Medicon Engineering Themes
Volume 8 Issue 3 March 2025
Article Type: Research Article
ISSN: 2834-7218

A Novel Noise Reduction Procedure

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Received: February 22, 2025; **Published:** March 06, 2025

DOI: 10.55162/MCET.08.266

Abstract

This paper examines a procedure to lower the noise of the system. The system under study is a 4-Slot Server. This Server has 3fan trays each of which has two fans. Our objective is to reduce the noise level. The procedure we adopt is the Constructal Approach [1]. The Constructal Law states that: " For a finite size system to persist in time, it should evolve in a manner to provide an easier access to fluid going through it". In past publications devoted to this subject in Industrial Contexts we studied the Condenser of Refrigerator, Thermal management under microgravity, Charger best design and quite recently the noise reduction in a 2-RU Server.

Keywords: Constructal Law; Noise Reduction; Vortex Ring; Correlations

Introduction

Reducing the noise levels in server designs have been one of the objectives of designers in Servers and Switch systems [1]. In this paper, we try to lower the noise level by using a Constructal Approach. The Constructal Law states that: "For a finite size system to persist in time, it should evolve in a manner to provide an easier access to fluid going through it [2]. In an Industrial Context, to persist in time means that a program which supports a system should not be eliminated. One of the reasons that we made use of Constructal Law, is its power to predict the design [2]. In some of past publications in the industrial contexts, such as the Refrigeration, Thermal Management in Microgravity, Stability analysis and finally Charger Thermal design were addressed [3-5]. Here, in this paper the Acoustic Aspects and Constructal Law will be investigated. The system under study is a 4Slot Server, and the noise generations are thought mainly to be due to three fan trays which are in the push mode. By push mode, we mean the direction of air is from the inside of the System to the outside. We made a distinction between Component level and System level acoustic designs. Our method in this paper is purely experimental. The paper is presented in five parts. In part two, the acoustic set up, the measuring system and the characteristics of the acoustic chamber are explained. The experimental protocol will be explained in that section. In Part three, we devoted it to the noise reduction; in 3a the component level noise reduction is explained. While in section 3b, the system level noise reduction is presented. In part four, some curves to characterize the acoustic of the system are presented and finally; in part five the conclusion and discussions are presented.

Materials and Methods

In this section we will focus on the experimental set up and the Data Acquisition System that we used. We conducted all experiments in an anechoic acoustic chamber with 10 Microphone set-up, see Figure 1. The chamber's temperature is maintained at a constant temperature, and humidity. The microphones are connected to a DAS System provided by Nelson Company. A software is used particularly for the results of this system. The test results cover component and system levels which will be discussed in Section 3.

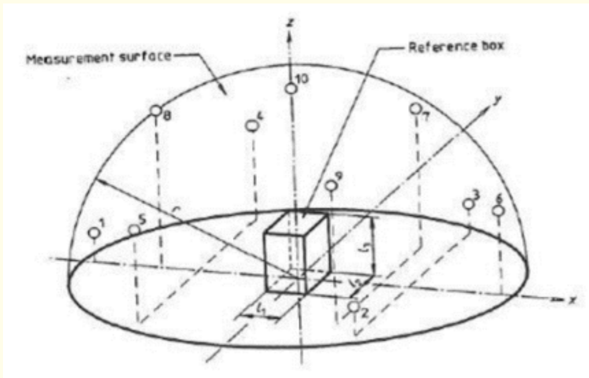

Figure 1: 10 Mics System.

Results

In this section, our approach will be explained, see figure 2.

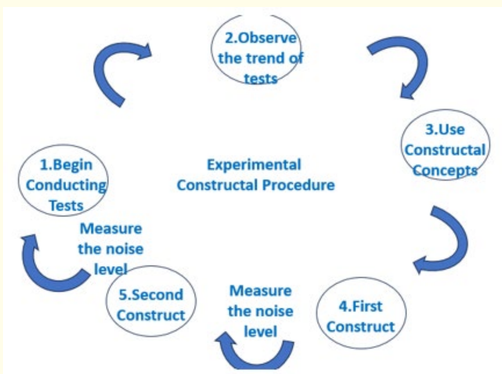

Figure 2: Our approach.

As can be observed from figure 2, we used a trial-and-error procedure to reach our objective. It should be emphasized that our paper is purely experimental.

3a: Component level

In section 3a, our experimental protocol will be presented in two parts.

First, we will present the acoustic results of cooling fans. Then after establishing the base line, we will put foams on the fans.

Fan System

Our final goal is to reduce the noise level, so we simply used foams in the cooling fans.

The fans characteristics are as follows:

1. A 12 cm by 12cm in cross section for each of the fans. In each fan tray there are two fans.
   In our system there are three fan trays.
2. The fans are all in the so -called "*push*" mode (the air will go through the system).
3. Fan speeds are controlled from 2500 RPM (10% load) to 4700 RPM (100% load). It should be emphasized the values are approximative.

The following results are obtained:

Loads	Fan 1	Fan 2	Fan 3	Fan 4	Fan 5	Fan 6	Fan 7	Fan 8	Fan 9	Fan 10	Fan 11	Fan 12
10%	2986	1884	3005	1905	3227	2088	3204	2033	3016	2012	3128	2035
30%	3994	2685	4122	2568	4361	2730	4365	2799	4166	2687	4228	2691
70%	5572	3406	5642	3351	6087	3590	5966	3602	5781	3488	5837	3550
100%	5744	3426	5831	3406	6206	3691	6171	3673	5986	3554	6033	3607

Table 1: Fan speeds at different loads.

In table 1, at different load level, the speed of each fan is presented.

3b. System level

In table 2, the system noise reduction is presented:

The Load	Noise (Original System), dB	Noise After Constructal Solution, dB
10%	73.6	73.4
30%	81.3	80.5
70%	87.6	87.2
100%	88.5	87.6

Table 2: The component noise reduction.

We should emphasize that, to obtain the result of table 2, we made a duct (or baffle with foams).

The duct and foams are shown in Figure 3:

Figure 3: Duct (baffle and foams).

Discussions

As we mentioned in the previous section, we tried a trial-and-error for designing the duct. Our results are shown in Figure 4:

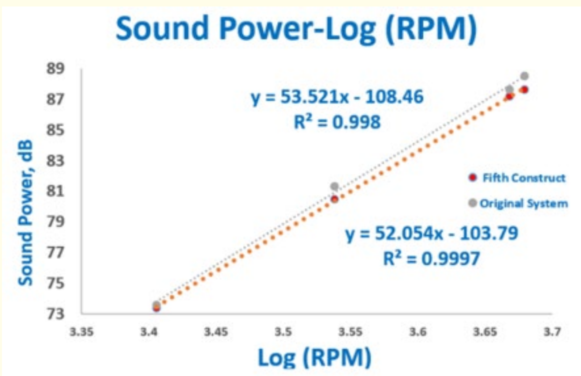

Figure 4: The comparison of the bare system with baffle and foam.

Conclusions

In this paper, we adopt the same procedure; Constructal with an addition of the Vortex Ring concept. The paper uses baffle to reduce the noise. To be more precise, baffle is a small duct which will be added to the Server. In addition to use the Constructal Concept, we used the fluid-solid interactions to reduce the noise level. Our approach is purely experimental, and we measure in each stage the Acoustic power in a 10-Mic set up. In our study, we considered the load of 10%, 30%, 70% and 100%. We measured the speed of fans.

This part was achieved by using the software commonly named "Diag". To some extent our solution method was based on trial and error. Also, we used the concept of the Vortex Ring. It was thought that the smaller the Vortex Ring, the smaller the noise level. In this work we used two different fan trays. In the first fan trays approach, we went up to 4th construct. Then, we used this experience and found the shape of the baffle. Our study shows by adopting this procedure plus applying foam we can reduce the noise level 0.9 dB.

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