UDC 621

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# MODELING THE MOVEMENT OF AIR INSIDE THE COMPUTER

*Подаючи проблему на розгляд круговороту повітря усередині комп'ютера і зберігання стійкого, низькотемпературного від роботи. Опис охолоджування прикладних методів і круговороту повітря для комп'ютерів з великими обчислювальними державами і високими графічними здібностями. Зразкове уявлення з результатами аналізу.*

*Подавая проблему на рассмотрение круговорота воздуха внутри компьютера и хранения устойчивого, низкотемпературного от работы. Описание охлаждения прикладных методов и круговорота воздуха для компьютеров с великими вычислительными державами и высокими графическими способностями. Образцовое представление с результатами анализа.*

*Presenting the problem to the circulation of air inside the computer and of keeping the stable, low temperature of the work. Describing cooling applied methods and the circulation of air for computers with the great computing powers and high graphical abilities. Model presentation with results of analysis.*

## 1 Introduction

The times when aluminum radiators were efficient enough to take outlet warm from computer chips are far away from nowadays. The reason of this state is increasing power voltage for processors and constant rising amount transistors in CPU structures. To solve problems with computer components high temperatures cooling sets were design.

Thanks to CAD 3D and CFD systems it is possible to execute analysis and optymalize air flow through working computer.

## 2 Description of the problem

### 2.1 Cooling methods

Trying to solve the problem with keeping stable low temperatures during working individual components two cooling methods were created:

- **passive cooling** – the least efficient cooling method, using at the beginning of computers
- **active cooling** – use fan based onto radiator. This solution let faster change warm air to cool air what improve cooling efficient.

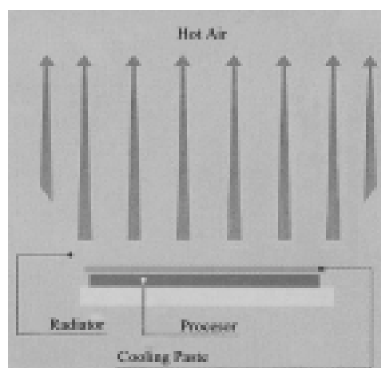


**Fig. 1. Passive cooling**

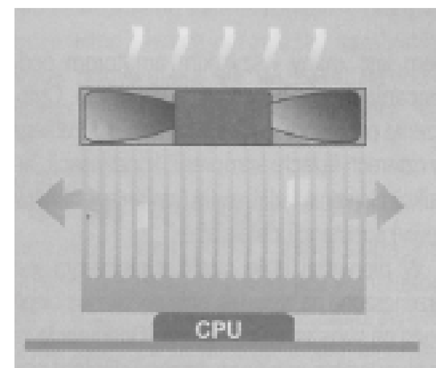


**Fig. 2. Active Cooling**

### 2.2 Cooling set

In next step of evolution appear cooling devices that became create cooling sets. Nowadays there are three kinds of those sets adapted for individual cooling medium:

- **air cooling set**
- **water cooling set**
- **cooling set use change state of aggregation effect –** They have very good efficient. They are use to cool extremely loaded processors. Idea of work for these devices is similar to fridge. Cooling execute at four steps: compression, condensation, pressure reduction and oxidation cooling medium. At first step heat from processor is carry through heat conductivity to cooling medium. For this step is responsible evaporator inside that heated up medium change state of aggregation. Next cooling medium in gas state is carry from evaporator to compressor that increase gas pressure to condensation pressure value in order to change state of aggregation from gas state to fluid state (cooling process).

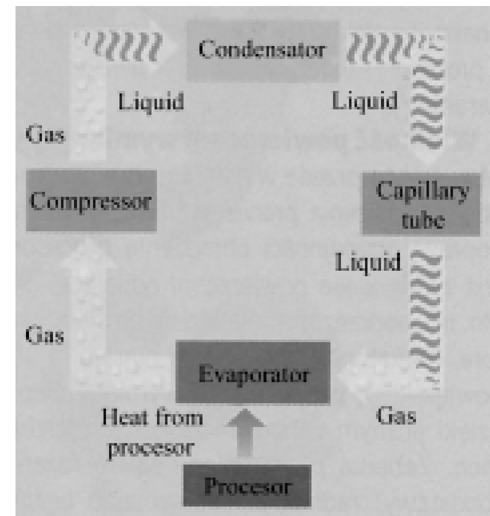


**Fig. 3. Cooling set use change state of aggregation effect**

### 2.3 Circulation of air for computers

Typical air changing inside computer cover is realize using three fans based on extreme walls. One of them is responsible for suction cool air from environment. The other are responsible for through out heat air.

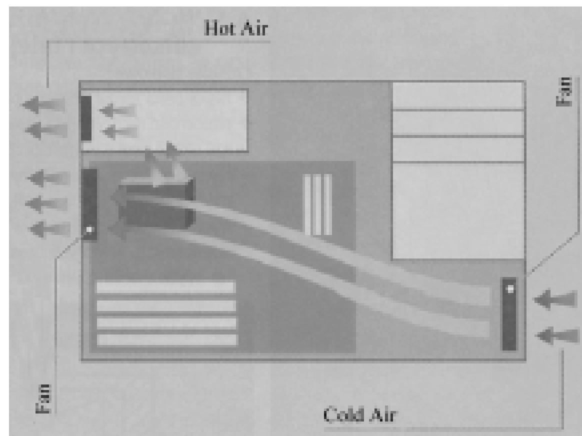


**Fig. 4. Circulation of air for computers**

## 3. Description the platform COSMOS FloWorks

COSMOSFloWorks is CFD (Computation Fluid Dynamics) application integrated with SolidWorks platform. It is a tool for preparing and executing liquid and gas flow and thermal analysis.

COSMOSFloWorks base on Navier-Stokes equations (1). For discretization application use Finite Volume Method.

$$\frac{D\vec{\upsilon}}{Dt} = \vec{b} - \frac{1}{\rho}\vec{\nabla}p + \nu \cdot (\nabla^2 \vec{\upsilon} + \frac{1}{3}\vec{\nabla}(\vec{\nabla} \cdot \vec{\upsilon})) \tag{1}$$

where D/Dt – Stokes operator,

v- velocity,

b- mass force (exp. gravitation),

ρ – fluid density,

p- pressure,

υ- kinematic fluid viscosity

## 4. Model and results of analysis for the flow and the temperature presentation

### 4.1 Model presentation

Model created at SolidWorks is simplified example of vertical PC station. Model consist of basic components that have influent on temperature of flowing air. For simulation two types of cooling were defined: active cooling (processor) and passive cooling (chipset).

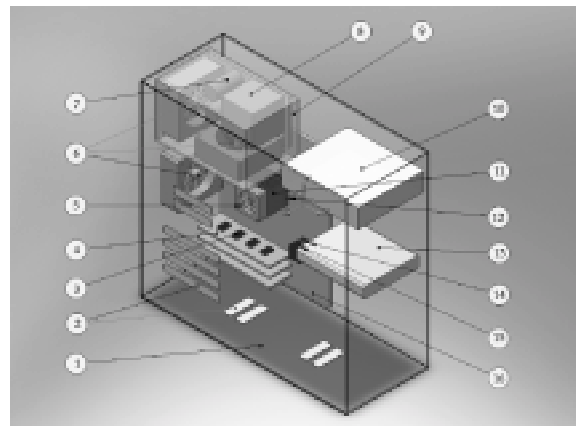

**Fig. 4. Model:**
**1.Casing 2.Intake air holes 3.Chips 4.Adapter card 5.Fan 1 6.Fan 2**

**7.Capacitros 8.Transformer 9.Power supply adapter casing 10.CD-ROM 11.Radiator 1 12.Processor 13.HDD 14.Chipset 15.Radiator 2 16.Motherboard**

### 4.2 Results of analysis for the flow and the temperature

As results of simulation following values of expected parameters were calculated:

Table 1

| Goal Name | Unit | Averaged Value | Minimum Value | Maximum Value |
|---|---|---|---|---|
| GG Av Static Pressure | [Pa] | 101325 | 101323 | 101326 |
| SG Outlet Av Static Pressure | [Pa] | 101320 | 101305 | 101334 |
| SG Intlet Av Static Pressure | [Pa] | 101330 | 101325 | 101333 |
| GG Av Temperature of Fluid | [K] | 317,7 | 316,9 | 318,4 |
| SG Inlet Mass Flow Rate | [kg/s] | 0,01456 | -0,0009 | 0,0317 |
| VG Chip Max Temperature | [K] | 794,1 | 790,1 | 796,8 |
| VG Processor Max Temperature | [K] | 341,2 | 337,6 | 344,8 |
| VG Small Chip Max Temperature | [K] | 333,4 | 333,1 | 333,8 |

Chipset temperature T= 794,064 [K] is much more higher then for other components what shows graph (Fig.5)

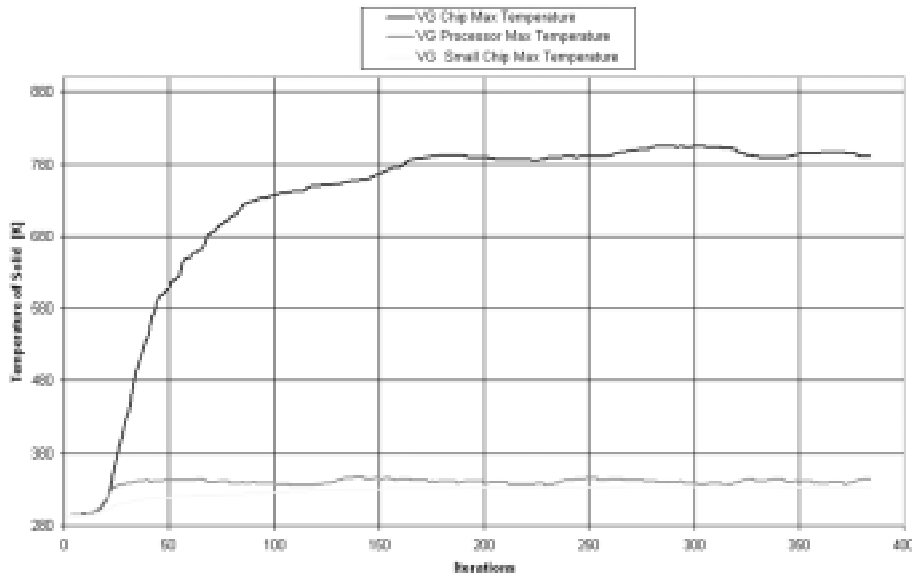


**Fig. 5. Temperature of solid**

## 5. Improvement the model and comparing results.

### 5.1 Improvement the model

In next model (Model 2) was change cooling method of Chipset (active method), and amount of inlets got higher.

### 5.2 Comparing results

Table 2

**Model 1**

| Goal Name | Unit | Averaged Value | Minimum Value | Maximum Value |
|---|---|---|---|---|
| SG Inlet Mass Flow Rate | [kg/s] | 0,01456 | -0,0009 | 0,0317 |
| VG Chip Max Temperature | [K] | 794,1 | 790,1 | 796,8 |
| VG Processor Max Temperature | [K] | 341,2 | 337,6 | 344,8 |
| VG Small Chip Max Temperature | [K] | 333,4 | 333,1 | 333,8 |

Table 3

**Model 2**

| Goal Name | Unit | Averaged Value | Minimum Value | Maximum Value |
|---|---|---|---|---|
| SG Inlet Mass Flow Rate | [kg/s] | 0,0095 | -0,0034 | 0,0228 |
| VG Chip Max Temperature | [K] | 337,8 | 336,8 | 338,4 |
| VG Processor Max Temperature | [K] | 361,9 | 359,9 | 363,3 |
| VG Small Chip Max Temperature | [K] | 343,9 | 343,1 | 344,7 |

Comparing results for two models:

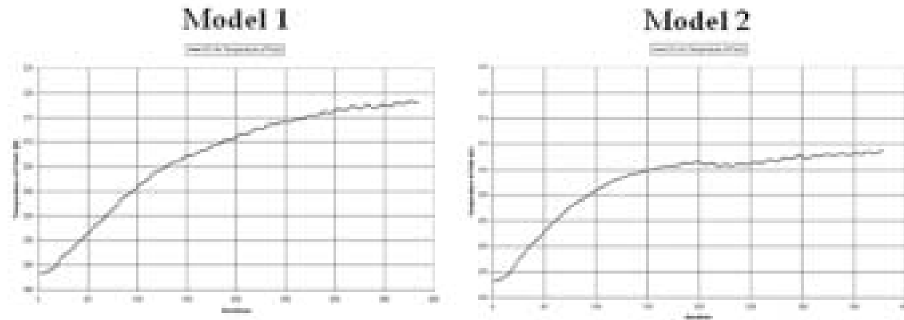


**Fig. 5. Temperature of air**

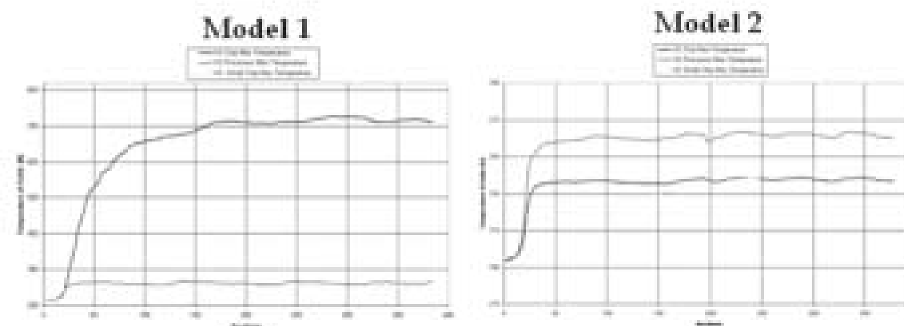


**Fig. 6. Temperature of solid**

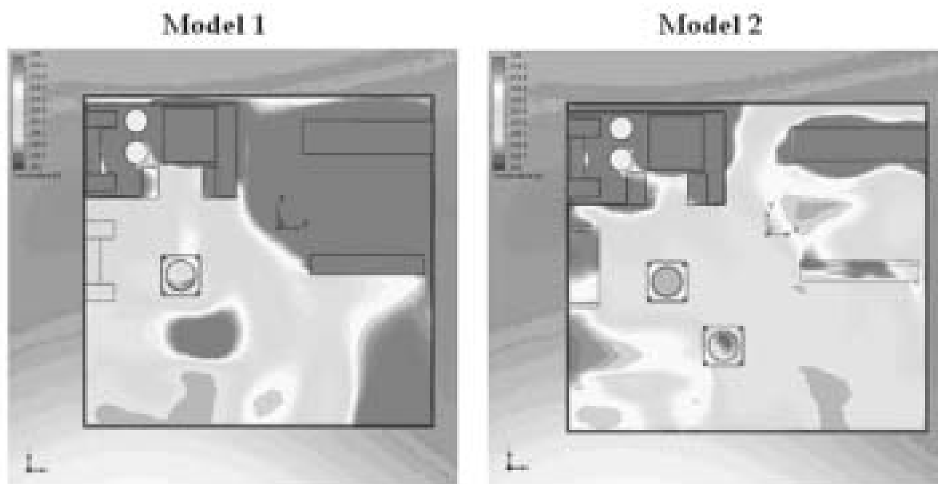


**Fig. 6. Temperature of solid**

## 6. Summary

In Model 2 using additional inlet wholes in computer cover, bigger radiator for Chipset and additional fan improve: speed of temperature stabilization, average temperature inside 10 [K] lower. Temperature of Chipset fall about 457 [K] what correspond with real values.

## Literature


1. COSMOSFloWorks Tutorial – Conjugate Heat Transfer.
2. PC World Komputer – Cooling set.



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