

THE AIR FLOW COMPUTER SIMULATION INSIDE THE COMPUTER SYSTEM UNIT

Introduction. With the development of information technology, software requires more computer performance. Along with the performance of computers, the heat dissipation of its components is also growing, which forces the development of more and more advanced and advanced cooling systems.

Back in 1999, the heat dissipation of processors did not exceed 44 watts, whereas in 2022 there are models with a TDP of 105 and even 170 watts. The thermal design power (TDP), is the maximum amount of heat generated by a computer chip or component (often a CPU, GPU or system on a chip) that the cooling system in a computer is designed to dissipate under any workload [1].

There are a huge number of ways to reduce the heat output of the processor. Here are some of them:

- increased airflow;
- competent layout of the space in the system unit;
- using thermal paste;
- lowering the voltage on the processor.

For optimal placement of components in the computer case and for choosing a cooler, it is better to use computer simulation. The simulation will allow observing visually where the airflows are directed, determine the temperature of each of the components and generally check the efficiency of the cooling system without the need for real measurements.

The airflow simulation in this study was performed using SOLIDWORKS Flow Simulation. SOLIDWORKS Flow Simulation is a convenient solution for computational fluid dynamics (CFD), built into SOLIDWORKS 3D CAD and allows you to simulate fluid and gas flows to calculate the performance characteristics and capabilities of the product [2].

Main part. Before starting air flow modeling, it is necessary to prepare models of computer components and assemble them into a single assembly. Our assembly is represented by a motherboard, two RAM plates, an m.2 SSD drive, a processor with a cooler and one fan on the back wall of the case (Figure 1).

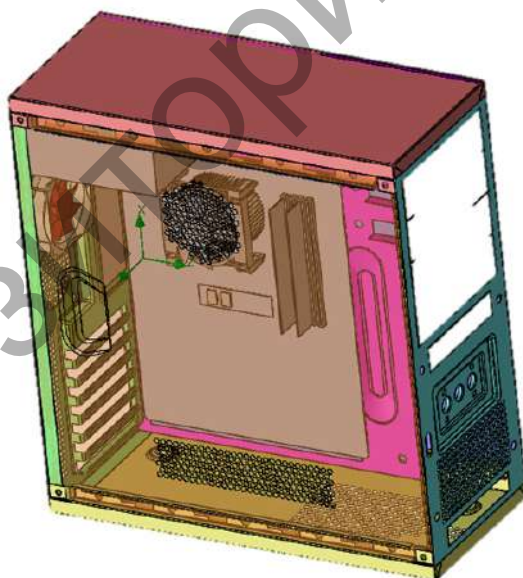


Figure 1 — Assembled system unit

When creating the Flow Simulation project, the External analysis type was selected, “Heat conduction in solids”, “Time-dependent” and “Rotation” (Sliding) were included from the physical models. Air is used as a fluid medium. The initial temperature is 38°C.

Let us begin with setting up the simulation. To facilitate calculations, we reduce the size of the calculated area to the size of the computer case. Next, it is necessary to adjust the rotation areas. The area of rotation is a model commensurate with the fan. It can be created using the tool “Rotated boss” (Figure 2).

We place the rotation areas in place of the fans and add them to the Flow Simulation (Figure 3). Models of rotation regions will not participate in the simulation, since they are not objects.

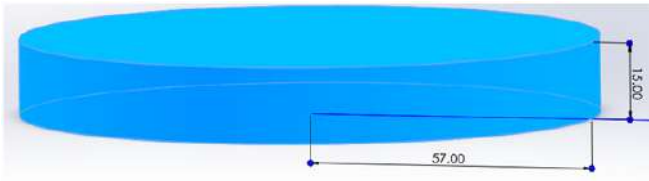


Figure 2 — Model of the rotation area

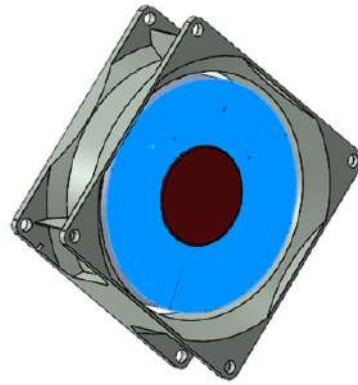


Figure 3 — Placed rotation area

Now we need to choose solid materials. We have the radiator of the CPU cooler made of aluminum, its sleeve and the heat distribution cover of the processor, which are made of copper. The chips of the processor, RAM and SSD drive are silicon.

The creation of areas that emit heat is carried out by the command “Conditions” — “Volume Source”. In our case, the CPU chip emits 65 watts of heat, RAM chips — 1.5 watts each, SSD drive chips — 20 watts each and power supply components — 30 watts.

As global targets, it is necessary to choose the average fluid temperature and the average velocity.

The setup is complete, we run the simulation. After the processing is completed, one can look at the flow trajectory and its temperature (Figure 4). We can notice that cold air enters the housing from below, and the heated air is blown out by the housing fan and the power supply.

Adding surface areas. The temperature of the hottest section is 47.6°C (Figure 5).

The picture in the cross section shows the temperature of the fluid and its directions. It looks like this (Figure 6).

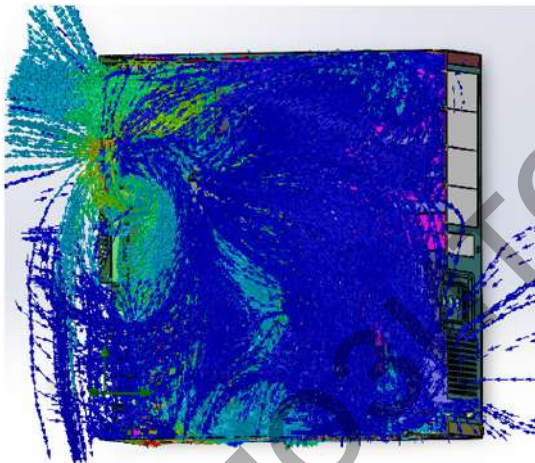


Figure 4 — Flow trajectories

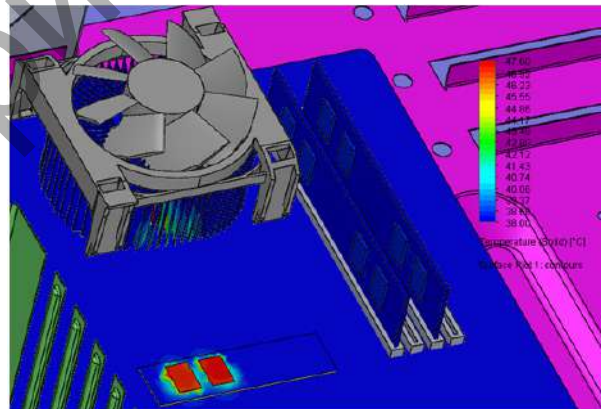


Figure 5 — Surface areas

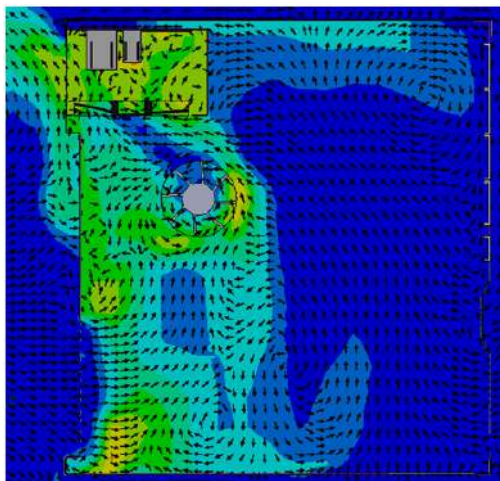


Figure 6 — Picture in cross section

None of the computer components has reached a critical temperature, then it can be concluded that the selected cooling system is suitable for this configuration.

Conclusion. Because of the research, the following conclusion was made: modeling of airflows inside the computer system unit allows placing components optimally without making real measurements.

The simulation of airflows in the computer system unit housing allows determining the efficiency of cooling systems. All the goals were achieved; the tasks of the work were completed.

References

- 1 Thermal design power — WordDisk [Electronic resource]. — Mode of access: https://worddisk.com/wiki/Configurable_TDP . — Date of access: 28.02.2022.01.04.2022.
- 2 SOLIDWORKS Flow Simulation. [Electronic resource]. — Mode of access: <https://www.solidworks.com/ru/product/solidworks-flow-simulation> . — Date of access:01.04.2022.

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DEVELOPING A BUSINESS PERFORMANCE EVALUATION APPLICATION

Introduction. Business is an activity that is aimed at making a regular profit. In modern conditions of a market economy, it is one of the main occupations. It also ensures the economic and social development of society. Such activity covers different areas - commercial, production, consulting [1].

Evaluation of the enterprise effectiveness due to its complexity involves the use of private and generalizing indicators.

According to individual indicators, it is possible to determine:

- application efficiency of each of the company's resources;
- the sales results of each type of the company's products/services.

According to generalized indicators, we determine:

- the enterprise efficiency of all resources, products/services;
- the whole company performance.

The efficiency of a company is evaluated in several stages.

First we calculate and evaluate the overall profitability indicators, which reflect the effectiveness of the company production activities:

- 1) profitability of business — to inform about the share of net profit in sales revenue;
- 2) return on sales — to give an idea of the share of profit from sales in sales revenue;
- 3) profitability of products sold — to show the efficiency of product sales.

Then we calculate and evaluate the general indicators of profitability, reflecting the efficiency of the use of enterprise resources:

- 1) return on current assets — reflects the efficiency of the use of working capital organization;
- 2) profitability of non-current assets — reflects the efficiency of use of non-current assets of the enterprise;
- 3) return on equity — reflects the efficiency of the use of net worth by the organization;
- 4) return on invested capital — characterizes the return on the amount of monetary funds invested in the business;
- 5) return on borrowed capital — characterizes efficiency of the use of borrowed capital by the organization [2].

Main part. In this work, the main task was to develop a software product that provides an assessment of business performance and analysis of the results.

The integrated development environment Visual Studio 2019 was chosen to develop the software product. The high-level programming language C# was used to write the application code.

The principle of the application is quite simple: the user needs to fill in the initial parameters for further calculation of business performance indicators, and then click on the “Calculate” button. An example of business efficiency evaluation is shown in Figure 1.

In order to find out how exactly the economic indicators were calculated, you must click on the button “Show formulas”, after which the window shown in Figure 2 will appear.

The developed application also supports the Russian language. In order to change the application language, it is necessary to perform the following actions: click on “File—Language” and select the Russian language. The method of changing the application language is shown in Figure 3.