EXPERIMENTAL THERMAL SIMULATION OF THE HIGH AUDIO SPEAKER

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ABSTRACT:
This paper uses a thermal simulation model that can be applied to electromagnetic field and for the sound. Due to the symmetrical structure difuzorlui using AXI-symmetric pattern which significantly reduces computing time.

Key words :magnets, air gap, coil

1.INTRODUCTION

To reduce the number of elements we consider membrane for thermal analysis, a little thicker than the real one. Construction details of the frame (chassis) will also be simplified, preferably using straight line model.
Model with main geometrical parameters is shown in Figure 1, and values are given in Tab.1

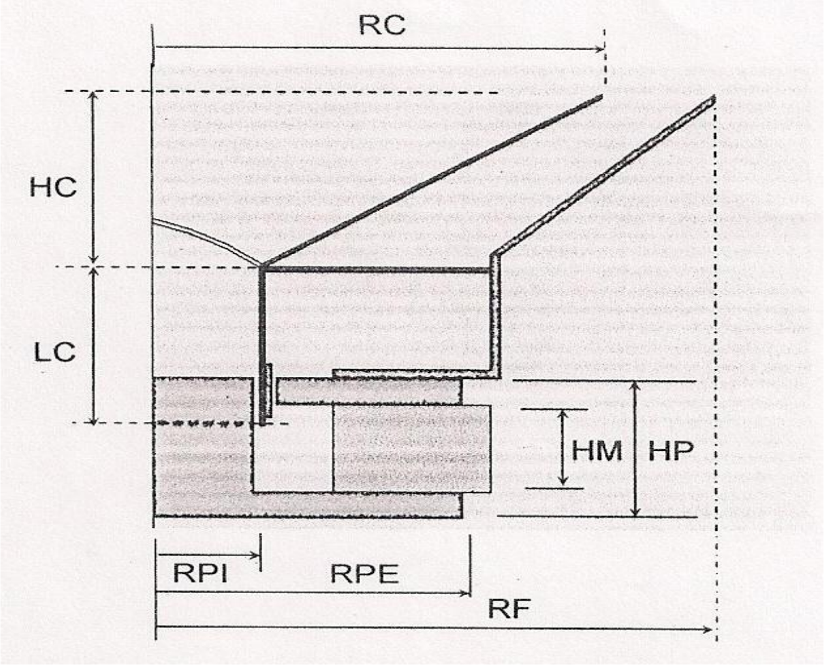

Fig1*.The speaker used in the simulation represented with the main parameters (ambient air is presented in full)*

Table 1. Geometric parameters of the model speaker

Parameters (mm)	RC	HC	RPI	RPE	HM	HP	RF
P100	40	20	9	27,5	10	16	50
P200	85	30	17	43,5	15	27	100
P300	125	50	25	60	20	32	150

In the mesh, special attention was paid to interior cavity where there is most important, namely the heat transfer coil. In the air gap were used rectangular elements. The discretized (with mesh) is shown in Figure 2 (a)

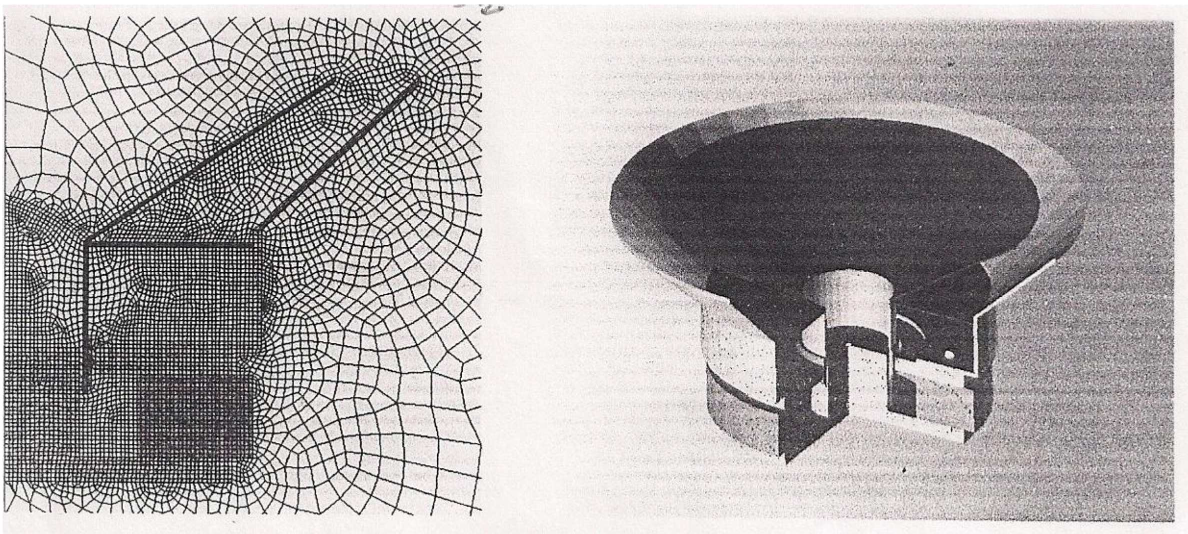

Fig.2 *(a) The discretized., (B) 3D model made by extension symmetry due*

2.MATERIALS

Material parameters used in the analysis are presented in Tab.2

Tab.2. Material properties used in analysis

Mat.nr.	**Materials**	**Thermal conductivity (W/ m ·K)**	**Density (Kg / m^3)**	**Specific heat (J/ Kg· K)**
1	**Ferrite (magnet)**	**3,2**	**4400**	**750**
2	**Soft steel (pole piece)**	**48**	**7840**	**450**
3	**Paper (membrane)**	**0,18**	**900**	**1340**
4	**Copper (coil)**	**380**	**8920**	**385**
5	**Aluminum (support coil)**	**180**	**2600**	**1256**

ANSYS has been used in the simulation, request that the material always be No.1 air (or fluid) and taking into account mecanisumul natural convection (buoyancy) physical properties of air to be highlighted in particular are temperature and density.

Area that extends to the air must be large enough not to influence the flow of heat in the area of interest, but bear in mind the overall size of the model.

Analysis performed using conjugate heat transfer process. Both areas of fluid and solids are modeled together using the same type of finite element.

CFD analysis (Computational Fluid Dynamics) performs calculations necessary to satisfy the law of conservation of momentum and mass. This analysis is (fluid flow) suitable for problems involving convection cooling. The disadvantage of this method is that for materials with thermal conductivities is different the precision is not good. Analysis was performed with a transient simulation for high enough temperature to obtain the stationary solution.

Analysis of steady state model is applied using the initially solutiones. Coil was modeled with constant power density proportional electric power applied to the speaker.

3. RESULTS OF MEASUREMENTS AND SIMULATION

Simulations and measurements were made assuming that we have two types of speakers that we call "small", P100 and that "high", P200 frames with outer diameters of 100 mm and 200 mm respectively. Figure 3 shows the speaker P100.

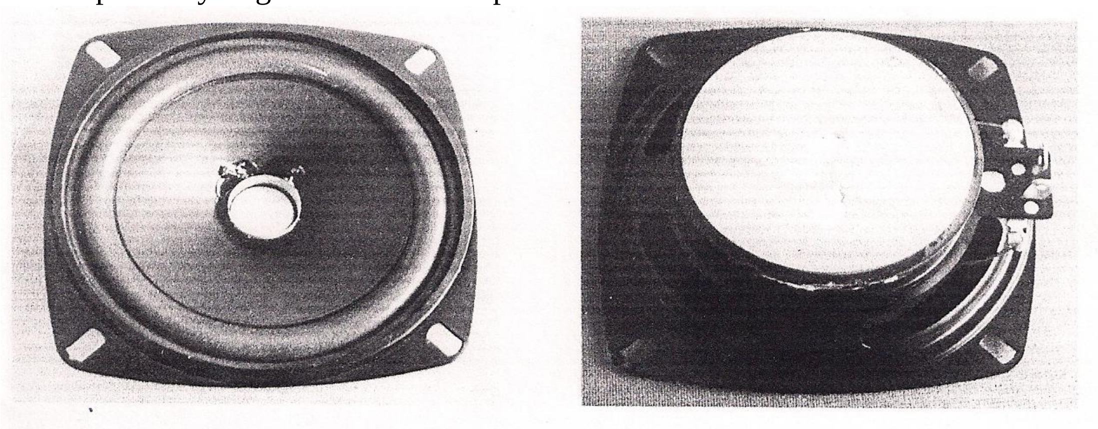

Fig.3 .*P100 speaker with diameter 100 mm (a) front view (b) rear view*

Speakers analyzed power ratings of 20 and 100 W. The measurements were made using about 100 Hz sinusoidal signal.

For temperature measurements were used based on contact measurements based on an acquisition system with thermocouple on one side and additional measurement system based on IR (infrared). We used a total of five thermocouples placed in different positions, including positions "hidden" for IR measurements.

Speaker P100 was prepared in two versions with a coil made in support of a classic paper and support alumniu.Masuratorile and simulations were conducted at a power level of 16W for small speaker, 50 W respectively the largest.

Measurement results are presented based thermocouples in tabele3, 4 and 5

Table 3. Measurement results on loudspeaker of 10 cm coil support the paper.

			Temp.termocuple(°C)					
Frequency (Hz)	**Power (W)**	**Tmax(IR) (°C)**	**1**	**2**	**3**	**4**	**5**	**Area graph from fig.6.**
100	**8**	**39**	**34,3**	**32,5**	**30,2**	**27,5**	**23,9**	**A**
1000	**8**	**63,8**	**52,8**	**50,3**	**47,1**	**43,7**	**34,2**	**B**
100	**16**	**74**	**54**	**50,9**	**45,7**	**35,6**	**25,6**	**C**
1000	**16**	**86,1**	**70,4**	**66,5**	**61,1**	**55,8**	**40,2**	**D**
100	**20**	**88,6**	**68,8**	**65,1**	**58,7**	**41,7**	**26,9**	**E**
1000	**20**	**92,5**	**75,8**	**71,4**	**65,4**	**59.4**	**41,4**	**F**

Table.4. Measurement results on loudspeaker of 10 cm aluminum coil support.

		Tmax Infrared (°C)			Temp.termocuple(°C)				
Frequency (Hz)	**Power (W)**	**Front**	**Profile**	**Back**	**1**	**2**	**3**	**4**	**5**
100	**8**	**38,8**	**29,6**	**39,5**	**30,7**	**30**	**27**	**26,8**	**24,2**
1000	**8**	**79,8**	**43,1**	**42,8**	**47**	**44,9**	**39,6**	**40,3**	**32,2**
100	**16**	**58,3**	**39,8**	**43,0**	**43,7**	**42,2**	**34,4**	**33**	**26,3**
1000	**16**	**109**	**53,5**	**57,6**	**63,6**	**60,1**	**51,9**	**52,2**	**38,6**

For data interpretation is necessary to specify the position thermocouples attached speaker. For Tables 3 and 4 position thermocouples was 1-5 in Figure 5:

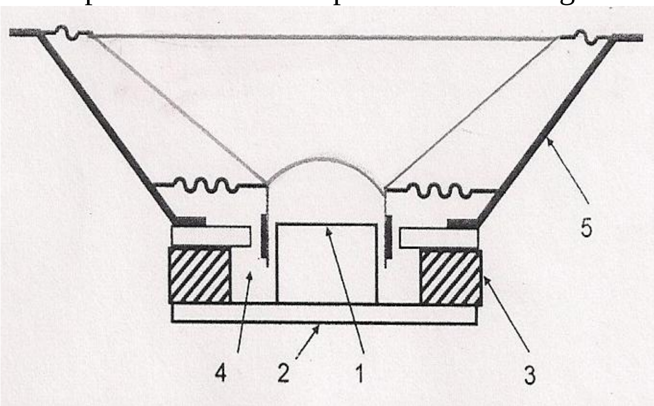

Figure 5 *Position thermocouples the measurements contained in Table 3 and 4, Bolt central flange 2 inf. Magnet 3, 4 cavity lateral to the coil, 5 Chassis*

Speaker P 200 with a diameter of 20 cm have been used only four thermocouples, thermocouples denoted by 1,2,3 and 4 in Table 5 are the positions in Figure 5, respectively as follows: 4 cavity, 2 flange. 3, magnet, 5 chassis.

Tab.5 Results of measurements for speaker on 20 cm with aluminum coil support

		Tmax Infrared (°C)			Temp.termocuple(°C)			
Frequency (Hz)	**Power (W)**	**Front**	**Profile**	**Back**	**1**	**2**	**3**	**4**
100	**20**	**63,7**	**44,5**	**39,3**	**35,1**	**37,7**	**32,6**	**25,5**
1000	**20**	**54,3**	**37,6**	**40,6**	**37,5**	**39,6**	**36,2**	**28,0**
100	**50**	**76**	**43,2**	**47,9**	**43,2**	**47,3**	**41**	**30,1**
1000	**50**	**101**	**56,1**	**60,3**	**52,1**	**60,8**	**47,8**	**28**

Mains based on data acquisition can be represented graphically and time evolution of temperature in the 5 samples that were placed in temperature. For configuration presents search The results for configuration presents in Table 3 is shown in Figure 6

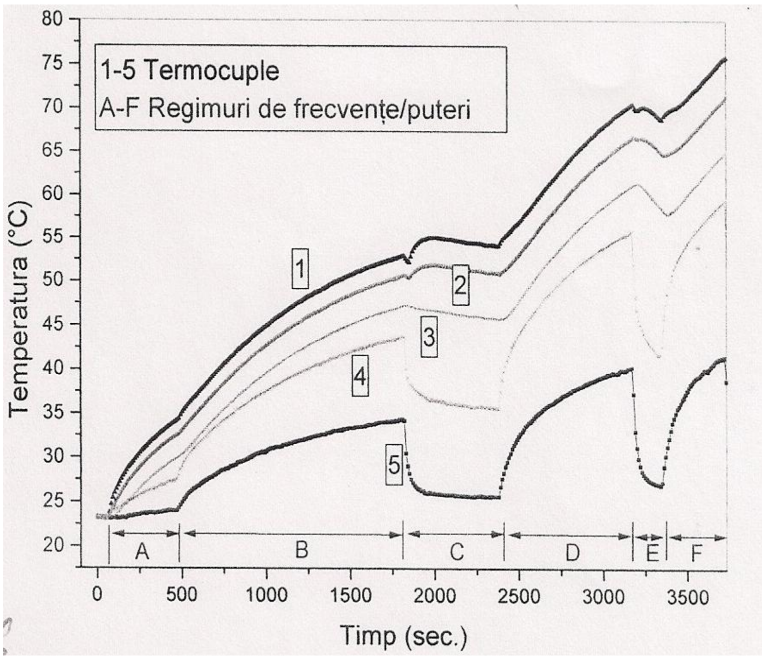

Fig.6*.Evolution of temperature measurement in the 5 point of measurement corresponding from Table 3.*

The data in Figure 6 have estimated thermal time constant of the speaker, a value that was useful for transient simulations the choice of the final simulation time.

CONCLUSIONES

Was performed thermal modeling and simulation of a permanent dynamic speaker on finite element analysis that uses fluid flow (CFD analysis) .

Simulation results were accompanied by complex measurements.

For the purposes at this stage of research the results of measurements corespond with the simulation results.

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