inter.noise 2000
The 29th International Congress and Exhibition on Noise Control Engineering
27-30 August 2000, Nice, FRANCE

I-INCE Classification: 1.3

A STUDY ON THE REDUCTION METHOD OF NOISE SOURCES IN HIGH SPEED ROTATING CD-ROM DRIVE

Y.S. Kim*, D.N. Heo*, D.J. Lee*, Y.C. Kim**

* Division of Aerospace Engineering, Department of Mechanical Engineering, Korea Advanced Institute of Science & Technology, 373-1, Kusong-dong, Yusong-gu, 305-701, Taejon, Republic Of Korea

** Information and Home Appliances Business, Samsung Electronics Co. Ltd, 416, Maetan-3 Dong, Paldal-Gu, 442-742, Suwon, Republic Of Korea

Tel.: 82-42-869-5755 / Fax: 82-42-869-3710 / Email: yskim@acoustic.kaist.ac.kr

Keywords:
CDROM, AEROACOUSTIC, AERODYNAMIC NOISE, NOISE REDUCTION

ABSTRACT
CD-ROM drives rotating high speed as 10,000 rpm cause serious noise and vibration problems, which limit the rotating speed of the device. At the speed of 10,000 rpm, the aerodynamic noise is dominant noise source. The present paper deals with the experimental approach how to identify the noise source based on the fundamental principles of aeroacoustics and to propose a reduction method of the noise source. Major noise source arises due to the high-speed airflow produced from the upper and lower surfaces on the rotating disk. So, effect of the airflow on the flow noise is discussed. Experimental studies are carried out in the anechoic wind tunnel with various design modifications, such as tray geometry and window size, to identify and reduce the major aerodynamic noise source and significant reductions of the noise source are obtained.

1 - INTRODUCTION
Rotating speed of CD-ROM becomes incredibly faster than the expectations at the beginning when the product was introduced in the market. Until now, no one can expect the limitation of the speed because consumers require faster drive whenever new device is introduced in the current market. To compete with other brand, the speed is one of the critical issues in the manufacturing industry.

During the last few years, engineers in industry have been able to manage the noise and vibration problems with trial and error method without any special background in knowledge especially in the area of aerodynamic noise. As the speed of disk is increased rapidly, over a certain speed, the aerodynamic noise overwhelms the vibration noise. Recently, the research on the flow noise taking into account the airflow characteristics due to a high-speed rotating has been performed [1-3]. As known to aeroacoustians, the aerodynamic noise increases with $5\sim6^{th}$ of rotating speed. Practically, to identify and reduce the noise source is not trivial considering the complicated structure inside the CD-ROM device as shown in Fig. 1.

The CD-ROM device is composed of disk, window tray, motors at the bottom place and electronic circuit plate also located below the window plate. The window is cut in the tray to read the disk information using the optical device located below the tray and moving linearly from the center of the disk through the end of the disk. All components are possible noise generators. In the present paper, experimental studies are performed to investigate the aerodynamic noise generated by the airflow around disc. Through the various design modifications, such as tray geometry and window size, the noise sources of the CD-ROM are identified and the reductions are achieved by minimizing the effect of important component of the device in view of aerodynamic noise.

2 - EXPERIMENTAL RESULTS AND DISCUSSIONS

2.1 - Experiment description
Sound pressure level was measured with a 1/2in condenser type microphone (Type 4165, B&K) mounted at 10cm away from the front upper edge of the CD-Rom at an angle of 45 degrees. An FFT (Fast Fourier

Figure 1: Photograph of the CD-ROM device.

Transform) analyzer (PULSE Type 3560, B&K) was employed to acquire and process the large volumes of data. All data are the results of 400 linear averages, using a 3200 points sampling up to 12.8kHz and a Hanning data window. The result frequency resolution is 4Hz.

2.2 - Experiment results

The present experiments are carried out in the anechoic wind tunnel by changing the tray geometry and window size as shown in Fig. 2. Major noise source arises due to the high-speed airflow produced from the upper and lower surfaces on the rotating disk. One of the noises caused by this high-speed airflow is due to the air near the upper side and lower side of the disk passing through the window and impinging on the components in the electronic circuit plate. And the other noise is that the air injected between the lower surface of the disk and the window tray impinges on the guide wall in the window tray. The role of the guide wall is to prevent the disk being miss-located from the center when the computer is located vertically.

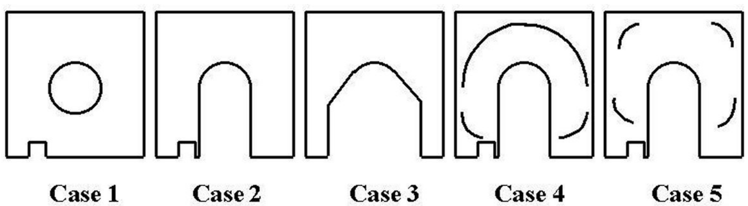

Figure 2: Various schematic diagrams of the tray.

Fig. 3 shows the background noise of the anechoic wind tunnel and CD-ROM motor noise driving motor only. As the background noise is nearly below the 22dBA, it is considered that the background noise is suitable for the noise experiments. Each peak of motor noise signal appears at harmonic frequencies of RPS (revolution per second). This peak can be amplified or diminished according to the geometry of CD-ROM and the flow condition. However it seems that this peak does not significantly affect to the overall SPL.

Fig. 4 shows how the window size influences the flow noise level. To investigate the window size effect we tested three types of the tray as shown in Fig. 2. First case is the non-window tray, which is the ideal tray. However real tray must have the window to read the disk information. Second case is the narrow window size, and third case is the broad window size. As the window size is broadening it is shown that the sound pressure level is increased. The reason why seems that the much more airflow is impinged on the components in the electronic circuit plate. The noise characteristic of the window size is the narrow peak around 2000(Hz) like a mountain.

For the guide wall effect, two types of the tray were tested. As shown in Fig. 5, the noise characteristic of guide wall is represented as a broadband noise between 3000(Hz) and 8000(Hz) approximately. In case 5, which is the minimum guide wall case, the sound pressure level is lower compared with the case 4.

3 - CONCLUSIONS

The purpose of this study is to identify and reduce the CD-ROM noise sources by experiments. In our experiments, one of the noise sources caused by this high-speed airflow was found to be the flow noise of

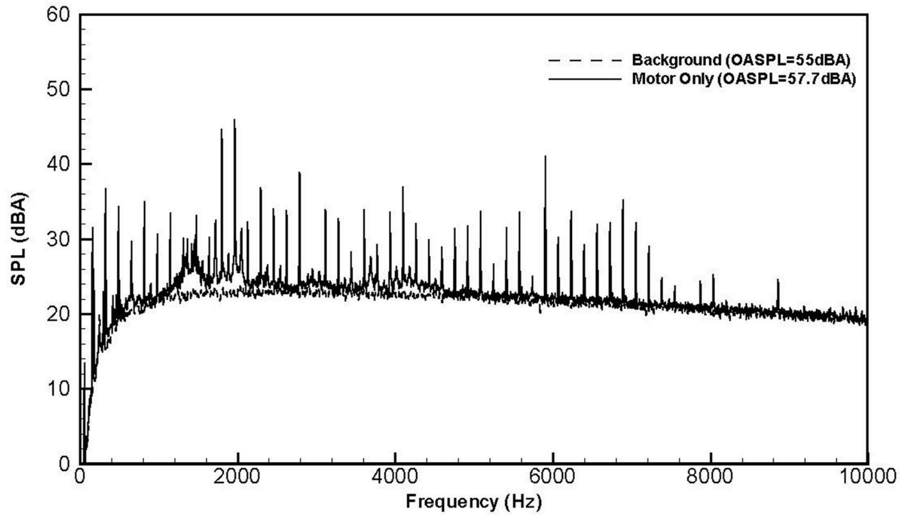

Figure 3: Frequency spectrum of the background noise and CD-ROM motor noise.

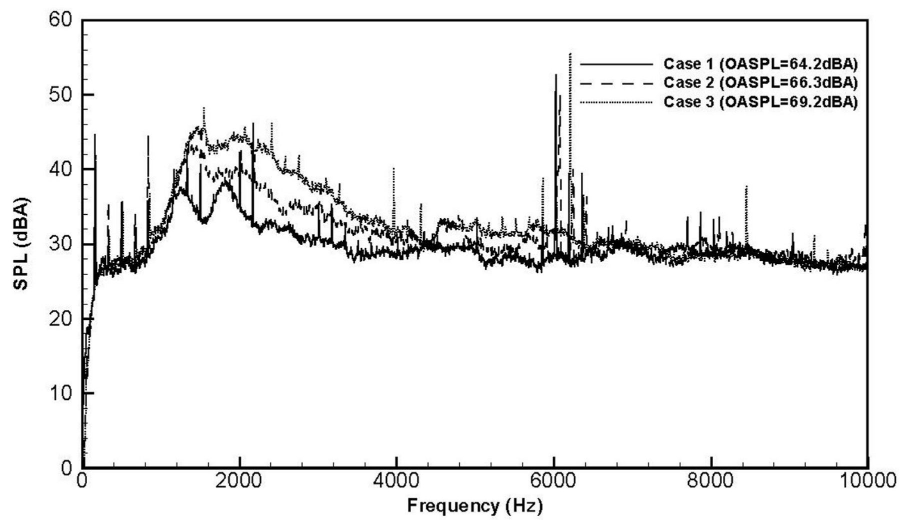

Figure 4: Frequency spectrum showing the window size effect.

the air passing through the window and impinging on the components in the electronic circuit plate and the other was that the air injected between the lower surface of the disk and the window tray impinges on the guide wall in the window tray. Through the various design modifications, such as tray geometry and window size, significant reductions of the noise source could be obtained.

ACKNOWLEDGEMENTS

This research was supported by the Samsung Electronics Co. Ltd.

REFERENCES

1. **C. D. Angelo III, C. D. Mote Jr.**, Aerodynamically Excited Vibration and Flutter of a Thin Disk Rotating at Supercritical Speed, *Journal of sound and Vibration*, Vol. 168(1), pp. 1-54, 1993

2. **A. A. Renshaw**, Critical Speed for Floppy Disks, *ASME Journal of Applied Mechanics*, Vol. 65, pp. 116-120, 1998

3. **S. Kim, G. Han, H. Son**, A Study of Characteristics of Disk Vibration and Rotating Airflow in Magneto Optical Disk Drives, *IEEE Transactions on Consumer Electronics*, Vol. 44(3), pp. 601-605, 1998

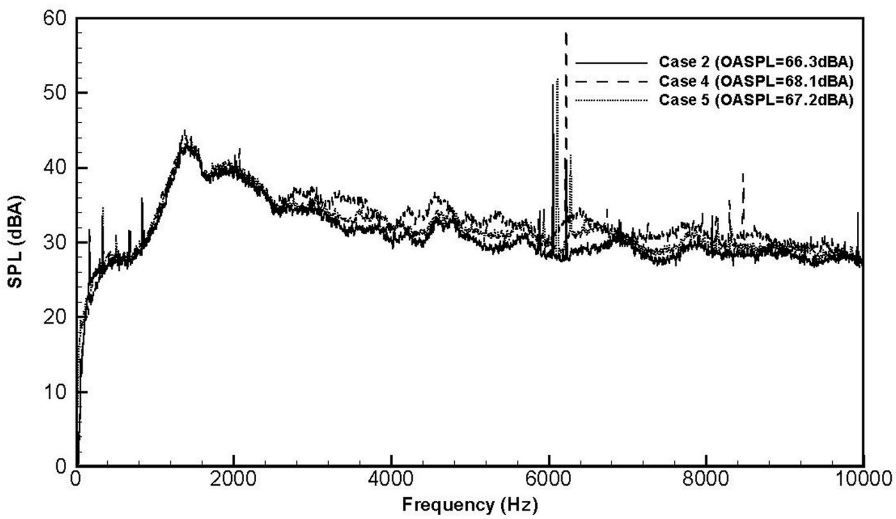

Figure 5: Frequency spectrum showing the guide wall effect.