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Transmission of High-Intensity Aerial Ultrasonic Waves Using Pipe
パイプを用いた強力空中超音波の音波伝送

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1. Introduction

To irradiate the specified place with high-intensity aerial ultrasonic waves, it is necessary to move the body of a sound source to the place. If any obstacle is placed between the specified place and the sound source, however, it will be difficult to provide the good irradiation. There will also be a problem that ultrasonic waves may diffuse during propagation. If these problems can be solved, it can be expected that the more effective irradiation with ultrasonic waves may be realized and that the range of applications may be widened.[1-4)]

To solve these problems, this study made basic examinations on the transmission of high-intensity aerial ultrasonic waves (frequency: 20 kHz) using a long pipe with small diameter.

2. Experimental system

Figure 1 shows the schematic view of the experimental system used for this study. To produce aerial ultrasonic waves, we used a source of ultrasonic waves, which comprised two step horns (which had a small end face of 40 mm in diameter and a large end face of 70 mm in diameter). The ultrasonic source had a driving frequency of 20 kHz. Acrylic pipes were used to transmit ultrasonic waves. The pipes had an inner diameter of 20 mm that was similar to the wave length (17 mm). Their lengths were 90 to 108 mm. To measure the sound pressures in pipes, we used a 1/4-inch condenser microphone with a probe of 2 mm in diameter.

Figure 2(a) shows the sound pressure distribution on the vertical center axis r of the horn vibration surface. It indicates that the sound pressure was simply decreased in the distance range of 20 mm and more from the vibration surface. **Figure 2(b)** shows the sound pressure distributions in the direction perpendicular to the axis r around the points A and B as shown in Fig. 2.

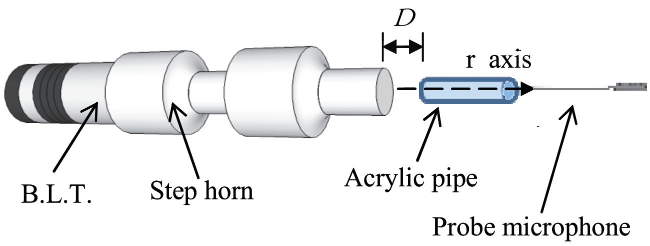

Fig. 1 Schematic of experimental equipment.

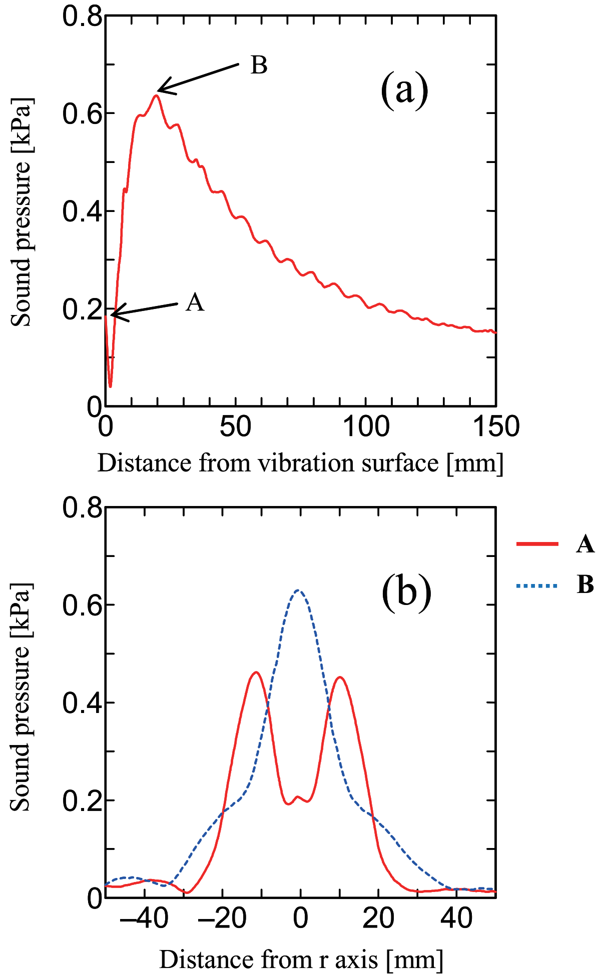

Fig. 2 Distribution of the sound pressure around ultrasonic source. (a) : in the direction of the axis r, (b) : in the direction perpendicular to the axis r.

3. Sound pressure distribution in the installed pipe

Figures 4 to 6 show the sound pressure distribution characteristics in the installed pipes having different lengths. **Figure 3** shows the sound

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pressure distribution in the pipe which was installed with its end (placed at the point A) close to the vibration surface and with its axis coincident with the axis r. The figure indicates that the sound pressure value varied slightly depending on the length of the pipe. **Figure 4** shows the sound pressure distribution in the pipe installed with its end placed at the point B. The figure indicates that almost the same sound pressure distributions and sound pressure values were provided regardless of the lengths of pipes. In addition, the figure indicates the great characteristic that the sound pressure values significantly increased around the openings of the pipes on the sound wave radiation side.

Figure 5 shows the sound pressure profiles in the pipe of 104 mm in length which was installed at the variable distance from the vibration surface of the ultrasonic source. In the figure, the horizontal axis indicates the distance ***D*** between the vibration surface and the end of the pipe. The figure indicates that the sound pressure distributions formed inside and outside the pipe had almost the same tendency, and that the sound pressure value had a periodical variation depending on the distance ***D***.

4. Conclusions

We made examinations on the sound pressure characteristics inside and outside of a long and linear pipe of small diameter that was installed close to the ultrasonic wave vibration surface (20 kHz) at the same phase and irradiated with ultrasonic waves. The results revealed that the sound pressure distribution characteristics inside and outside the pipe varied largely depending on the length of the pipe installed as well as the distance between the pipe and the vibration surface. Thus, we expect that it will be possible to realize the more effective sound wave transmission by providing the appropriate size and position of the pipe.

References

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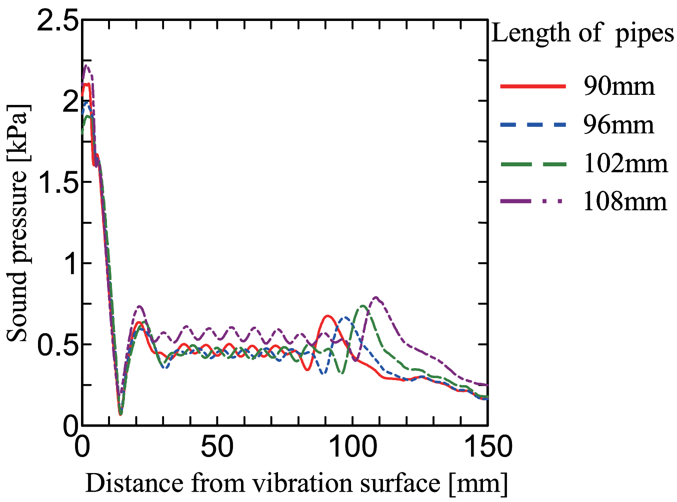

Fig. 3 Sound pressure distribution in the pipes installed with its end placed at the point A.

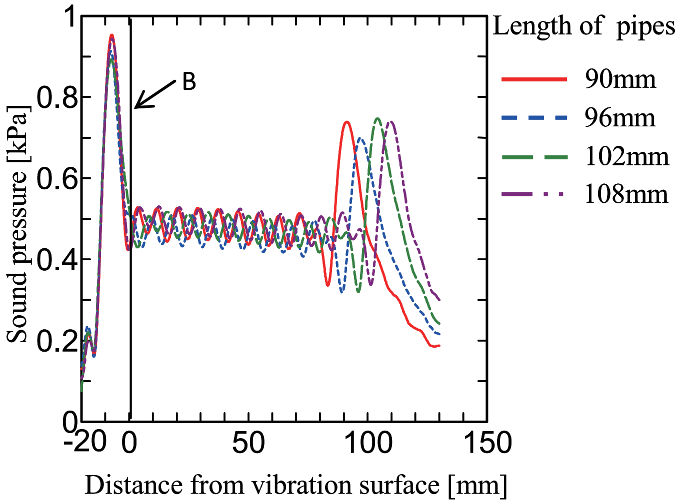

Fig. 4 Sound pressure distribution in the pipes installed with its end placed at the point B.

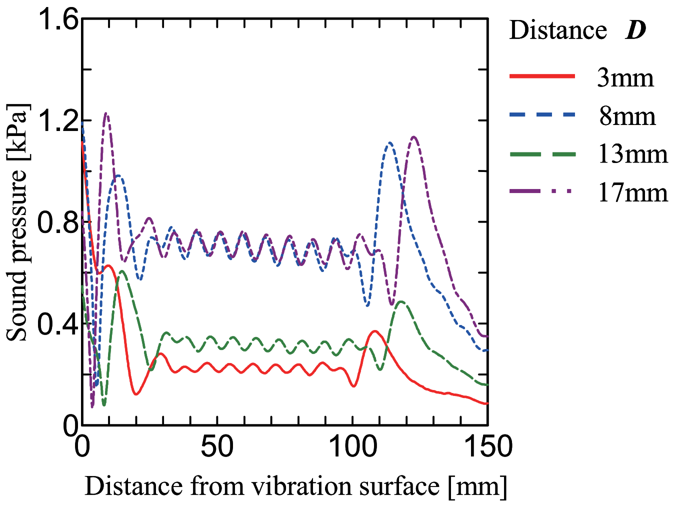

Fig. 5 Sound pressure distribution in the pipe installed at the variable position.