Eartip Modification Greatly Reduces Evanescent Waves.

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Abstract

Results: Sound-level increases in the ear canal and pressure losses of the standard front tube were measured at 50 dB SPL with an ER-10X otoacoustic emission probe. The front tube was modified by beveling the most distal ~2 mm of the outer lumens, leaving the central lumen intact. The aperture of the beveled configuration was about twice that of the standard front tube. Sound is emitted through surrounding outer lumens, which all end in the same plane.

Introduction

Methods

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Acknowledgments

References

Summary and Conclusions

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Figures

Figure 1. Beveling the Front Tube Changes Pressure Responses

The relative amplitude of the evanescent wave pressure is proportionate to the diameter of the tube. The tube with the smaller 0.25 mm (shown) showed the smallest spatial variation of the pressure (~ +/− 1 dB) for frequencies below 20 kHz (upper left). The pressure in the tube with the larger 0.76 mm diameter increased with distance (~ +/− 3 dB) for frequencies below 20 kHz (upper right). The pressure in the tube with the largest 1.3 mm diameter increased with distance (~ +/− 10 dB) for frequencies below 20 kHz (lower left). This is obvious at 20 kHz. The pressure in the tube with the smallest 0.25 mm diameter had no obvious variation with distance (lower right).

Table 1: Effect of Insertion Depth on Thresholds and Emissions in All Ears


Figure 2. Predicted Pressure


Figure 3. Effect of Insertion Depth on Thresholds and Emissions in All Ears

The discrepancy between the predicted and actual insertion pressure in the ear simulator at high frequencies is much smaller for the beveled front tube than for the standard front tube. The error in matching the pressure response at the frequencies of half wave lengths in the 7.9 mm tube with the pressure measured by the simulator's microphone is smaller for the beveled front tube at high frequencies than for the standard front tube.

Figure 4. Evanescent Waves Contaminate Thévenin Source Calibrations

Beveling the front tube greatly reduces the pressure amplitude of the evanescent waves relative to the plane waves. The amplitude of the evanescent waves becomes smaller as the probe tube is advanced further into the canal.

Figure 5. Methods

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Figure 6. Summary and Conclusions

1. Beveling the front tube increases the effective aperture of the eartip, which greatly enhances the effective aperture of the source. This reduces the amplitude of the evanescent waves relative to the plane waves.

2. Changing the shape of the probe's front tube appears to increase or decrease the amplitude of the evanescent waves, which can have a significant impact on the accuracy of the measurements.

3. Evanescent waves affect Thévenin source calibrations, increasing the magnitude of the source impedance and reducing the frequency dependence of the ear Simulator to high frequencies. Evanescent waves are not always present in the standard front tube.

4. Beveling the front tube greatly reduces the pressure amplitude of the evanescent waves relative to the plane waves. This reduces the relative amplitude of the evanescent waves, allowing the sound to begin to disperse before reaching the microphone inlet, reducing the relative amplitude of the evanescent waves.

5. The tympanic membrane is a sensitive sensor that is significantly affected by evanescent waves. This makes the standard front tube unsuitable for use in Thévenin source calibrations.

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