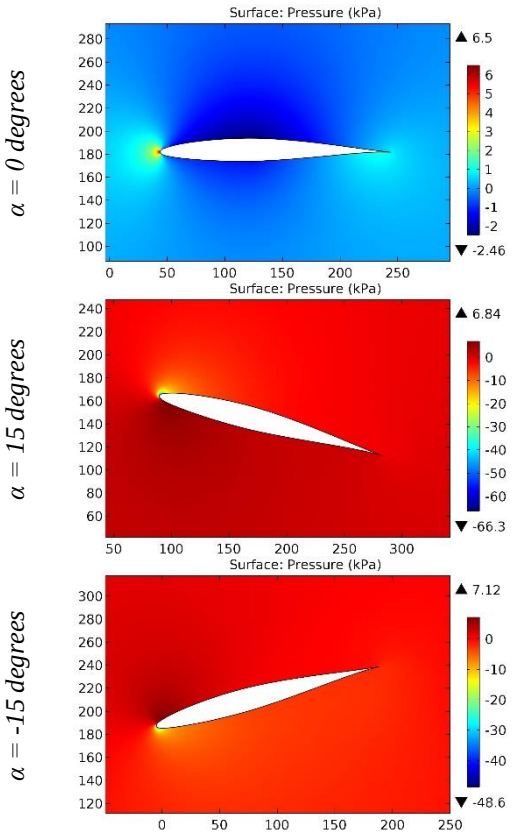


Figure 71. The pressure contours on the surfaces of the NA641112 airfoil.

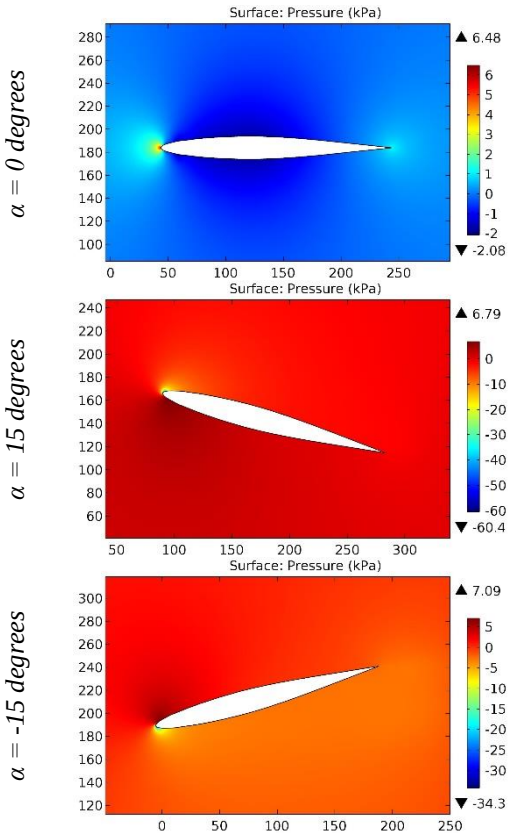


Figure 72. The pressure contours on the surfaces of the NA64A010 airfoil.

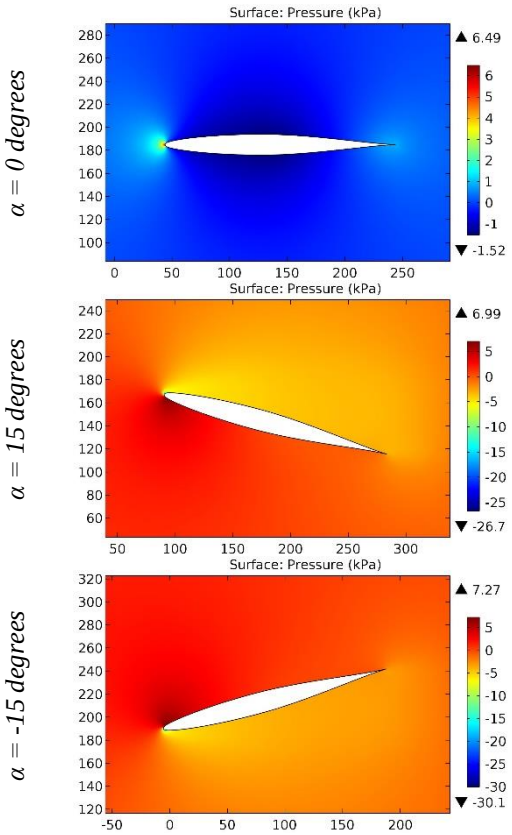


Figure 73. The pressure contours on the surfaces of the NA65-009 airfoil.

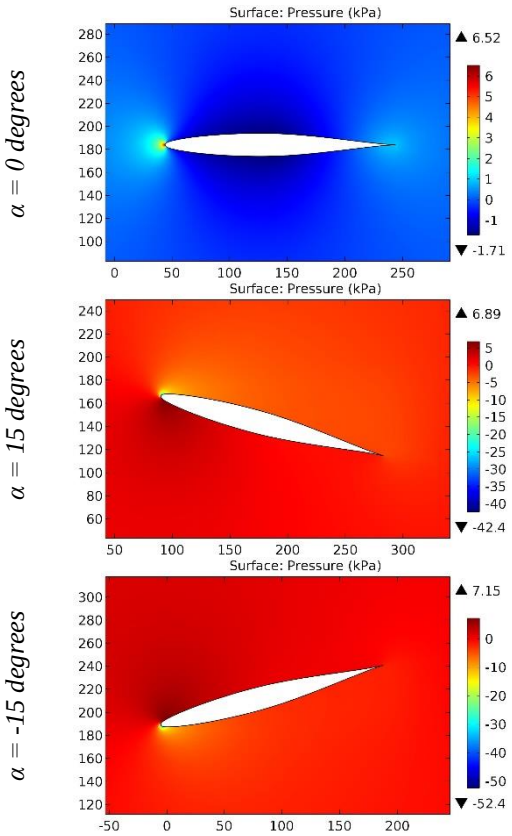


Figure 74. The pressure contours on the surfaces of the NA65-010 airfoil.

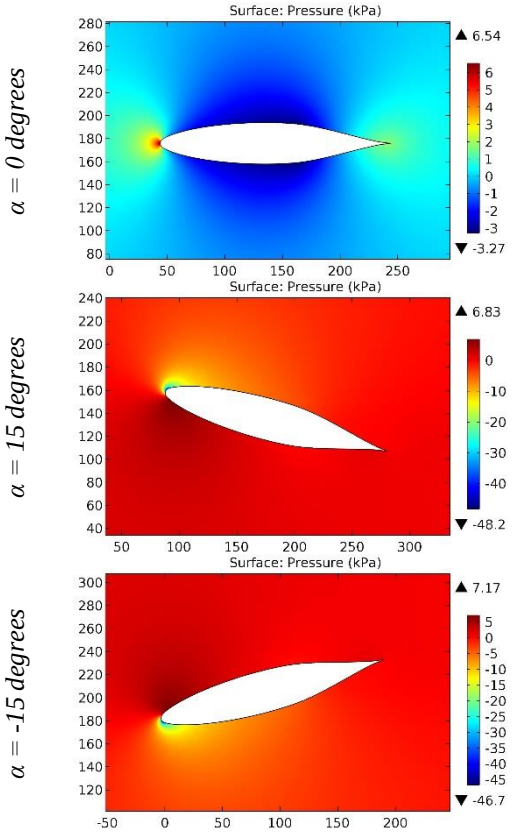


Figure 75. The pressure contours on the surfaces of the NA66-018 airfoil.

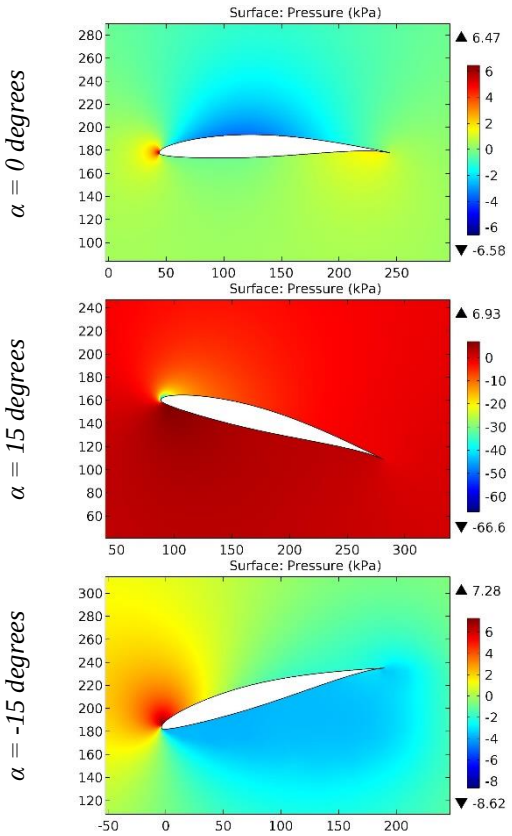


Figure 76. The pressure contours on the surfaces of the NA7 airfoil.

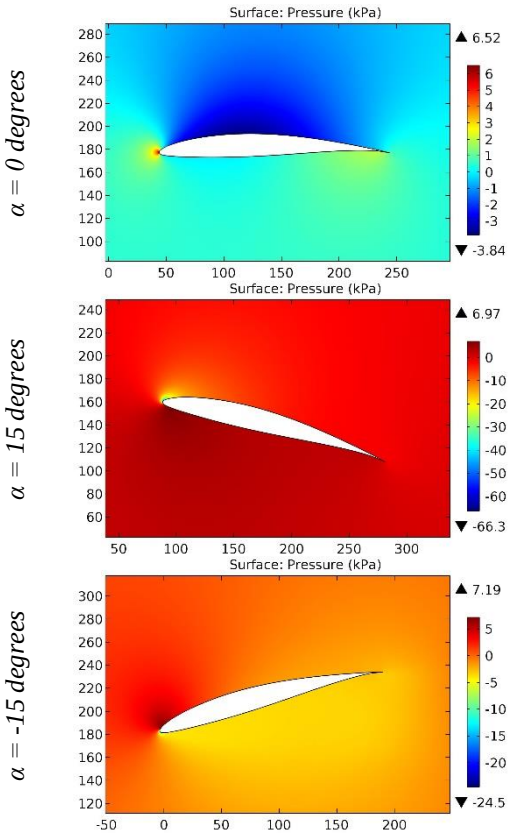


Figure 77. The pressure contours on the surfaces of the NA8 airfoil.

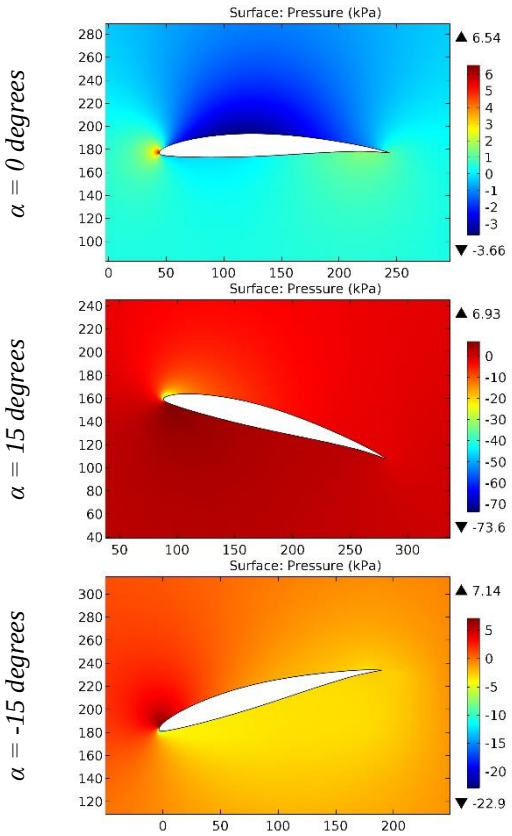


Figure 78. The pressure contours on the surfaces of the NA9 airfoil.

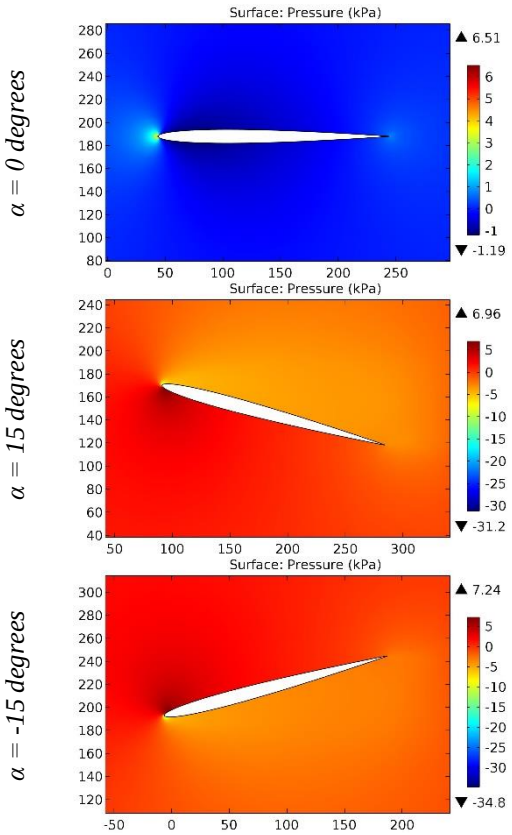


Figure 79. The pressure contours on the surfaces of the NACA 0006 airfoil.

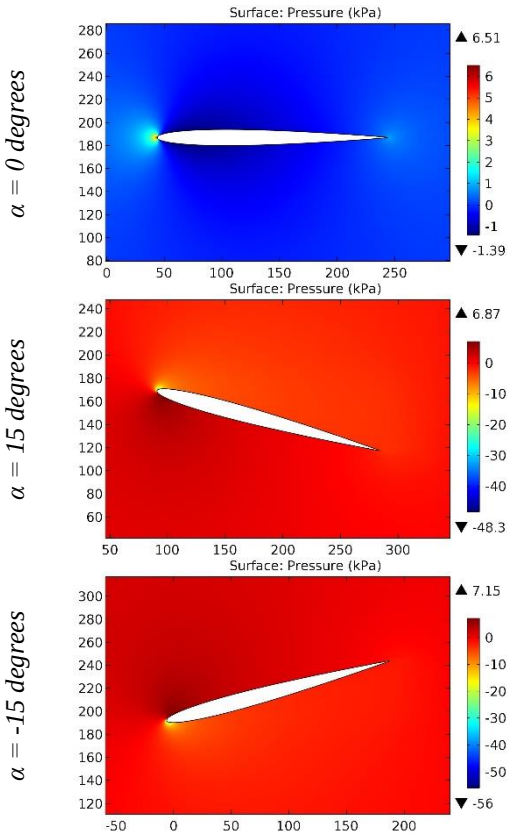


Figure 80. The pressure contours on the surfaces of the NACA 0007 airfoil.

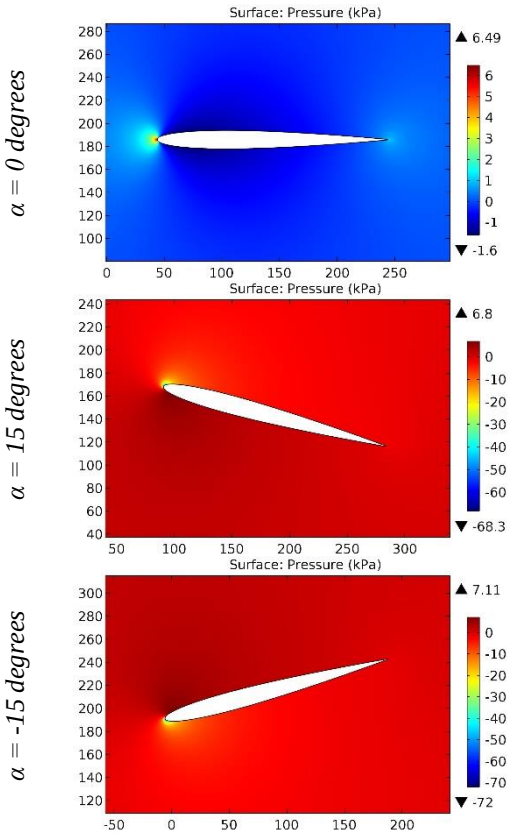


Figure 81. The pressure contours on the surfaces of the NACA 0008 airfoil.

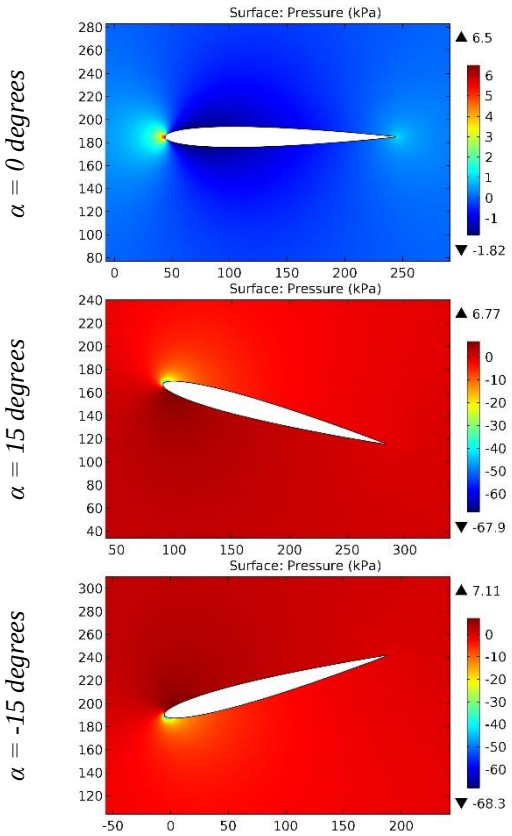


Figure 82. The pressure contours on the surfaces of the NACA 0009 airfoil.

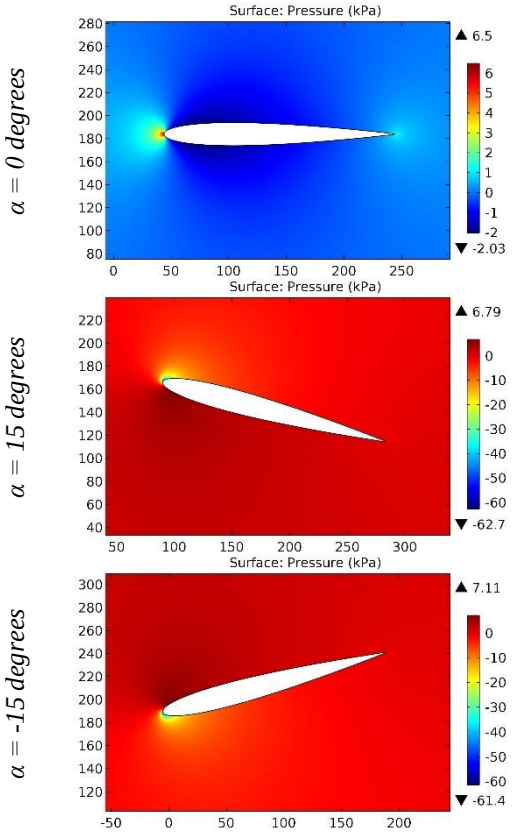


Figure 83. The pressure contours on the surfaces of the NACA 0010 airfoil.

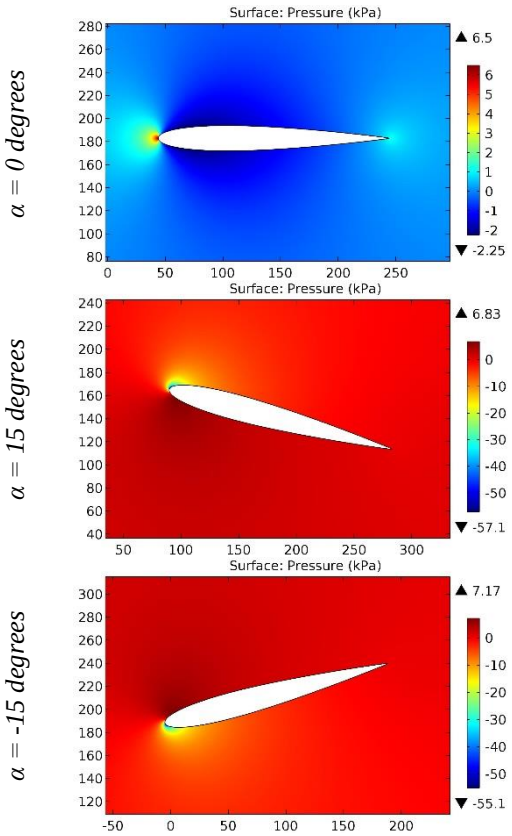


Figure 84. The pressure contours on the surfaces of the NACA 0011 airfoil.

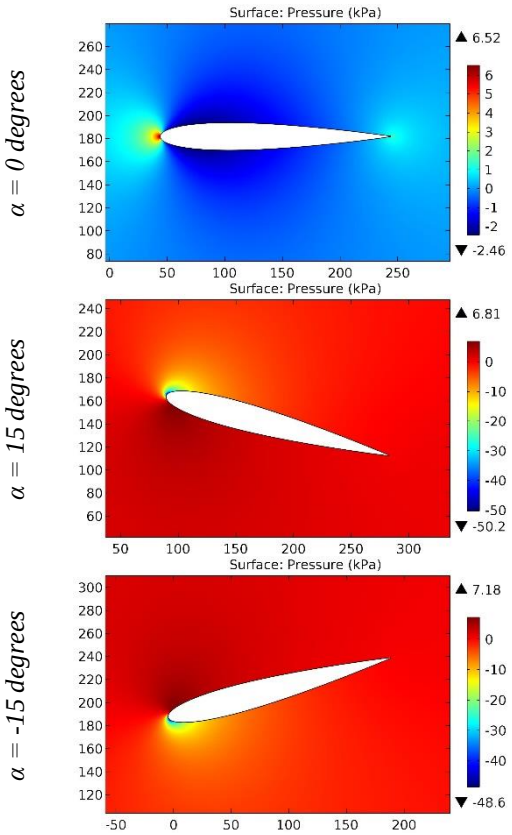


Figure 85. The pressure contours on the surfaces of the NACA 0012 airfoil.

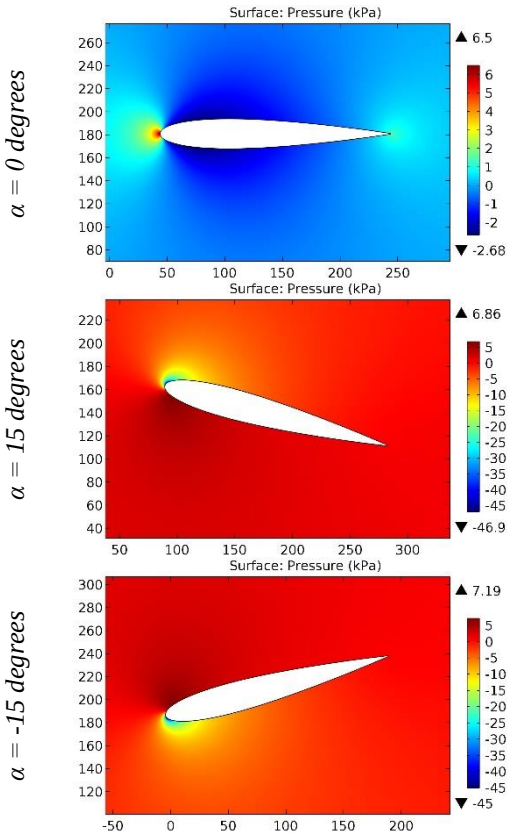


Figure 86. The pressure contours on the surfaces of the NACA 0013 airfoil.

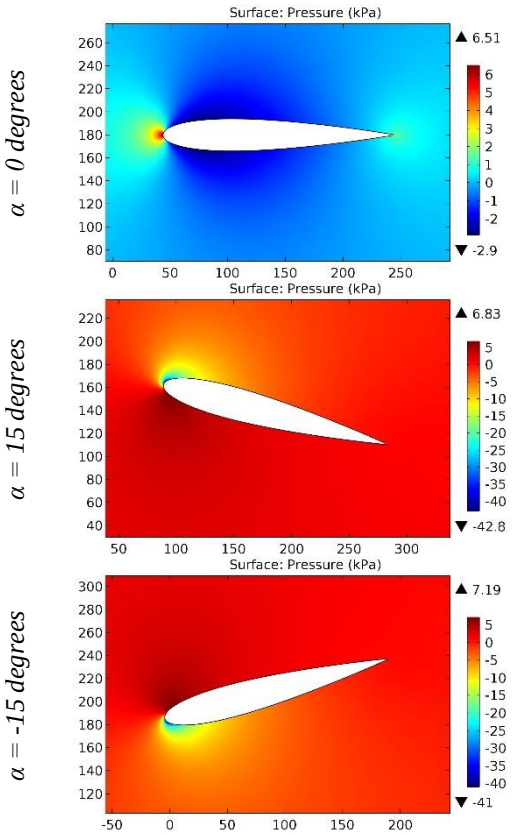


Figure 87. The pressure contours on the surfaces of the NACA 0014 airfoil.

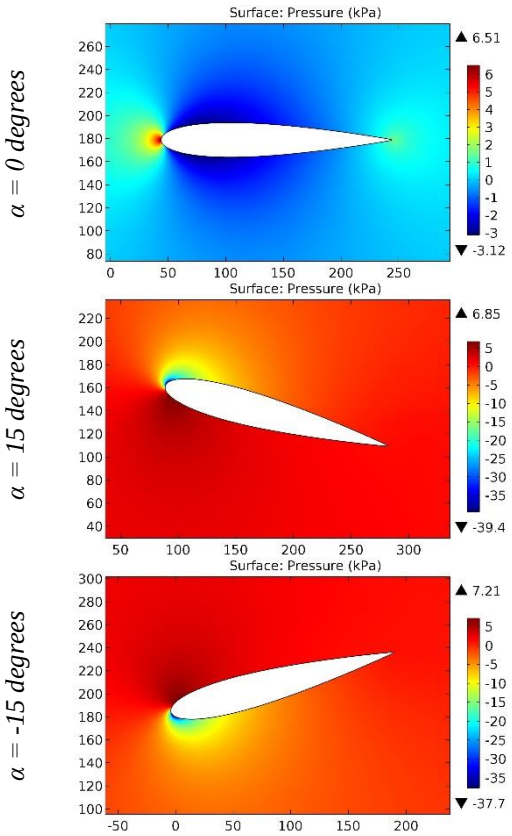


Figure 88. The pressure contours on the surfaces of the NACA 0015 airfoil.

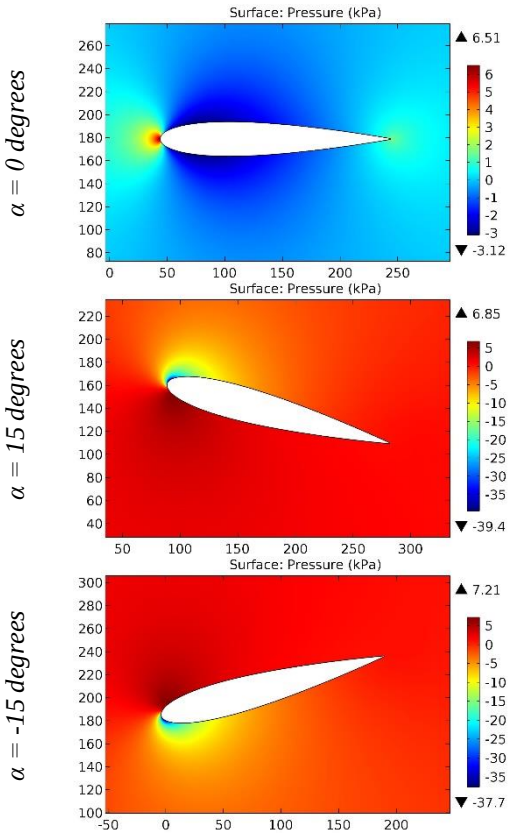


Figure 89. The pressure contours on the surfaces of the NACA 0015 by profile airfoil.

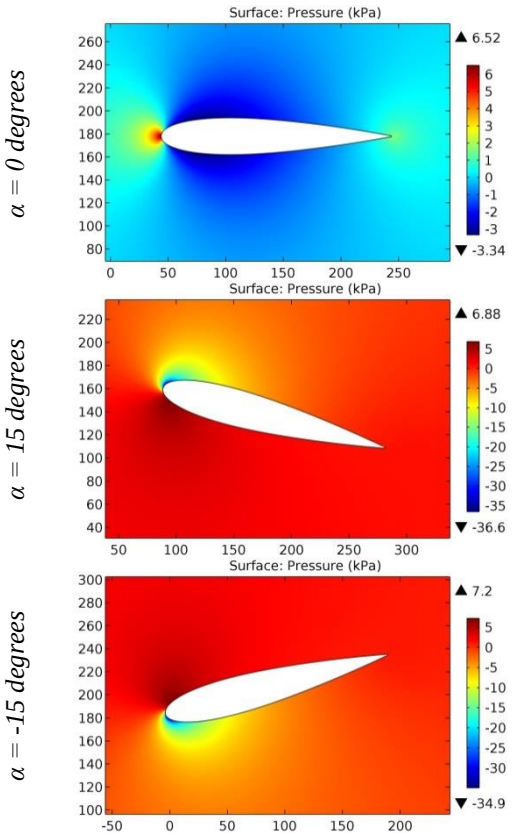


Figure 90. The pressure contours on the surfaces of the NACA 0016 airfoil.

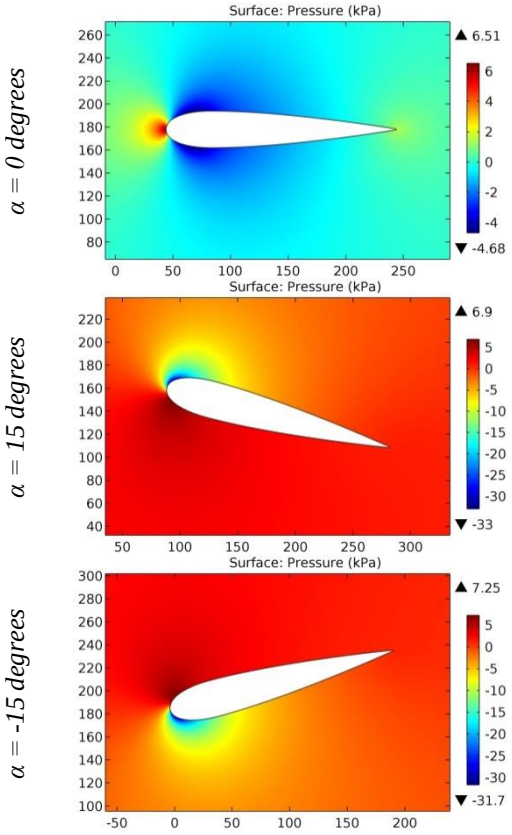


Figure 91. The pressure contours on the surfaces of the NACA 0016- 30-20 airfoil.

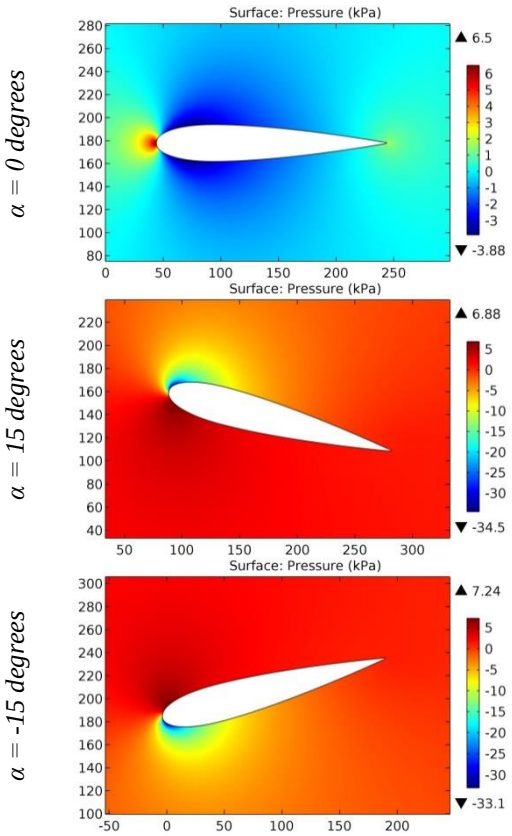


Figure 92. The pressure contours on the surfaces of the NACA 0016- 30-25 airfoil.

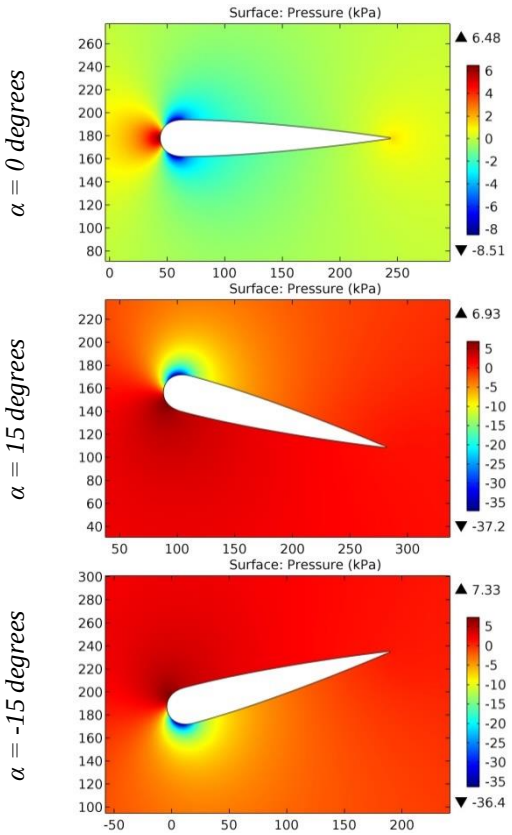


Figure 93. The pressure contours on the surfaces of the NACA 0016- Mod, airfoil.

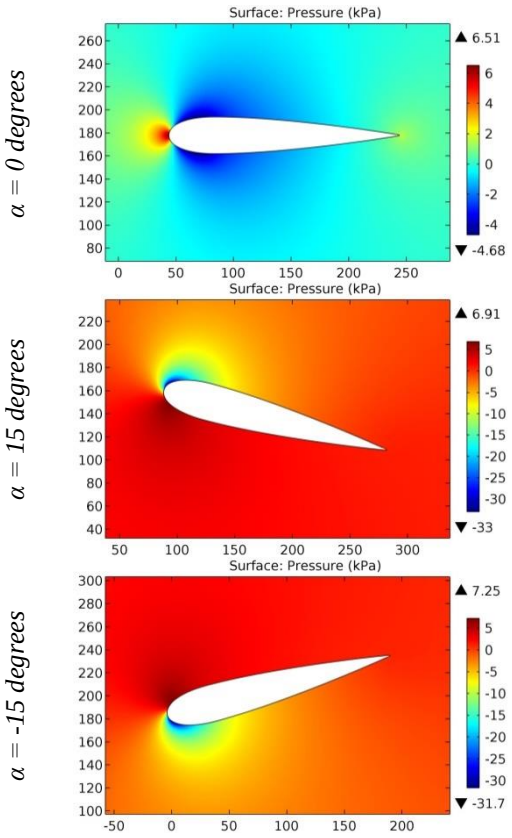


Figure 94. The pressure contours on the surfaces of the NACA 0016- Mod,30-20 airfoil.

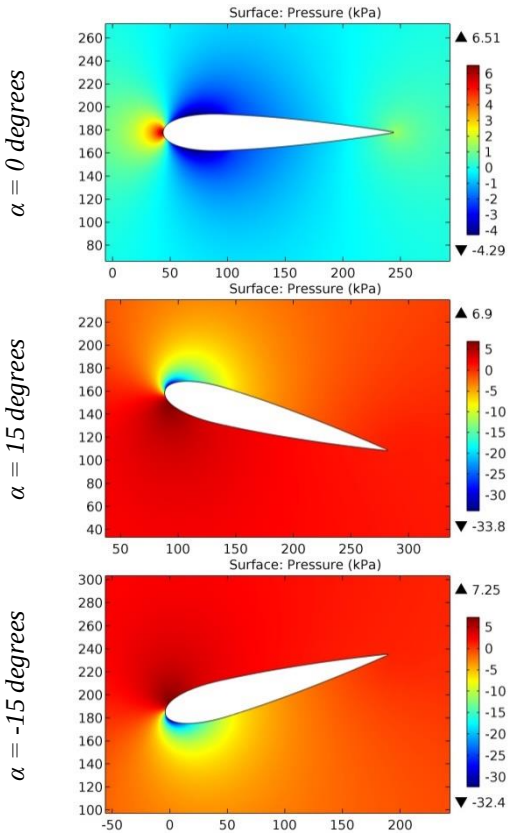


Figure 95. The pressure contours on the surfaces of the NACA 0016- Mod,40-30 airfoil.

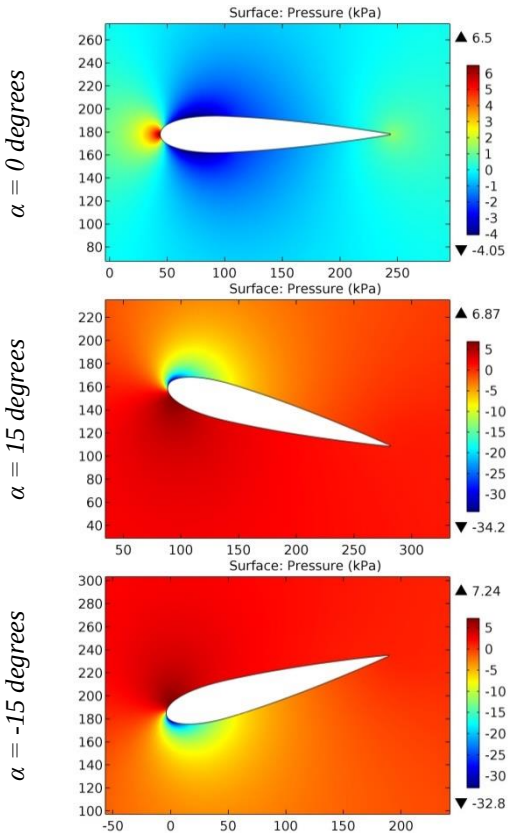


Figure 96. The pressure contours on the surfaces of the NACA 0016- Mod,40-32 airfoil.

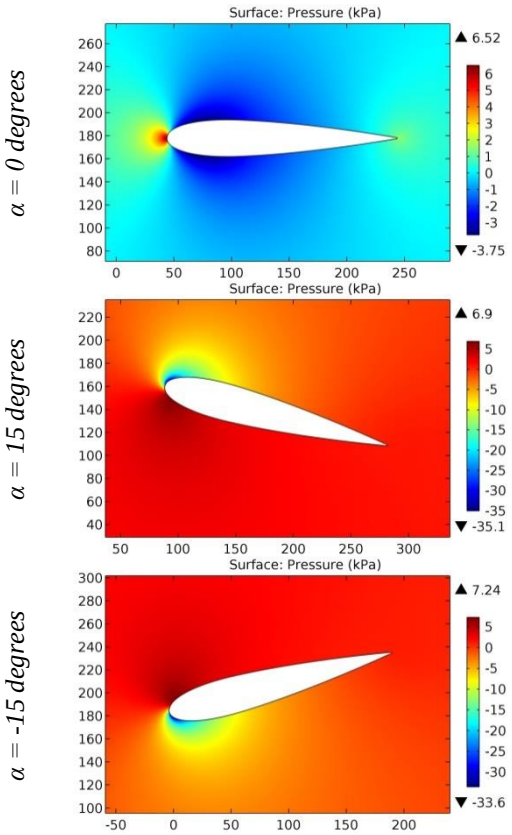


Figure 97. The pressure contours on the surfaces of the NACA 0016- Mod,40-35 airfoil.

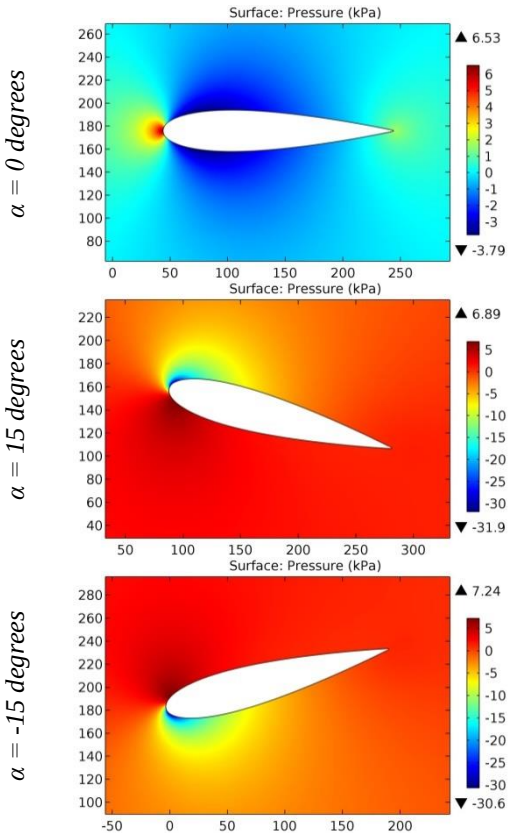


Figure 98. The pressure contours on the surfaces of the NACA 0018 airfoil.

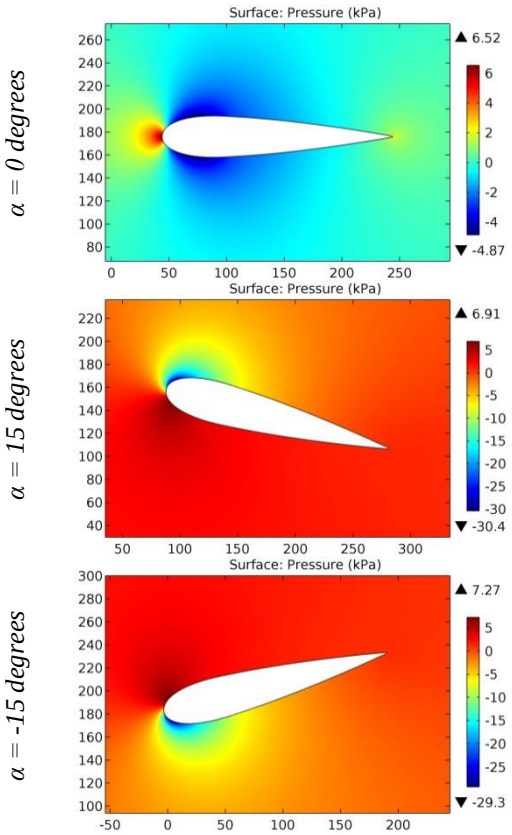


Figure 99. The pressure contours on the surfaces of the NACA 0018- Mod,40-30 airfoil.

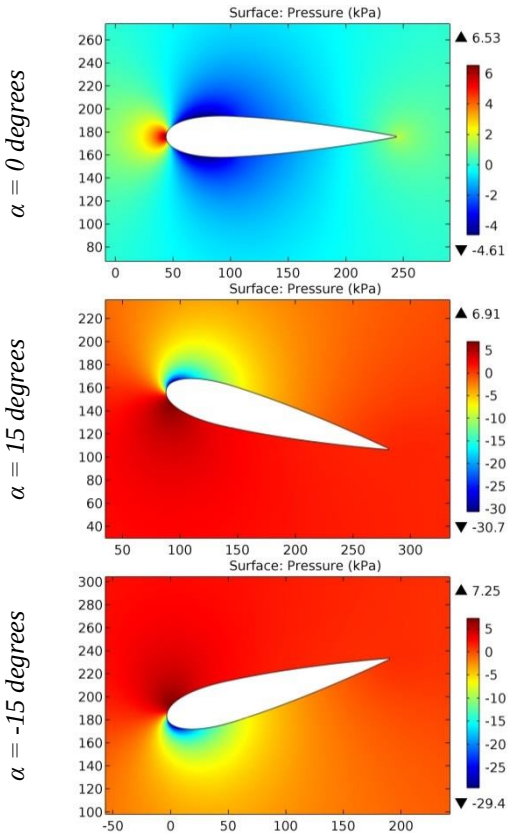


Figure 100. The pressure contours on the surfaces of the NACA 0018- Mod,40-32 airfoil.

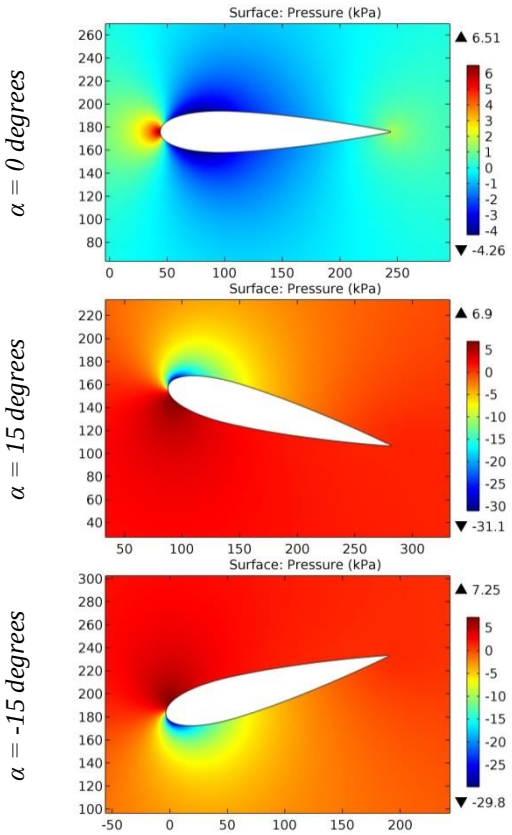


Figure 101. The pressure contours on the surfaces of the NACA 0018- Mod,40-35 airfoil.

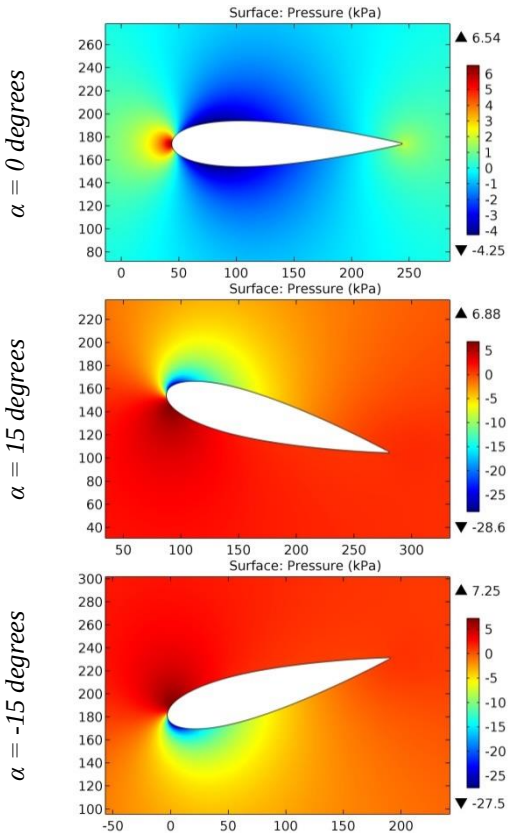


Figure 102. The pressure contours on the surfaces of the NACA 0020 airfoil.

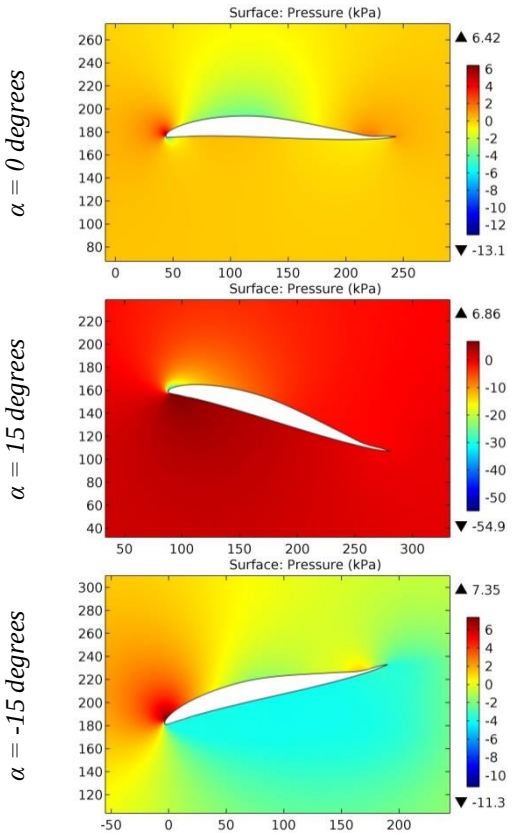


Figure 103. The pressure contours on the surfaces of the NACA 11-H-09 airfoil.

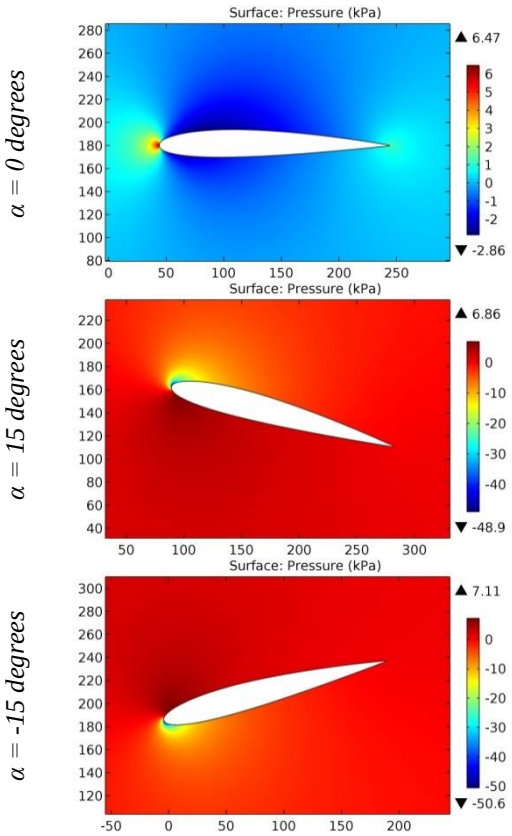


Figure 104. The pressure contours on the surfaces of the NACA 1412 airfoil.

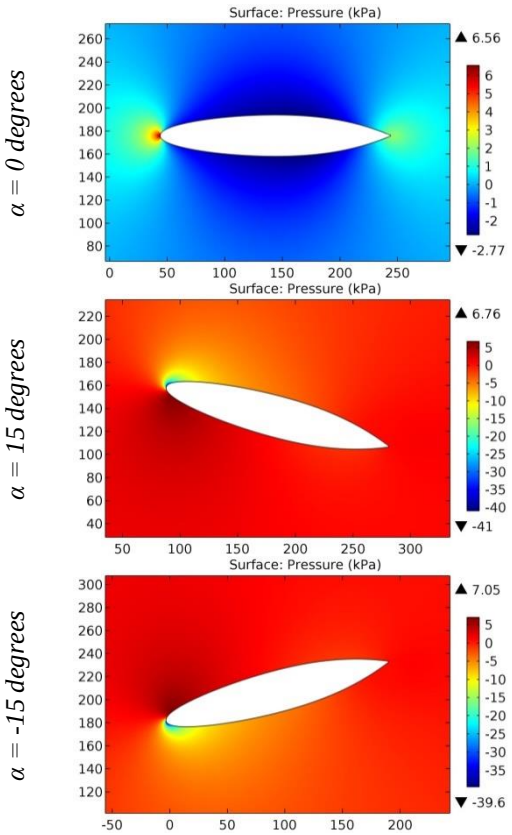


Figure 105. The pressure contours on the surfaces of the NACA 16018 airfoil.

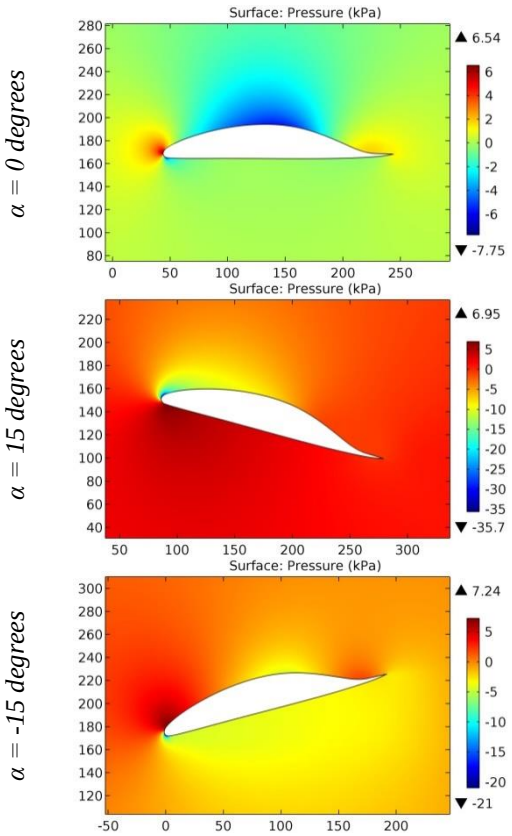


Figure 106. The pressure contours on the surfaces of the NACA 1-H-15 airfoil.

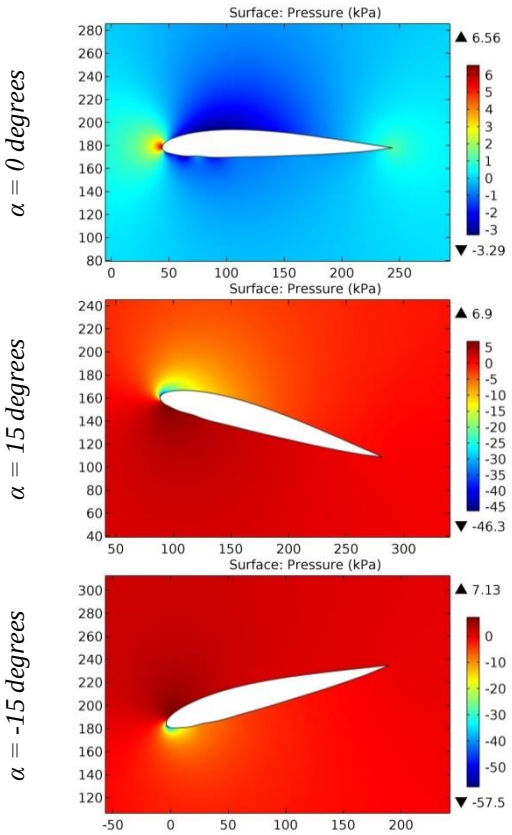


Figure 107. The pressure contours on the surfaces of the NACA 2 R 12 airfoil.

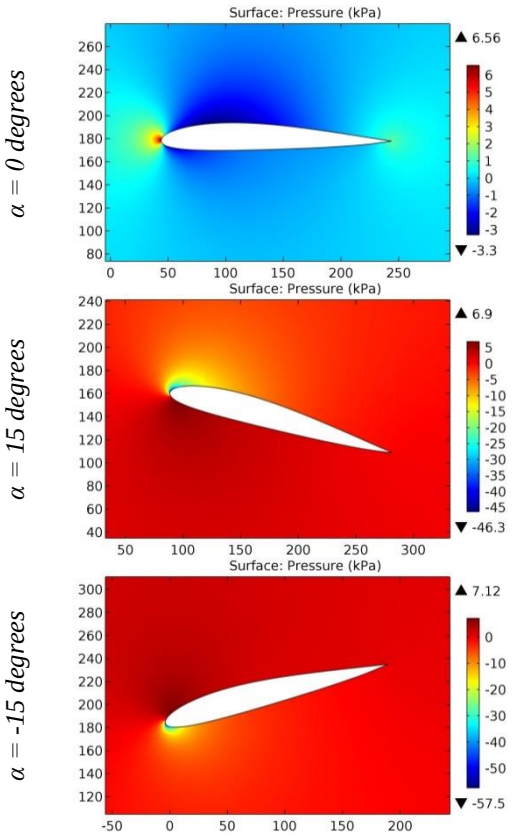


Figure 108. The pressure contours on the surfaces of the NACA 2 R1 12 airfoil.

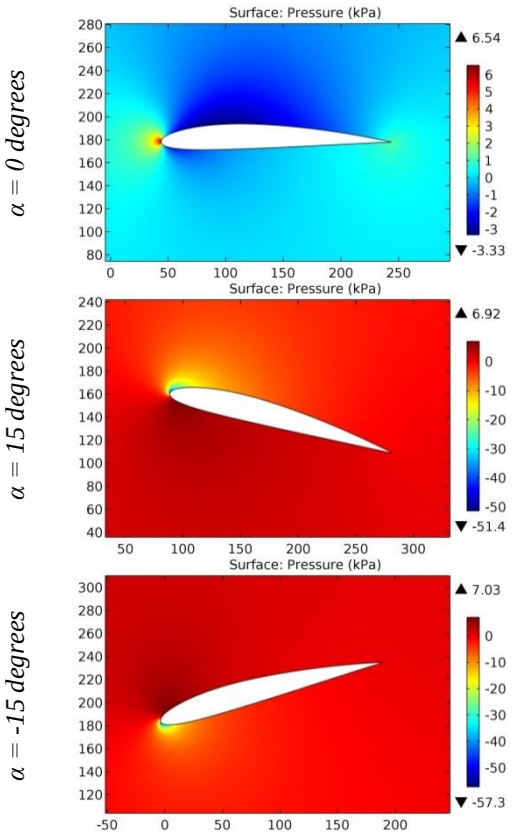


Figure 109. The pressure contours on the surfaces of the NACA 2,5411 airfoil.

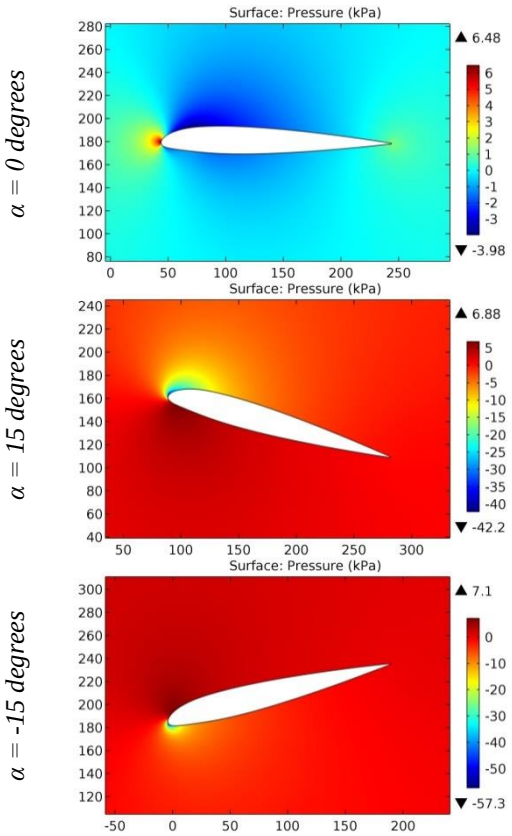


Figure 110. The pressure contours on the surfaces of the NACA 23012 12% airfoil.

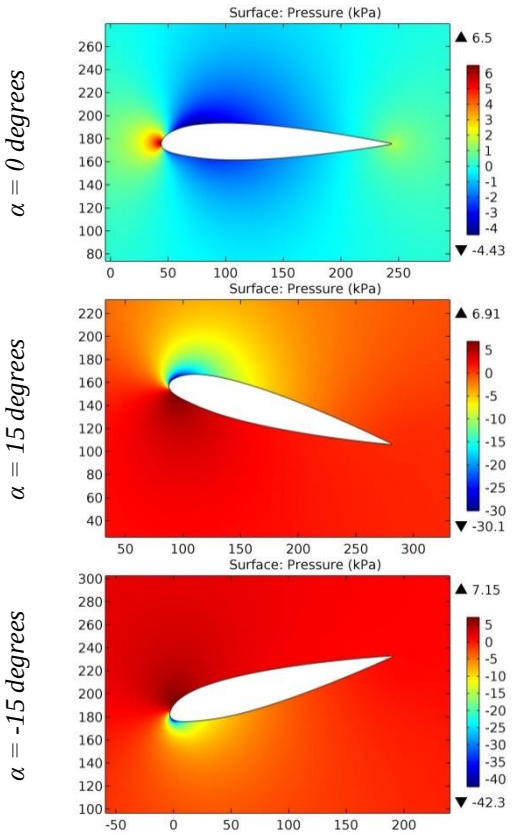


Figure 111. The pressure contours on the surfaces of the NACA 23016 airfoil.

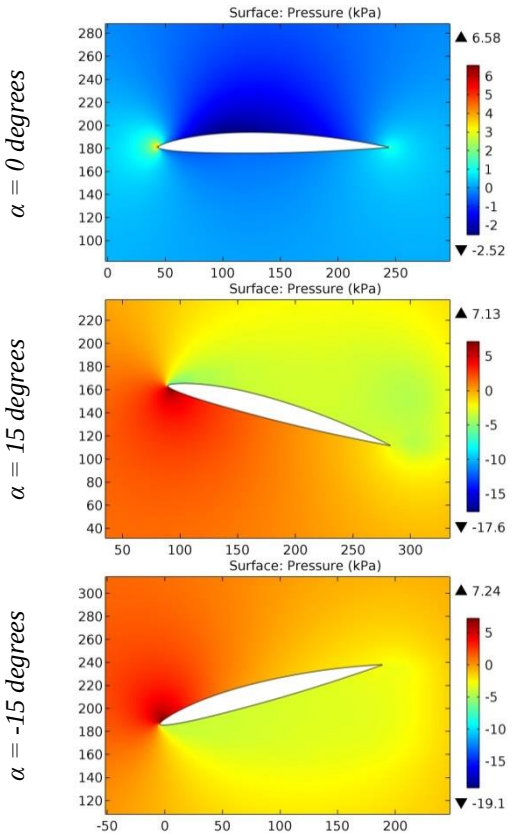


Figure 112. The pressure contours on the surfaces of the NACA 2409-34 airfoil.

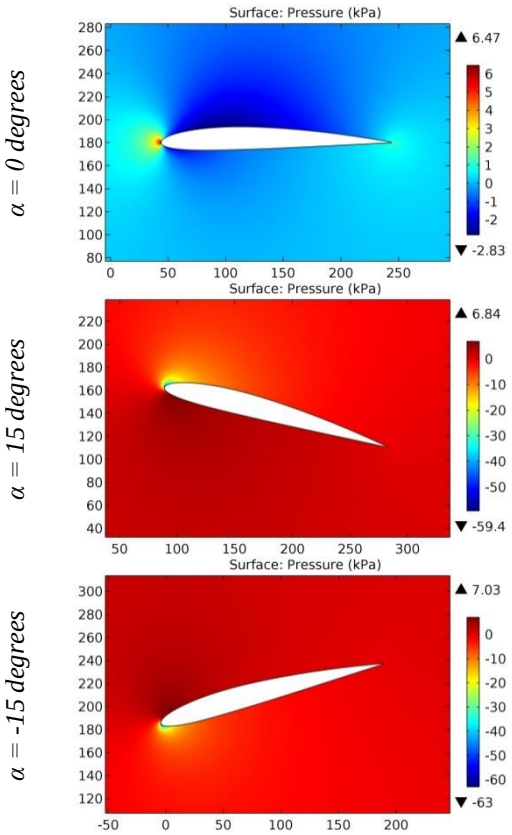


Figure 113. The pressure contours on the surfaces of the NACA 2410 airfoil.

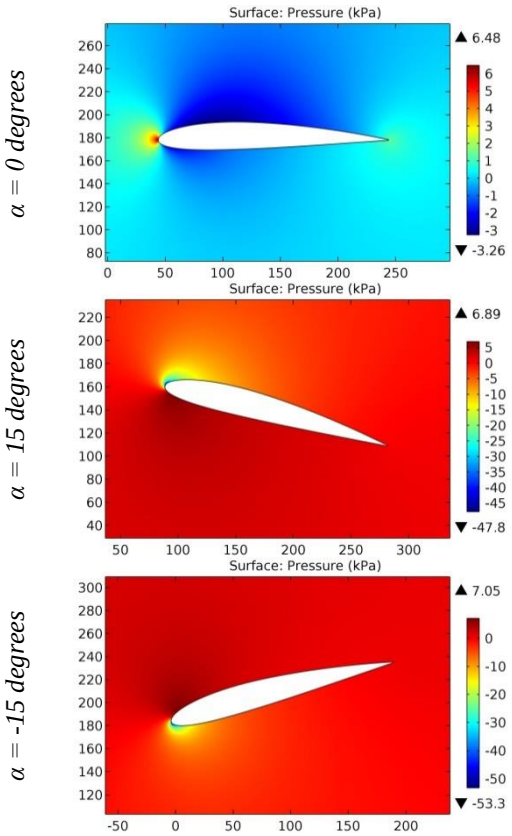


Figure 114. The pressure contours on the surfaces of the NACA 2412 airfoil.

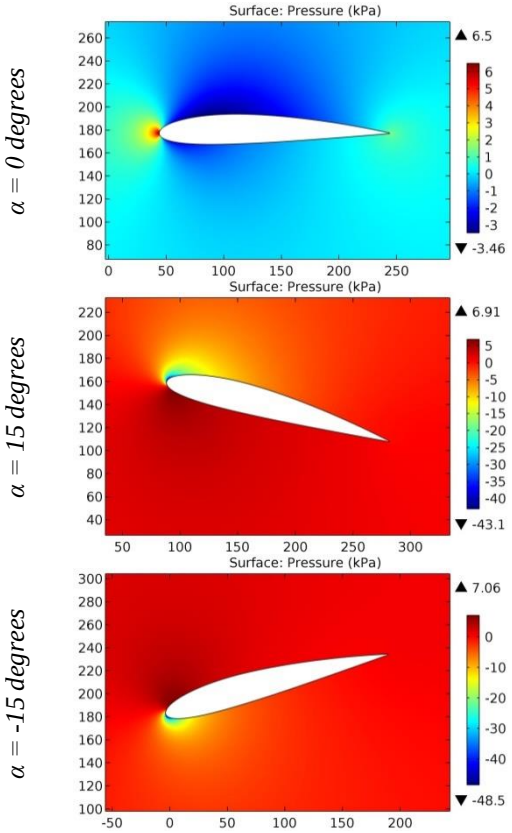


Figure 115. The pressure contours on the surfaces of the NACA 2413 airfoil.

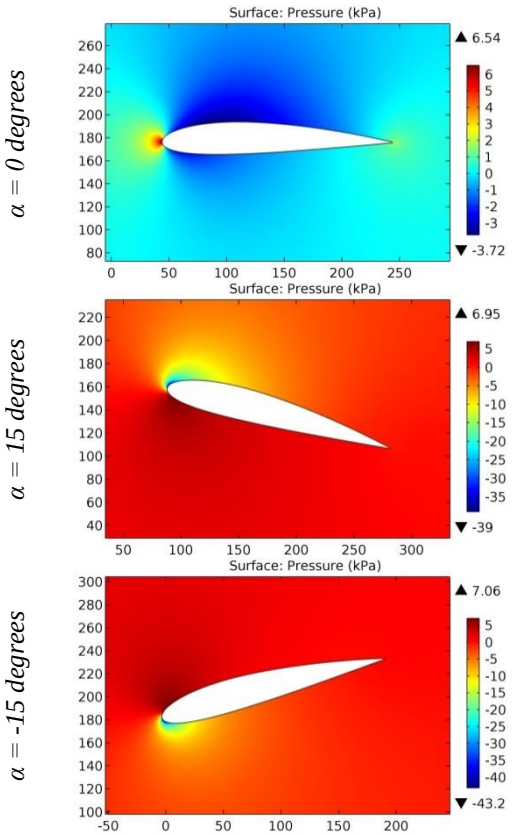


Figure 116. The pressure contours on the surfaces of the NACA 2414 airfoil.

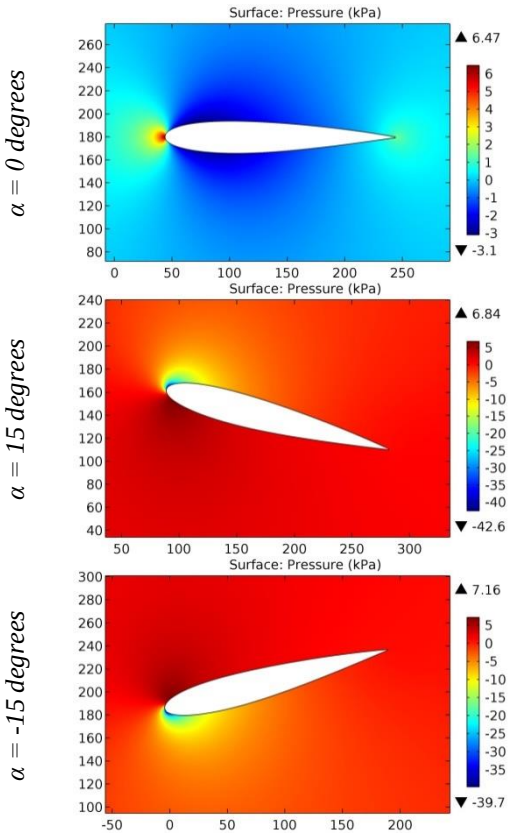


Figure 117. The pressure contours on the surfaces of the NACA 2414- Mod, airfoil.

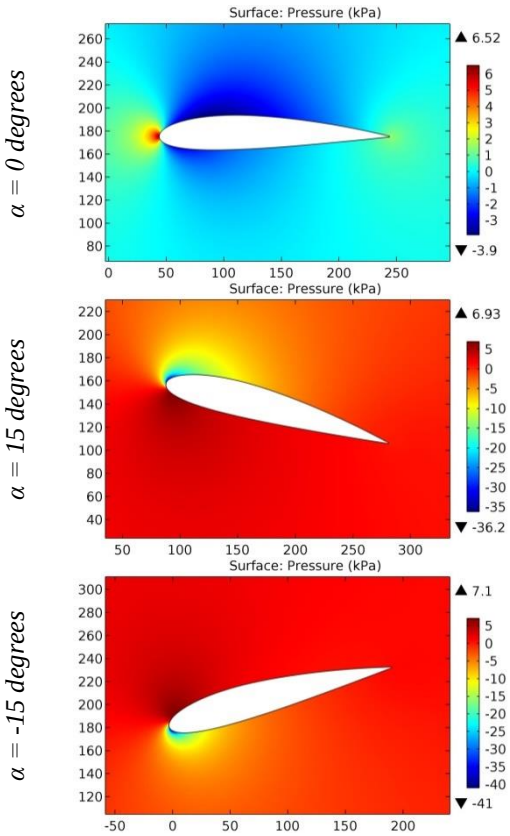


Figure 118. The pressure contours on the surfaces of the NACA 2415 airfoil.

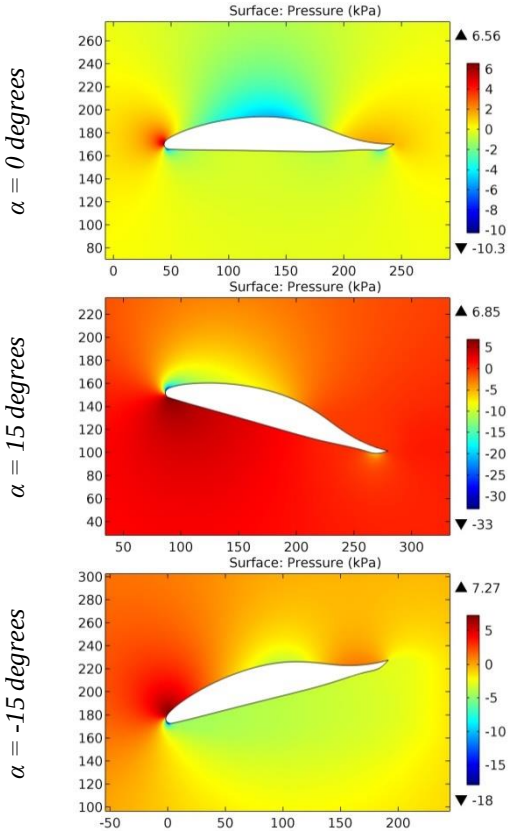


Figure 119. The pressure contours on the surfaces of the NACA 2-H-15 airfoil.

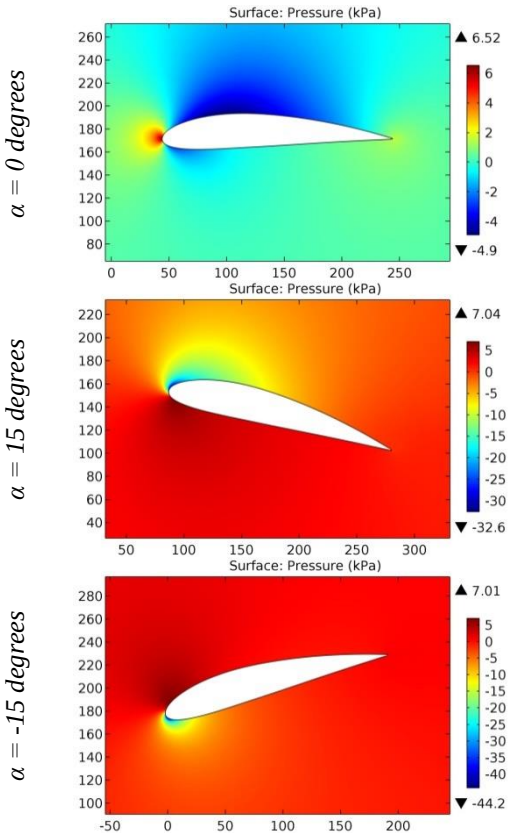


Figure 120. The pressure contours on the surfaces of the NACA 4415bis airfoil.

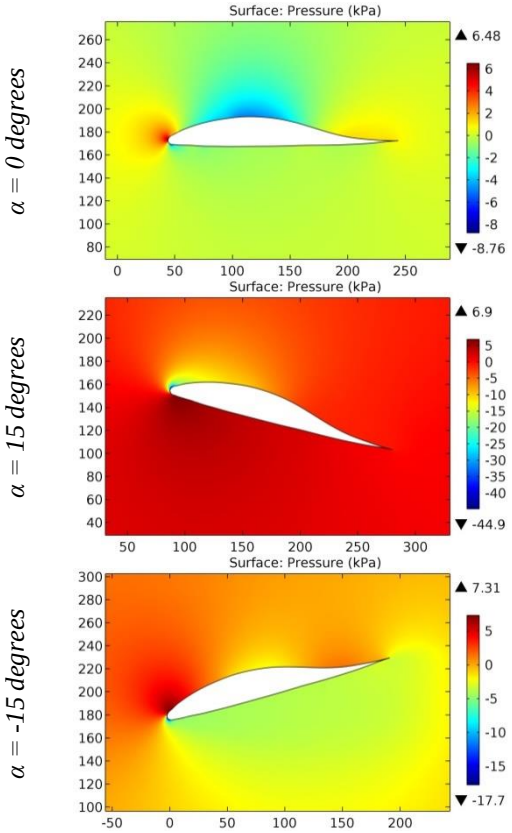


Figure 121. The pressure contours on the surfaces of the NACA 4-H-12,4 airfoil.

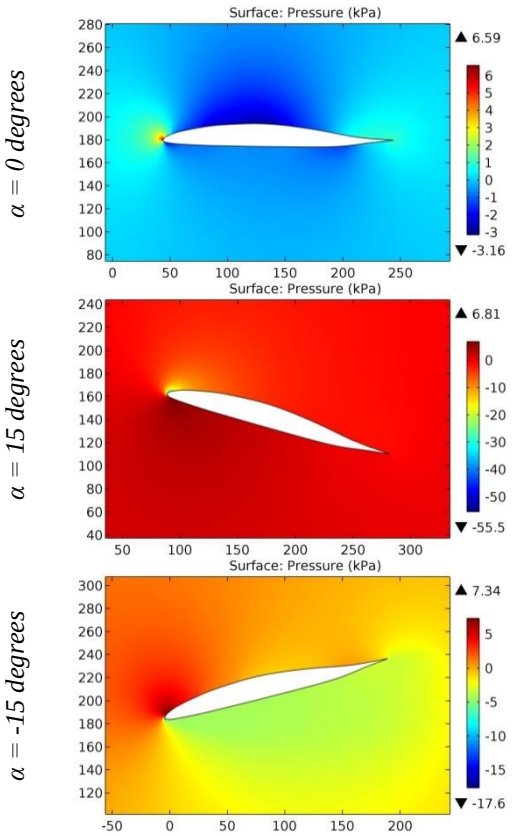


Figure 122. The pressure contours on the surfaces of the NACA 5-H-10 airfoil.

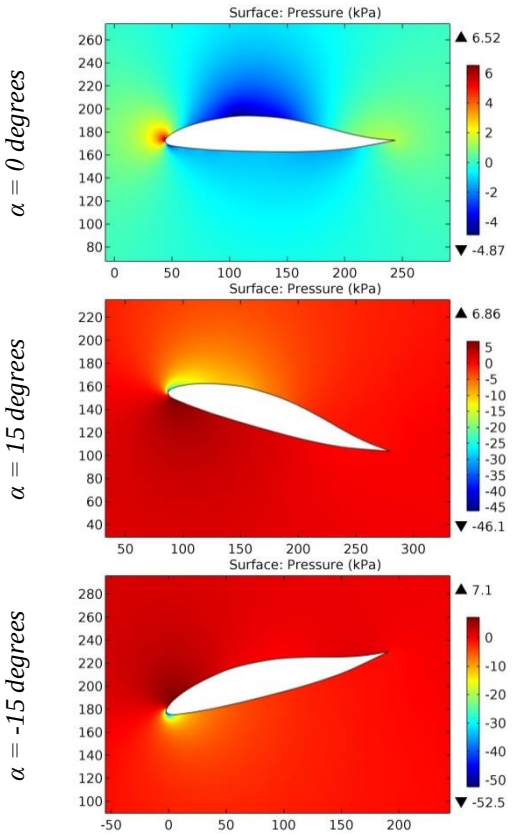


Figure 123. The pressure contours on the surfaces of the NACA 5-H-15 airfoil.

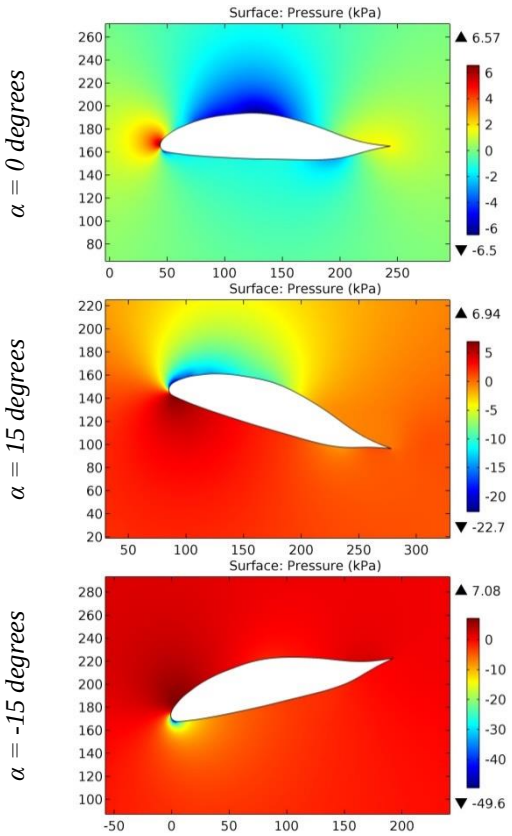


Figure 124. The pressure contours on the surfaces of the NACA 5-H-20 airfoil.

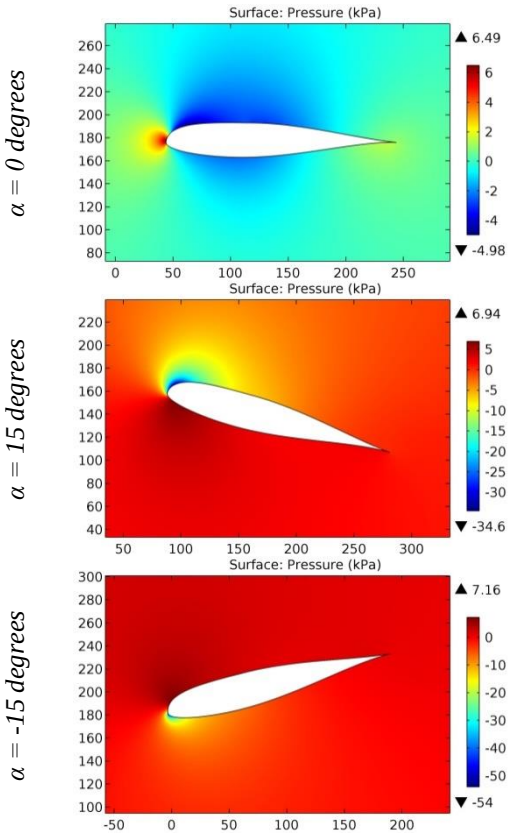


Figure 125. The pressure contours on the surfaces of the NACA 63(2)-215 MOD B airfoil.

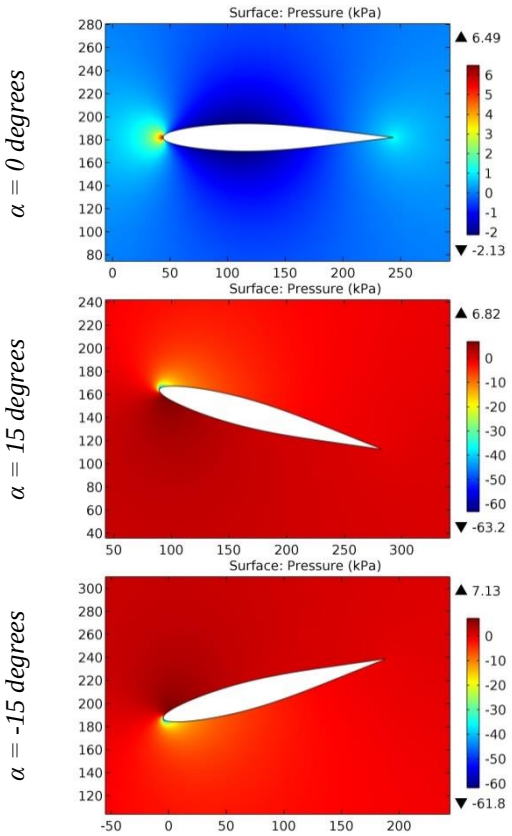


Figure 126. The pressure contours on the surfaces of the NACA 63012A airfoil.

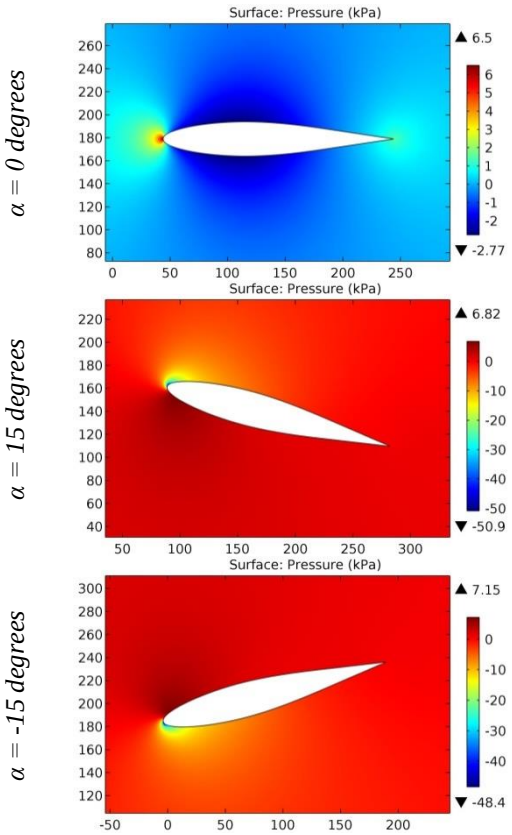


Figure 127. The pressure contours on the surfaces of the NACA 63-015A airfoil.

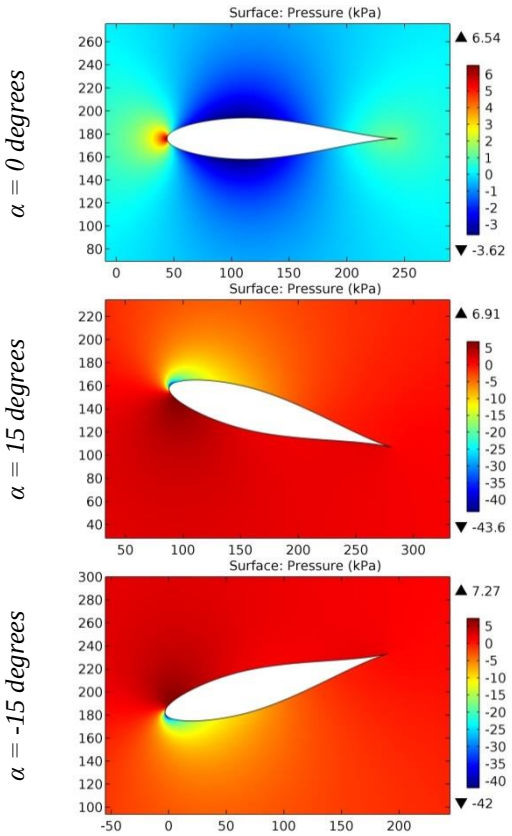


Figure 128. The pressure contours on the surfaces of the NACA 63-018 airfoil.

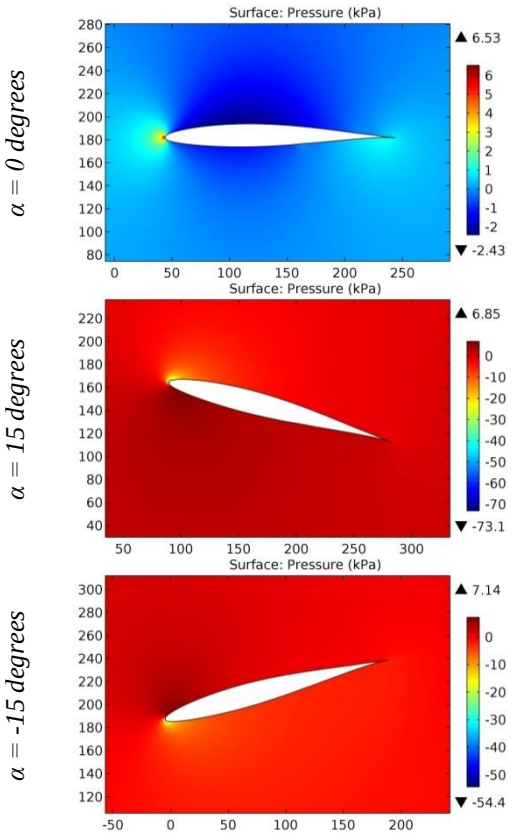


Figure 129. The pressure contours on the surfaces of the NACA 63-210 airfoil.

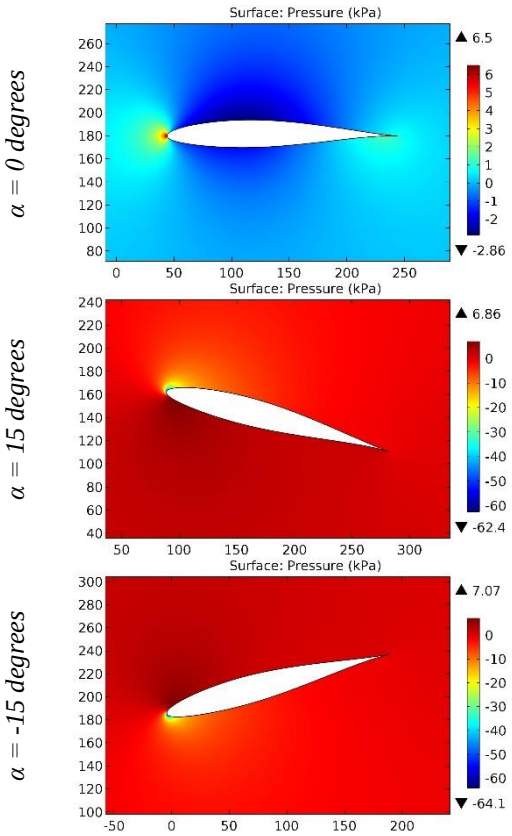


Figure 130. The pressure contours on the surfaces of the NACA 63-212 airfoil.

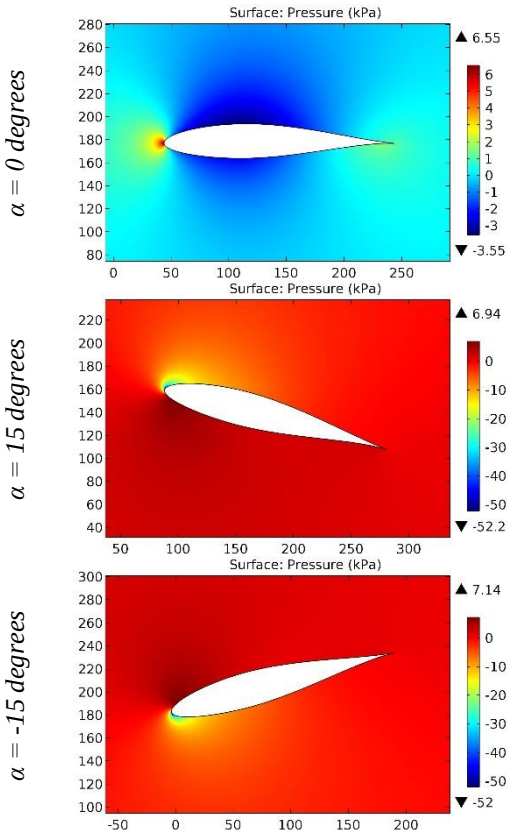
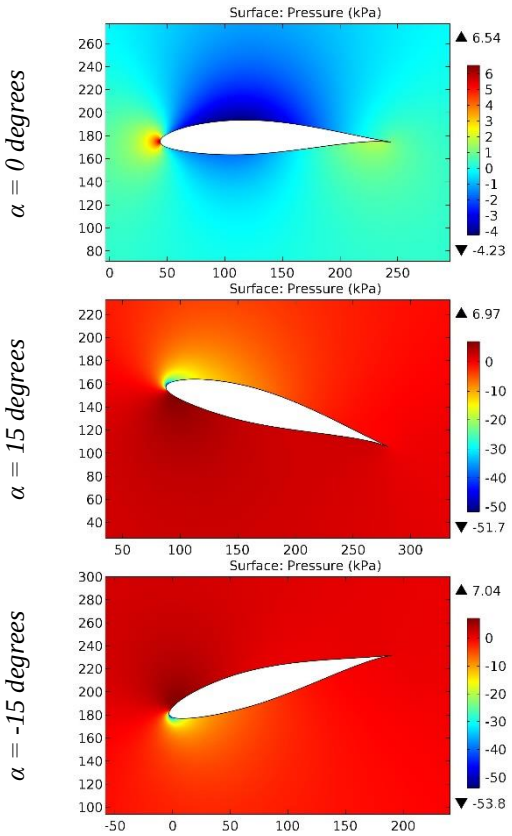


Figure 131. The pressure contours on the surfaces of the NACA 63-215 airfoil.



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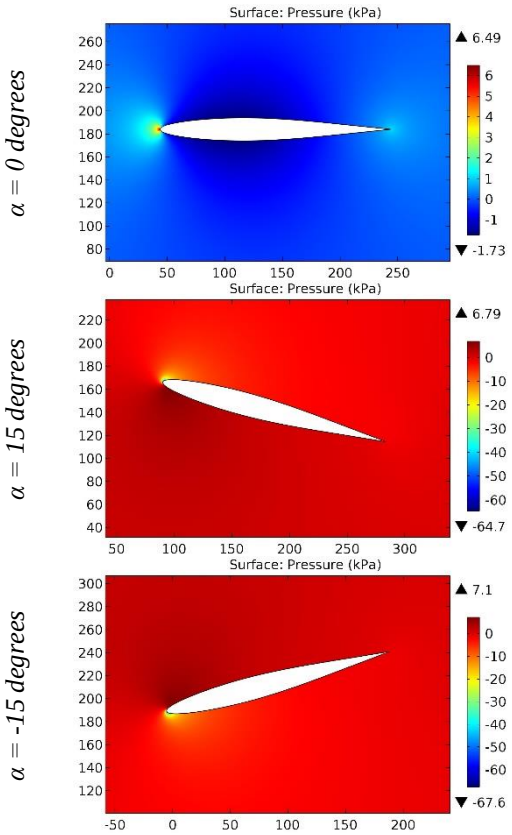

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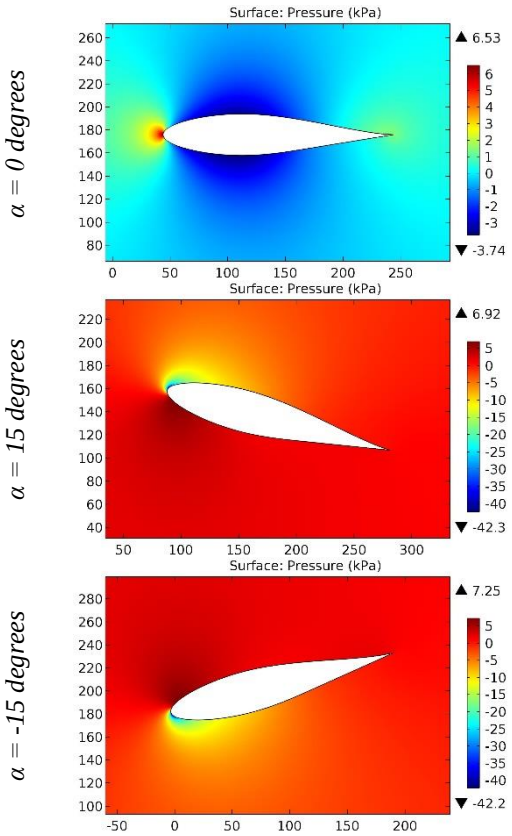

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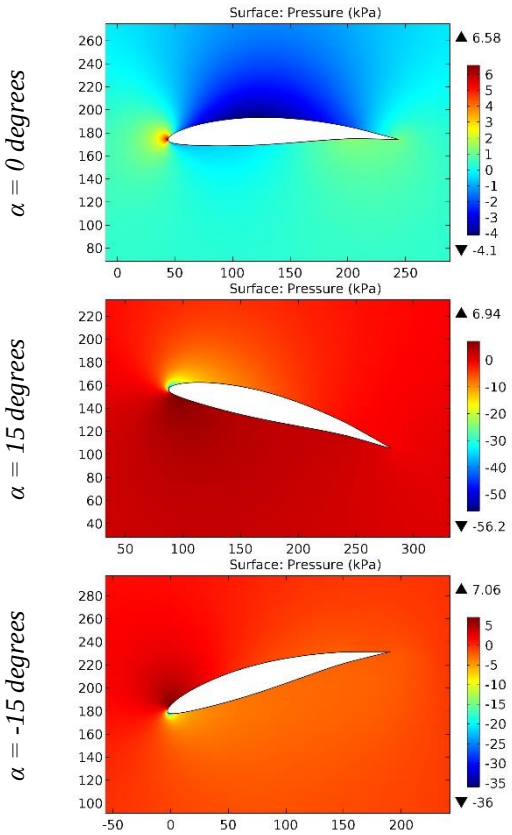

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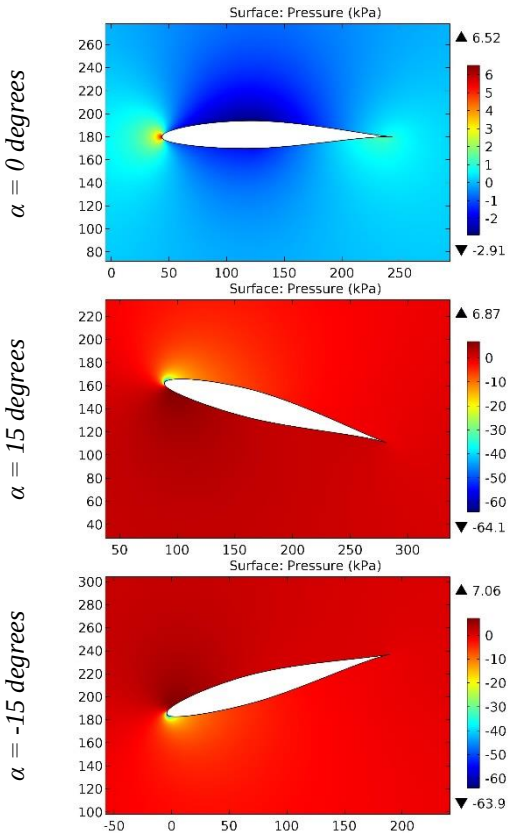

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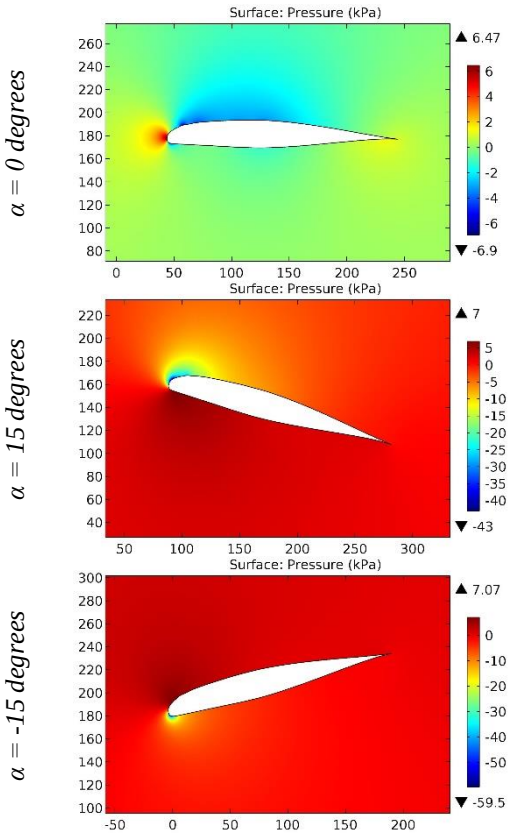

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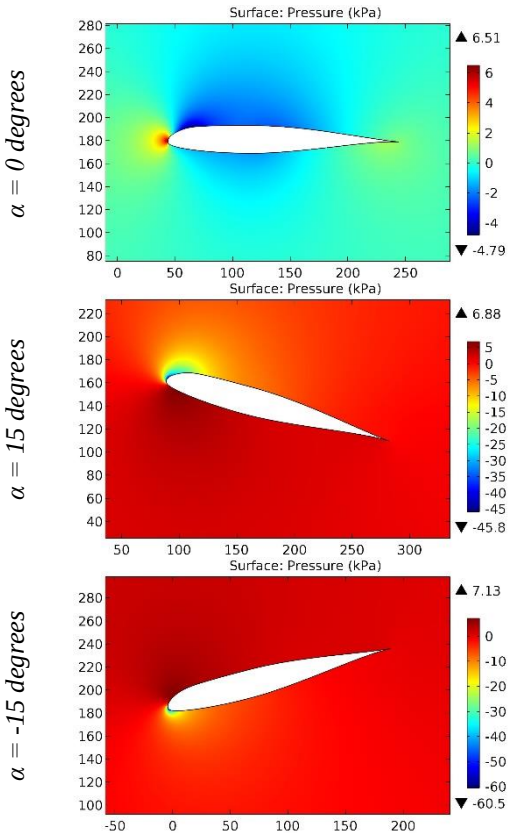

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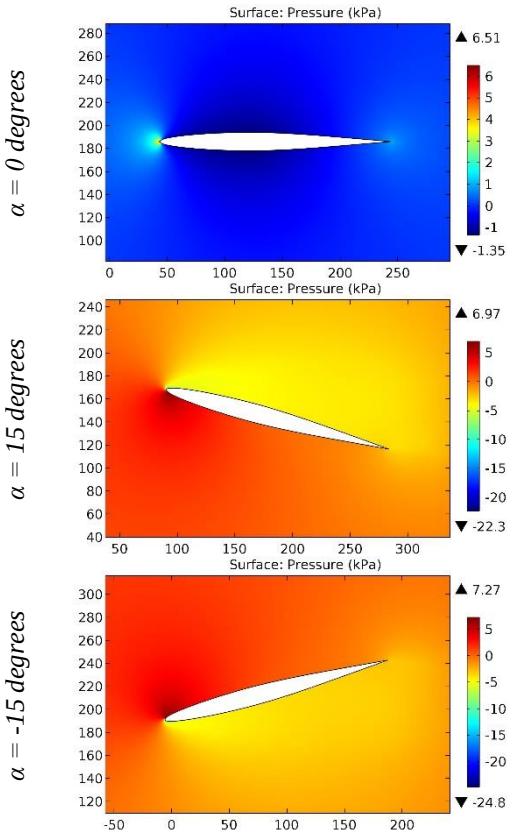

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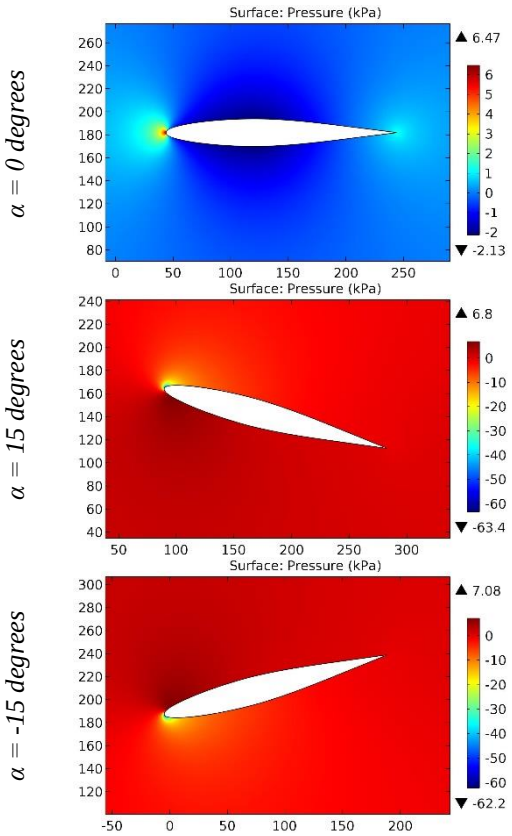

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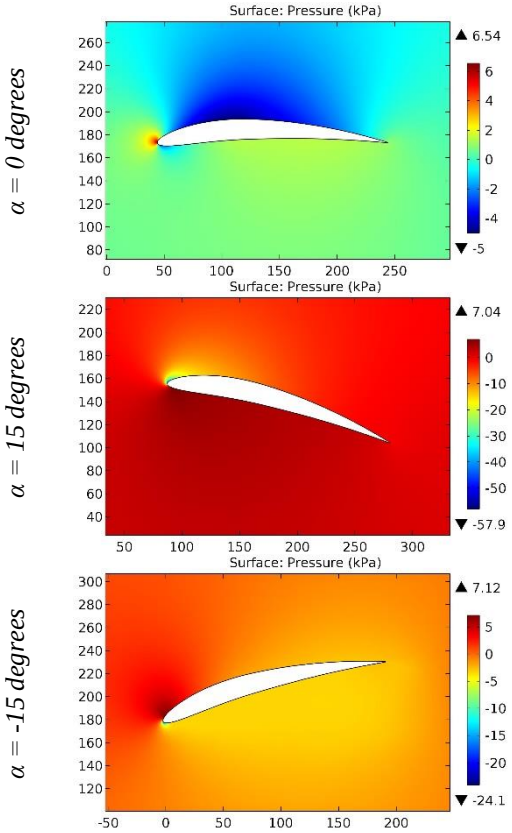

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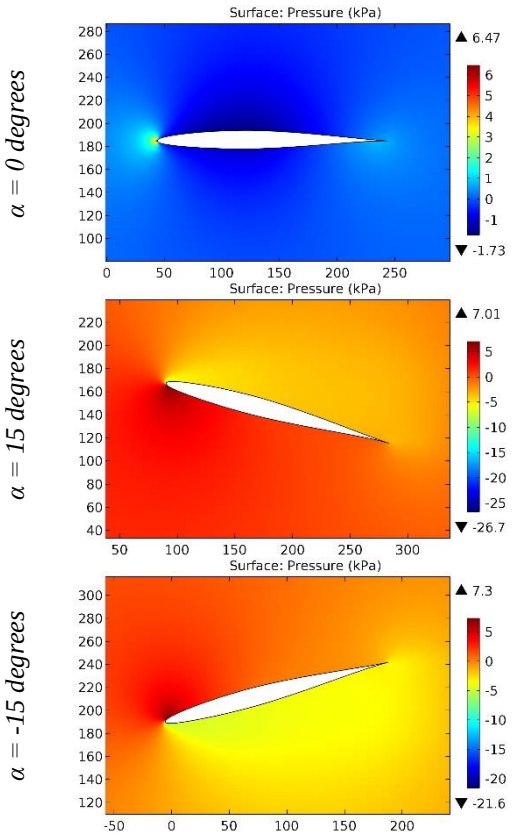

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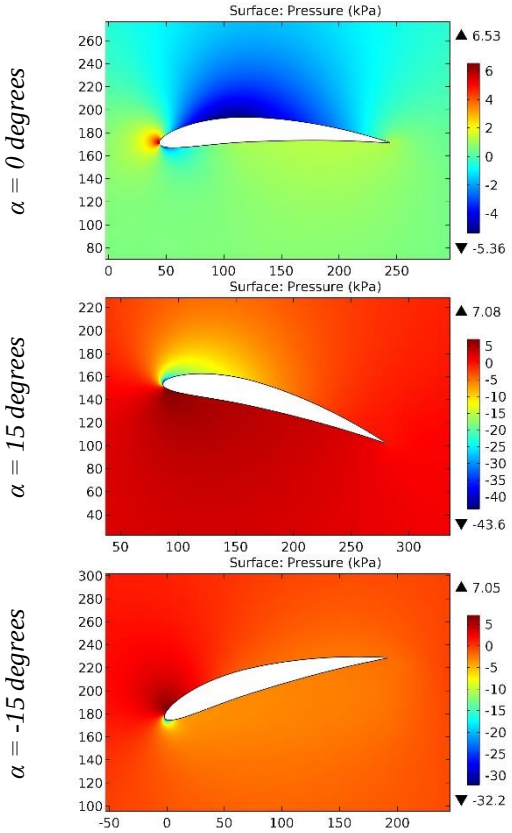

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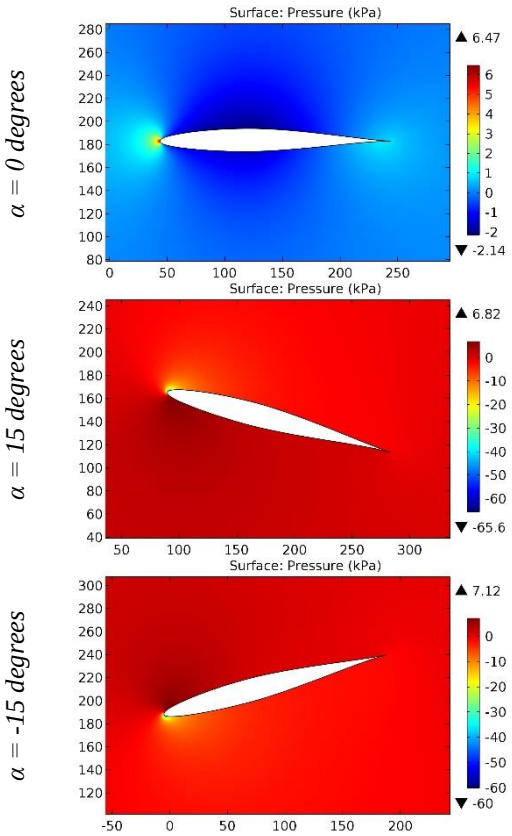

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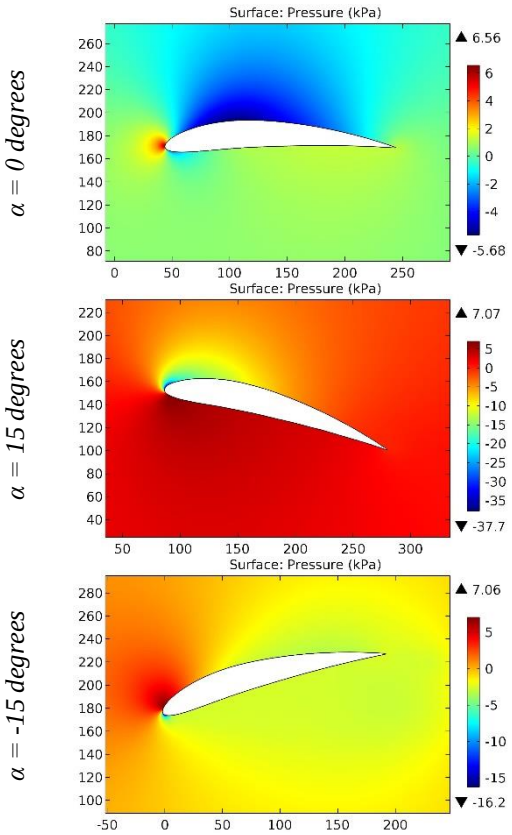

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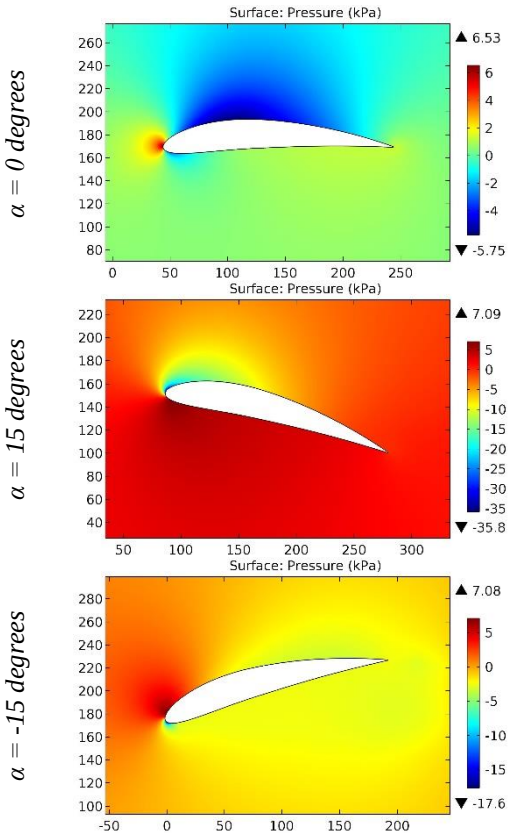

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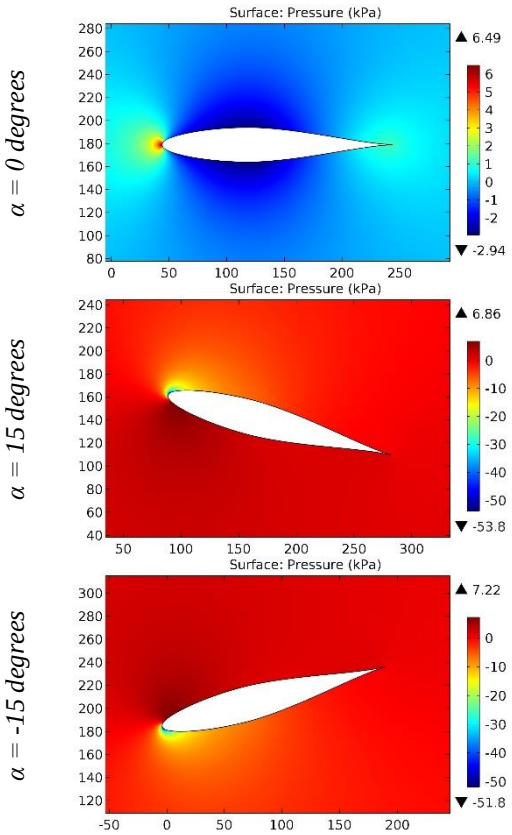

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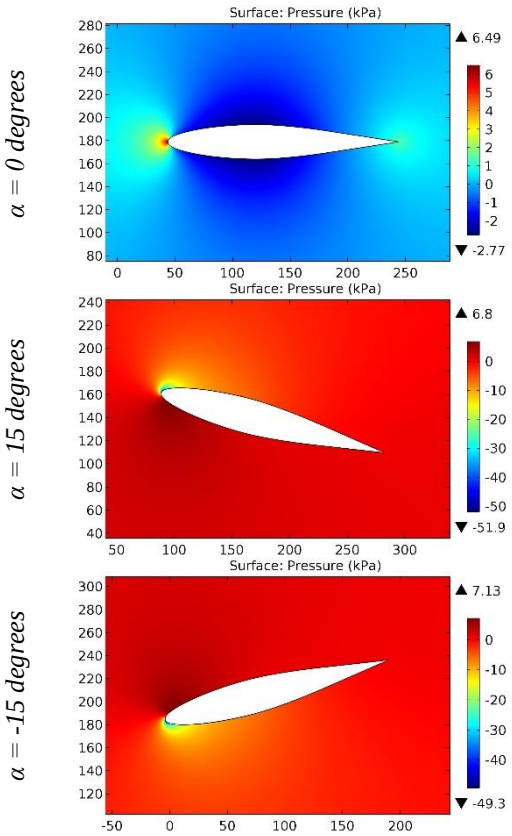

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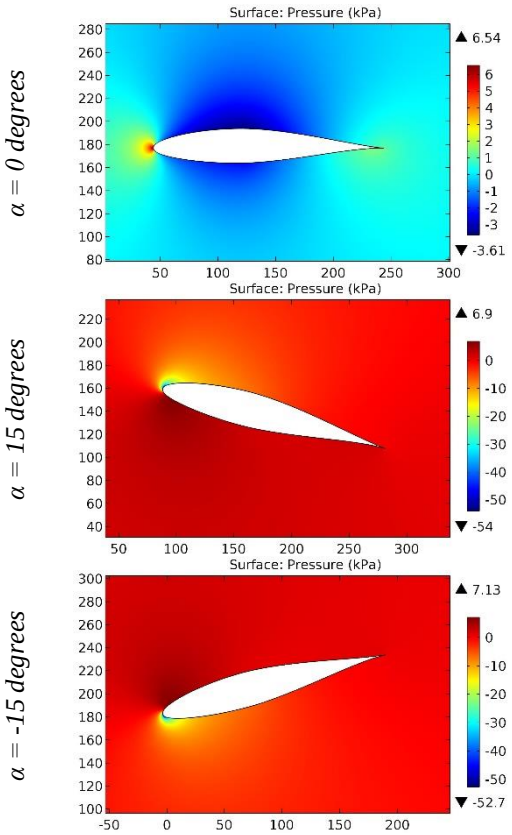

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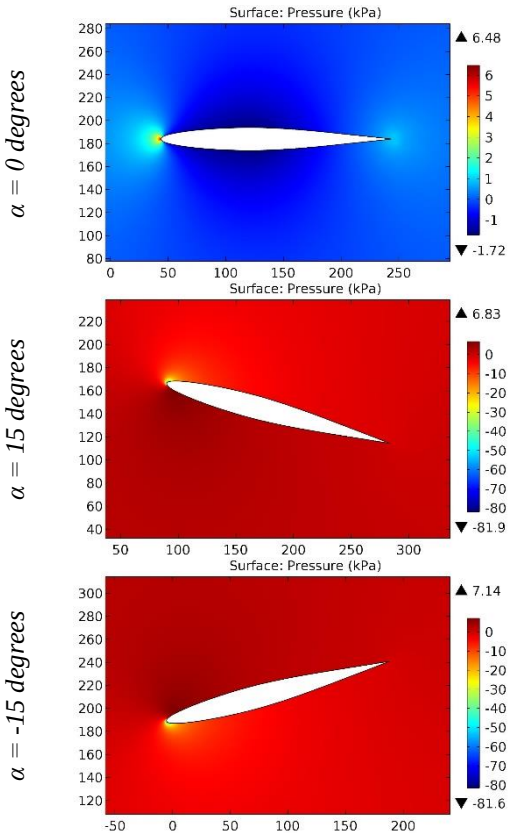

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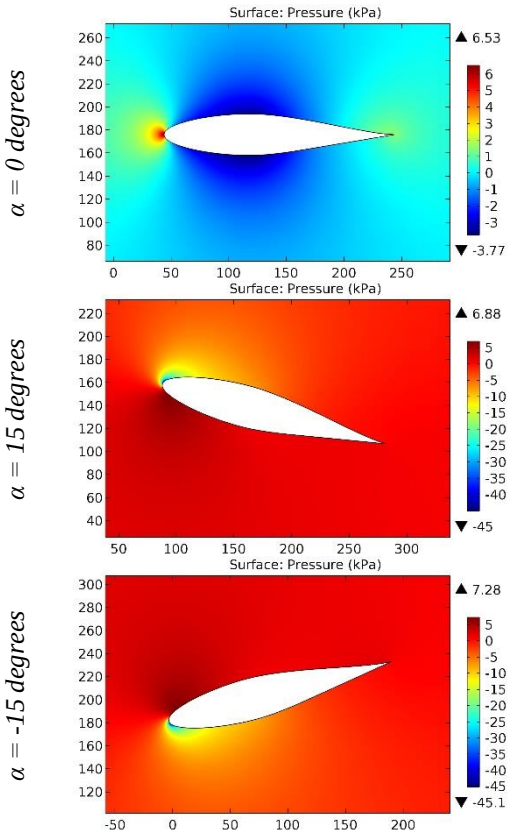

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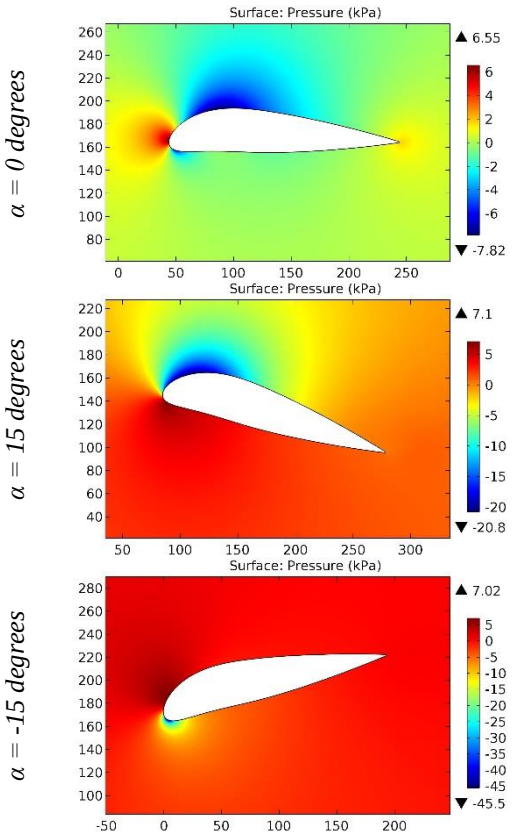

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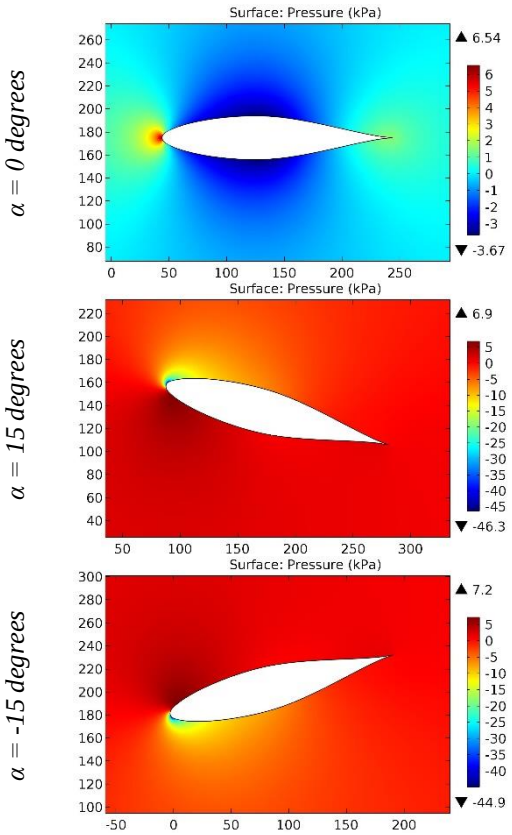

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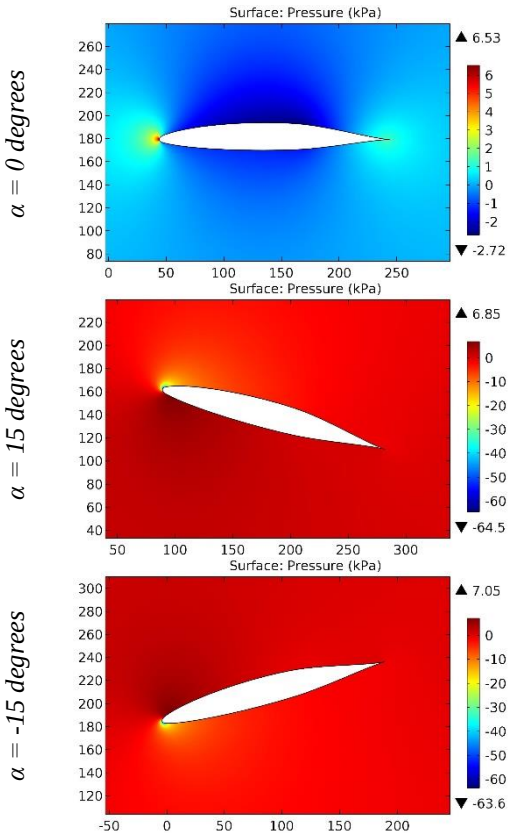

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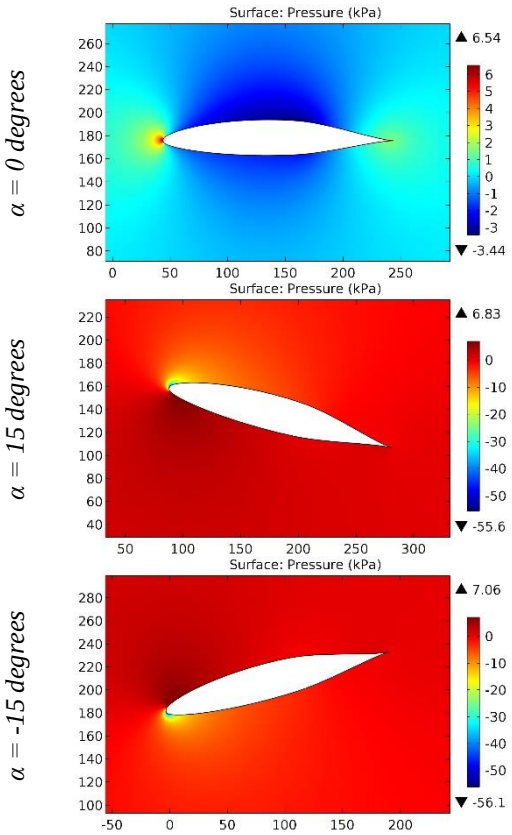

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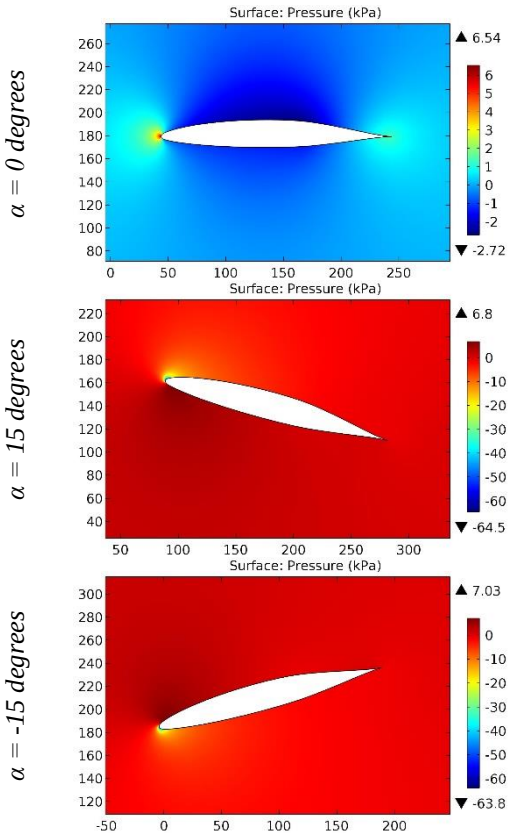

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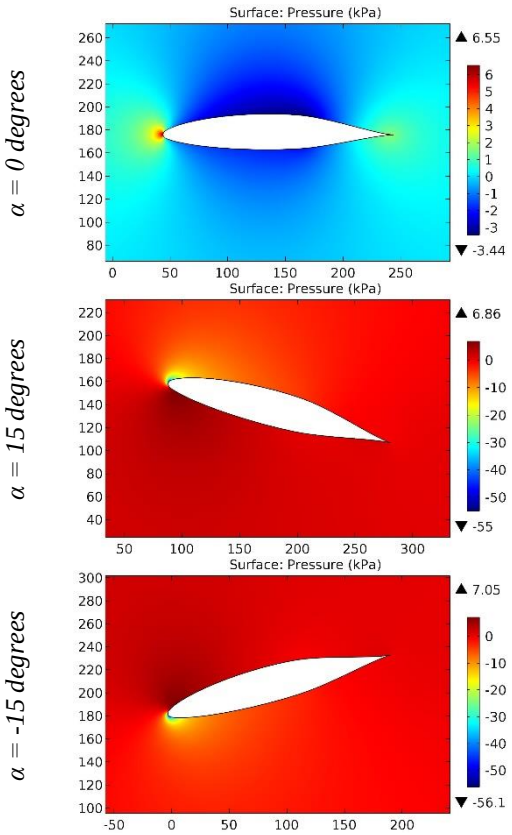

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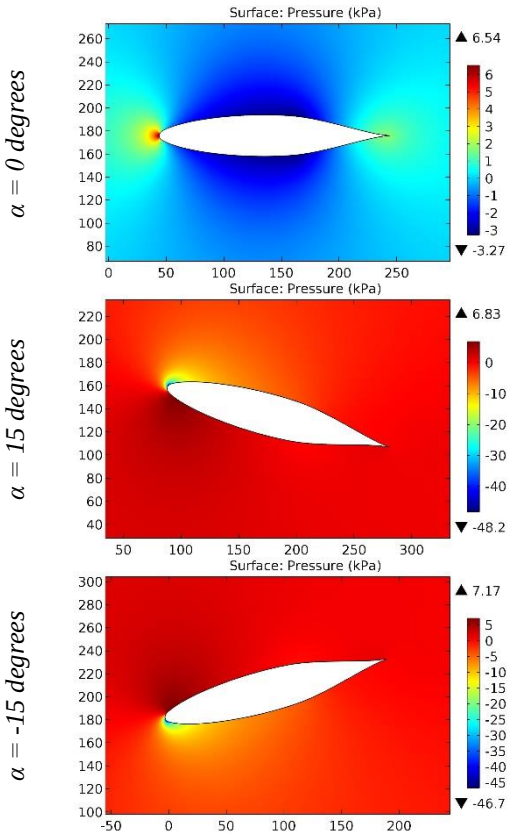

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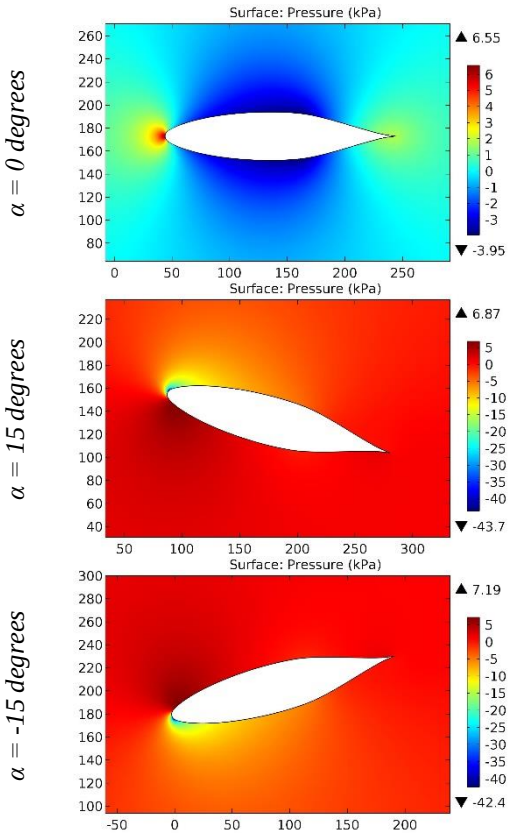

Figure 159. The pressure contours on the surfaces of the NACA 66-021 airfoil.

Conclusion

The optimal configuration of the airfoil is selected based on the best calculated aerodynamic characteristics of the wing, in particular the size of the leading and trailing edges and the ratio of pressures on the upper and lower surfaces. The maximum thickening of the airfoil at a distance up to the middle of the chord length ensures a reduction in drag on the leading edge during the airplane maneuvers. It is also illustratively proved that airfoils with the large camber have the large lifting force, expressed by the small value of the ratio of negative/positive pressures on the airfoil surfaces.

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