Abstract

The aim of this research is to determine the influence of the material used in custom earplug manufacturing on noise attenuation levels. The study addresses noise as an occupational hazard, emphasizing its impact on workers' health and the global prevalence of hearing loss. Three specific objectives are focused on: explaining how the material affects attenuation in acoustic pressure, examining attenuation levels across frequencies, and assessing attenuation levels in comparison to standard commercial earplugs (3M Reusable CLASE AS/NZS 1270). The justification underscores the importance of safeguarding workers' hearing health. The methodology involves the fabrication of custom earplugs using two types of silicone (Insta-Mold® Americana and Egger Flex S-Pro Germany) and their validation using the E-A-Rfit™ system. Data on noise attenuation are collected using the 3M™ E-A-Rfit™ Dual Hearing Validation System, and a statistical analysis is performed to verify the hypothesis that the material affects attenuation compared to standard commercial earplugs. Results indicate that the type of material used in custom earplug manufacturing influences noise attenuation levels. Egger Flex S-Pro Germany silicone recorded attenuation levels in acoustic pressure of 22.43 dB (right ear) and 17.86 dB (left ear), with standard deviations of 9.34 and 6.95, respectively. In contrast, InstaMold® Americana silicone exhibited higher attenuation levels, registering 27.00 dB (right ear) and 30.07 dB (left ear), with standard deviations of 2.94 and 4.99. This superior attenuation capability is attributed to the post-molding waxing process, ensuring the integrity of the initial mold shape and preventing material loss. Frequency-based attenuation levels were also evaluated, with Egger Flex S-Pro Germany silicone excelling at 8000 Hz (right and left ear), while Insta-Mold® Americana silicone demonstrated higher attenuation at 4000 Hz (right ear) and 8000 Hz (left ear). These results indicate the effectiveness of both custom earplugs for high-frequency noise common in industrial settings. XIII In comparison to standards, Insta-Mold® Americana silicone proved superior to 3M STD Reusable earplugs, CLASE AS/NZS 1270. The hypothesis testing supported significant evidence of higher adjusted or real Noise Reduction Rating (NRR) values for Insta-Mold® Americana silicone, calculated using the 3M™ E-ARfit™ system, tailored to individual anthropometric characteristics. The achieved efficiency was 93.58%, substantially surpassing the 53.08% efficiency of standard 3M STD Reusable earplugs. In summary, the material choice in custom earplug manufacturing is critical, with Insta-Mold® Americana silicone standing out as the most effective option. It provides superior attenuation in both acoustic pressure and frequency, ensuring optimal sealing of the ear canal and delivering high efficiency compared to existing commercial standards, such as 3M Reusable CLASE AS/NZS 1270 earplugs. This research offers relevant insights into the relationship between material and noise attenuation in custom earplugs, highlighting the importance of tailoring these devices to individual needs for effective hearing protection in noisy work environments. Future research is

recommended to explore materials that undergo post-molding waxing, guaranteeing material integrity and preserving the initial impression or mold shape of an individual's ear canal. Neglecting these conditions may compromise optimal sealing of the ear canal, allowing unwanted noise entry. Keywords: noise attenuation level, acoustic pressure, frequency, NRR (Noise Reduction Rating).