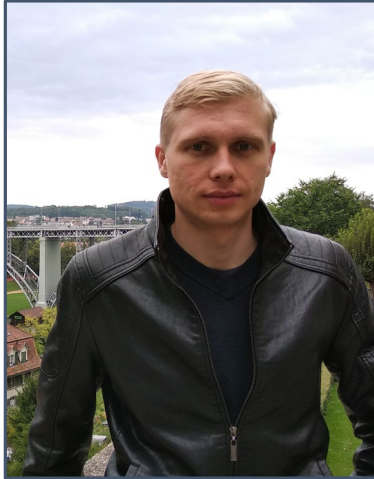


Usage of 3D Modeling in Engineering Education on the Example of the Noise Silencers Development



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Using 3D modeling technologies in education the following opportunities appear:

- visualization of parts and assemblies in space;
- holistic analysis of problems from related fields in relation the same product;
- development and analysis of complex structures;
- development of abstract and logical thinking of the student.

Usage of 3D Modeling in Engineering Education on the Example of the Noise Silencers Development

Here on the example of designs of noise silencers for the power equipment considered the solution of the following tasks:

- development of plate silencer from part design to complex assembly;
- modeling and aerodynamic optimization of plate silencer;
- simulation of temperature conditions of silencer materials;
- modeling of strains and determination of strength characteristics of the structure.

Model of silencers development

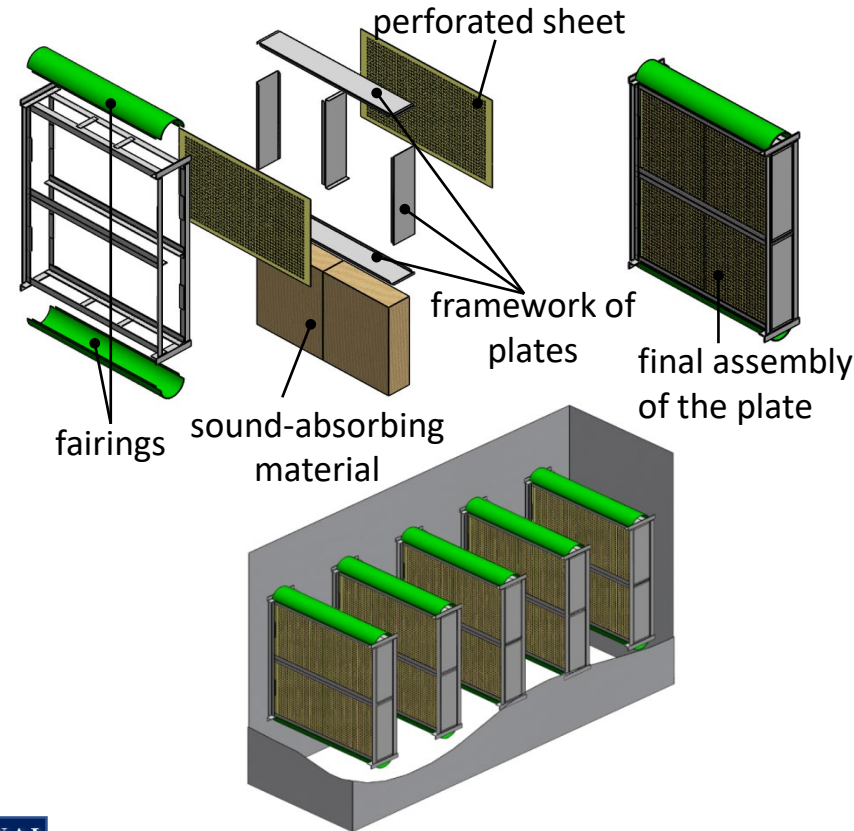
Shown an example of a plate dissipative silencer installed in the gas path of the boiler unit behind the exhaust fan. The solution of the problem allows the student:

- to learn the basics of the process of creating computer 3D models using previously acquired knowledge and determine the mass characteristics of the model;
- to solve design problems by changing and scaling the design of the prototype;
- to make the choice of plate dissipative silencer's steel to avoid corrosion.

Model of silencers development

First of all, a framework of plates from standard profiles with cells for the placement of silencer cassettes is developed. Subsequently, developing the design of the cassette.

In this example, the cassette filled with sound-absorbing material that protected from blowing out with fiberglass and perforated steel sheets on the sides. The cassette also has its own frame, which is made of sheet metal. In order to reduce aerodynamic resistance, installed input and output fairings on the plate frame.



Aerodynamics studding of the silencer

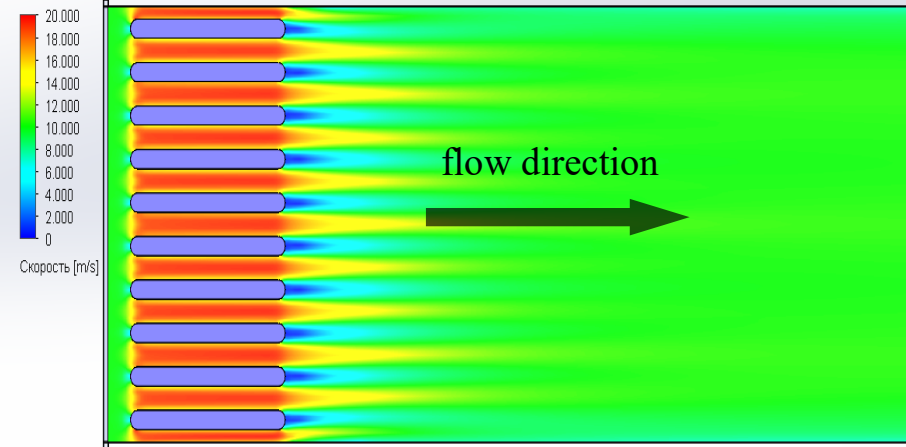
The student, depending on this topic of work, may modeling the gas flow at the place of the noise silencer installation.

The solution of this task allows the student:

- to determine the aerodynamic drag of the silencer;
- to optimize design of the dissipative silencer in order to reduce aerodynamic drag.

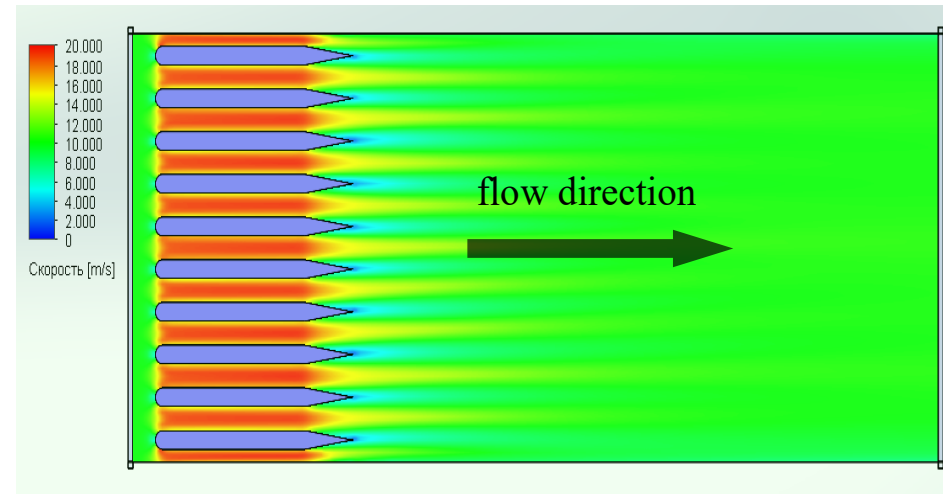
Aerodynamics studding of the silencer

To solve first problem, just developed model of a plate of silencer with cylindrical fairings is used. Mathematical modeling of the gas flow carried out in order to determine the aerodynamic drag. Mathematical modeling of aerodynamics carried out using finite element analysis, in which the computational domain divided into separate elements, and a system of Navier-Stokes differential equations is solving for them by reduction to a system of linear algebraic equations. In this example, the calculated aerodynamic resistance of the silencers is 61 Pa.



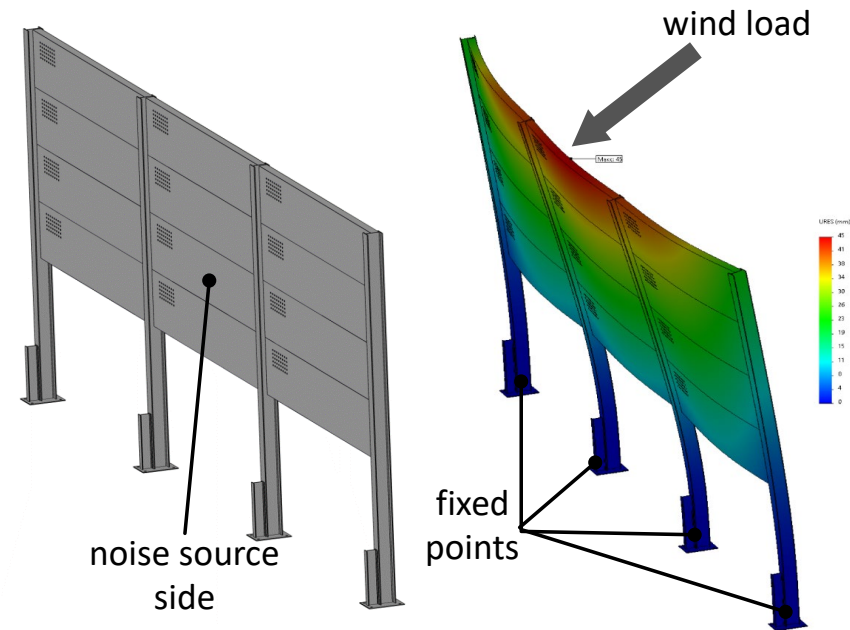
Aerodynamics studding of the silencer

Optimization of the design of the silencer shown on the example of the study of possible forms of plates to reduce aerodynamic resistance. This task involves the research potential of the student. In order to reduce the aerodynamic drag of the silencer, it is proposed to install a wedge-shaped outlet fairings, which reduces the aerodynamic resistance of the silencer. The simulation results show that the modernization of the design of the plate silencer allows achieving a decrease in aerodynamic resistance by 16.4% from 61 to 51 Pa.



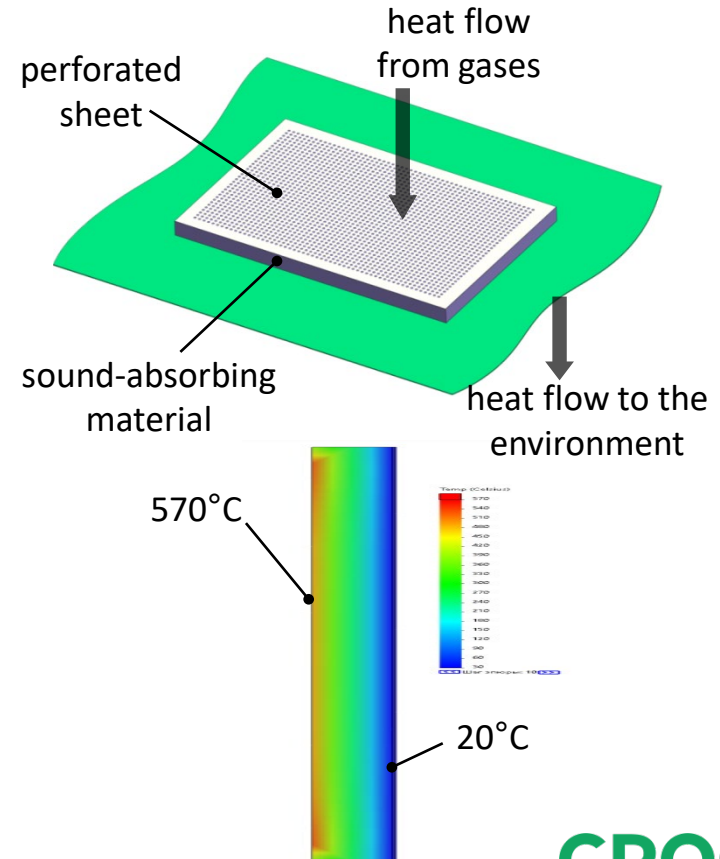
Strength calculation of silencers elements

In this case, the calculated standard wind load determined for Moscow region. Its value is 441 Pa. As initial data specified forces acting on the barrier and the fixed points. Materials assigned to all elements of the calculation model. According to the calculation results, it is possible to construct diagrams of the margin of safety, stresses, displacements, relative deformation, and fatigue characteristics of the material. The maximum value of the equivalent strain was 103 MPa, and the maximum value of the displacement of the upper edge of the barrier according to the simulation results was 40 mm.



The temperature conditions calculation

The initial data are the temperature of the flue gases, the initial temperature of all elements (30°C) and the coefficient of heat transfer to the environment (25 W/m²K). In solving the problem, a transition process is simulated. Figure shows the initial model and the temperature change in the structural elements after a time interval of 10,000 s. The time interval selected based on the conditions for achieving a stationary state of the system at which the temperature of the elements stops to change. The results obtained allow to conclude that it is necessary to use high alloy steel for the manufacture of perforated sheets and fasteners.

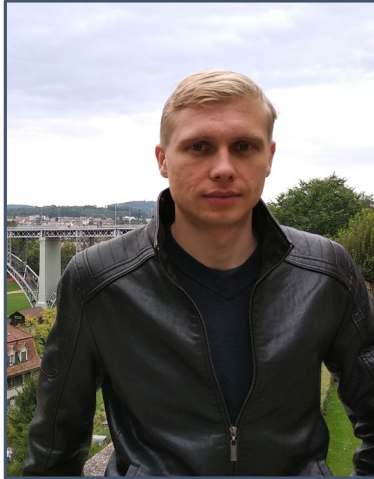


Conclusion

- Substantiated the expediency of using 3D modeling technologies in the educational process;
- Shown the possibility of a complex solution to problems in specialized programs from various fields of engineering knowledge. Information technology for modeling forms a student's systematic understanding of the tasks and problems of research;
- Shown the possibility of transforming an educational study task into a scientific one using 3D modeling technologies.

Thank you for attention!

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