LONG TERM INVESTIGATIONS OF SOUND ATTENUATION CHANGES IN EAR-MUFFS: PRELIMINARY RESULTS

PACS REFERENCE:

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ABSTRACT

Four models of ear-muffs popular in the Polish work environment have been tested for two years. The ear-muffs fulfill the EN 352-1 requirements and they are granted a certification mark. For two years, 15 samples of each model of ear-muffs were used every workday by the workers; 10 samples were exposed to natural atmospheric conditions; and 10 samples were stored in accordance with the manufacture's advice. Temperature and humidity were checked each day. After one- and two-year periods, sound attenuation was measured according to EN 24869-1. Changes in attenuation values: H, M, L and SNR of tested models of ear-muffs are presented.

INTRODUCTION

Noise at a workplace involves a risk to the health and safety of the workers. According to European Council Directive 86/188 EC, hearing protectors are used to reduce the risk resulting from the exposure to noise and to protect the workers against noise-induced hearing loss. To be effective, the hearing protectors must be selected after considering the characteristics of noise. Existing methods [EN 458] of assessing the A-weighted sound pressure level effective to the ear are based on the measurements of sound attenuation of hearing protectors in the laboratory conditions. In a "real world" situation the effective attenuation of hearing protectors may be significantly lower than in the laboratory. In the former, the measurements are performed for certification purposes, therefore, a new product is tested in standard atmospheric conditions. In the "real world" situation hearing protectors are usually used as long as there are no signs of any physical damage. The lack of signs of damage of hearing protectors does not mean that sound attenuation is not significantly diminished. In Europe, the work environment varies considerably (e.g. the environment of forest workers in North Europe and working conditions of hammer workers on the roads of South Europe). These environmental conditions also affect the rate of changes in the performance of hearing protectors.

Actually, to protect the workers against noise-induced hearing loss by means of hearing protectors, their effective "real world" attenuation of hearing protectors must be estimated.

The aim of the work was to assess how far the period of use and storage and exposure to natural atmospheric conditions affect sound attenuation of ear-muffs. Four models of ear-muffs, of normal size with headband, representative for the Polish work environment, were tested. The models fulfill the EN 352-1 requirements and they are granted a certification mark.

METHODOLGY

The new, just bought, 35 samples of each model of ear-muffs have been tested for two years.

Fifteen samples of each model (marked A 1, A2,....., A15) were supplied to 60 workers for their use. Noisy workplaces were chosen at four different industrial companies (two coal mines, a steel mill and in a wool factory). The noise at work-stands was measured and A-weighted sound pressure levels under the cup of tested ear-muffs were assessed, according to PN-EN ISO 4869-2. The estimated A-weighted sound pressure during the use of hearing protectors ranged from 84 to 70 dB. The workers were using the tested ear-muffs every day for two years. The temperature and humidity of air at each work-stand were measured.

Ten samples of each model of ear-muffs were exposed to natural atmospheric conditions (Fig.1) 8 h/working day for two years. The samples were mounted on special head simulators. The temperature and humidity of the air were controlled twice a day. During the other 16 h the samples were stored in accordance with the manufacturer's instructions.

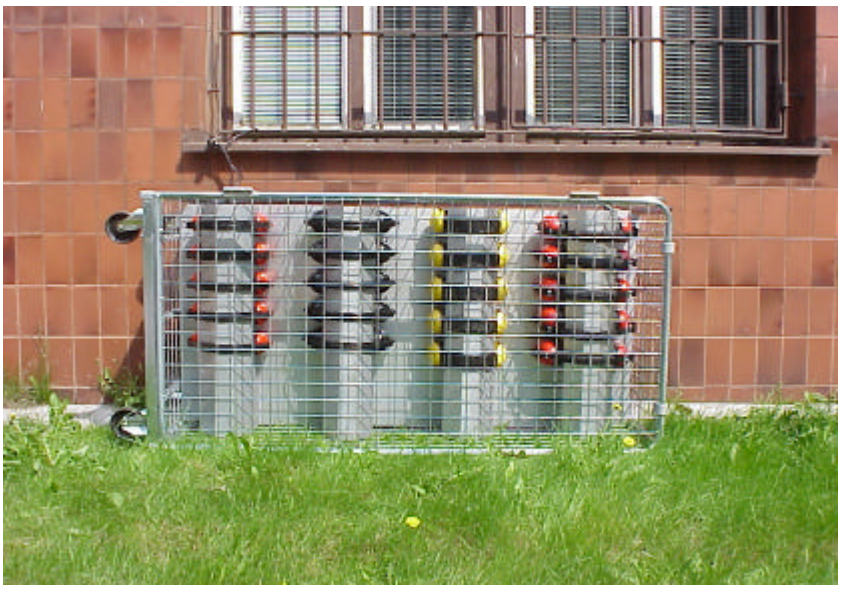


Fig. 1. Ear-muffs exposed to natural atmospheric conditions.

The remaining ten samples of each tested model of ear-muffs were stored in clean, dry, uncontaminated environment, according to the manufacture's recommendations, for two years.

After one year and then after two years of use and exposure to atmospheric conditions, the six samples of each model of ear-muffs, taken at random, were tested at the laboratory conditions. The sound attenuation and headband force of ear-muffs were measured. The measurements of sound attenuation were done in 16 subjects, in accordance with PN-EN 24869-1. The measurements of headband force were done according to EN 13819-1.The stored samples were tested after two years. The high-frequency attenuation value H, medium-frequency attenuation value M, low-frequency attenuation value L and single number rating SNR of hearing protectors were determined, according to PN-EN ISO 4869-2, based on the measured values of sound attenuation.

RESULTS OF LABORATORY TESTING OF EAR-MUFFS USE FOR ONE AND TWO YEARS

Figure 2 shows the differences between the estimated attenuation data of H, M, L and SNR of hearing protectors after using them for one and two years and values given in the manufacturer's instruction for users.

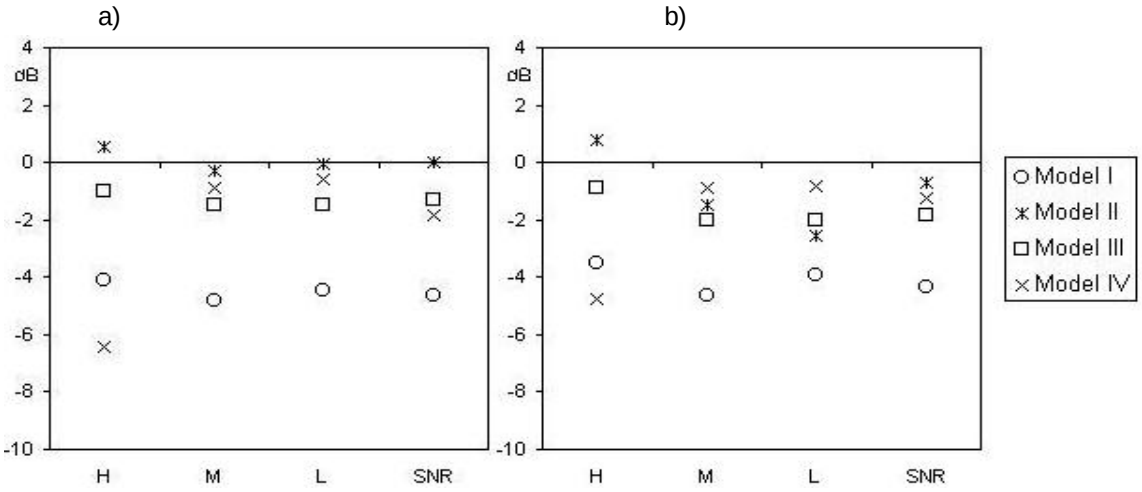
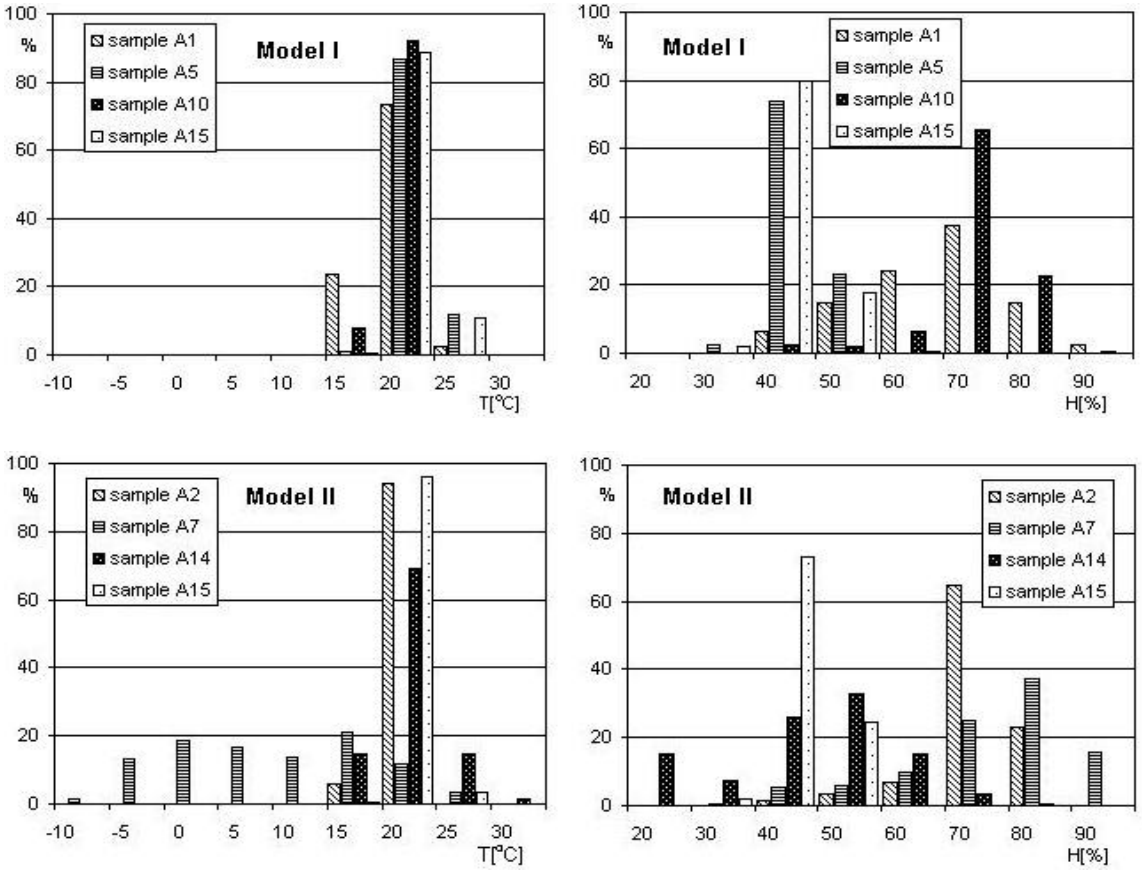


Fig 2. Changes in attenuation H, M, L, SNR of ear-muffs a) after a one-year use, b) after a two-year use.

In Figure 3, the histograms of temperature and humidity of air at work-stands where the tested samples of ear-muffs were used for two years are presented, they include data on: a) samples of model I, b) samples of model II, c) samples of model III, d) samples of model IV.



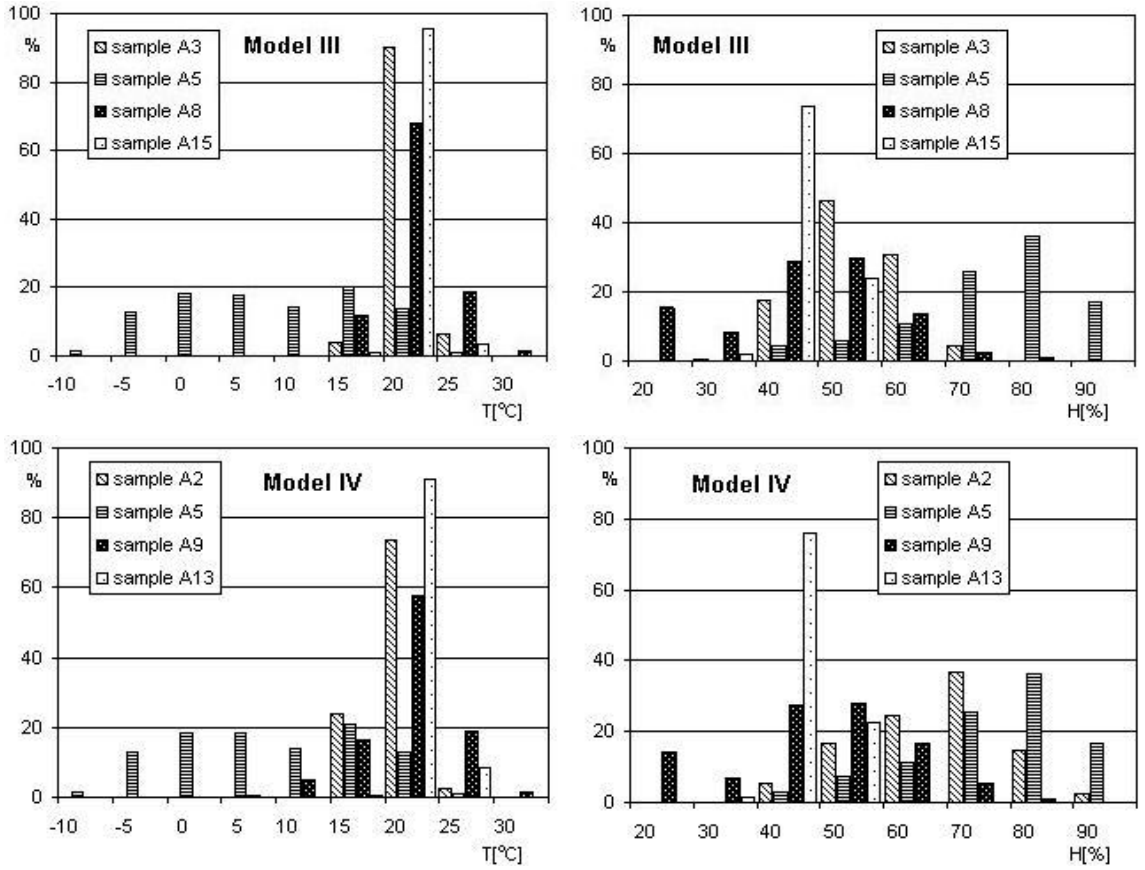


Fig. 3. Histograms of temperature and humidity of air at work-stands where the tested samples of ear-muffs were used for two years are presented, they include data on samples of model I, II, III and IV.

The most stable atmospheric conditions were observed at work-stands where samples of model I were tested. Nevertheless, all the estimated attenuation values of model I after a one-year use were significantly lower, about 4 dB on average, than those given in the manufacturer's instruction. The atmospheric conditions at work-stands, where models II, III and IV were tested, were very similar. The significant decrease in the attenuation value was observed in case of model IV, after the first year of use; estimated high-frequency attenuation value H was by 6.4 dB lower than that given in the information for the wearer. The second year of using ear-muffs of models I and IV did not affect significantly attenuation of tested samples. Much smaller changes were observed for model III; estimated attenuation values were lower by no more than 2. 3 dB. Attenuation values, H, M, L, SNR of model II were stable during a two-year use.

RESULTS OF TESTING THE EAR-MUFFS USE FOR ONE AND TWO YEARS IN EXPOSURE TO NATURAL ATMOSPHERIC CONDITIONS

Figure 4 presents the differences between the estimated attenuation data of H, M, L and SNR of hearing protectors after one- and two-year exposures to changing, natural atmospheric conditions and the values given in the manufacturer's instruction for users.

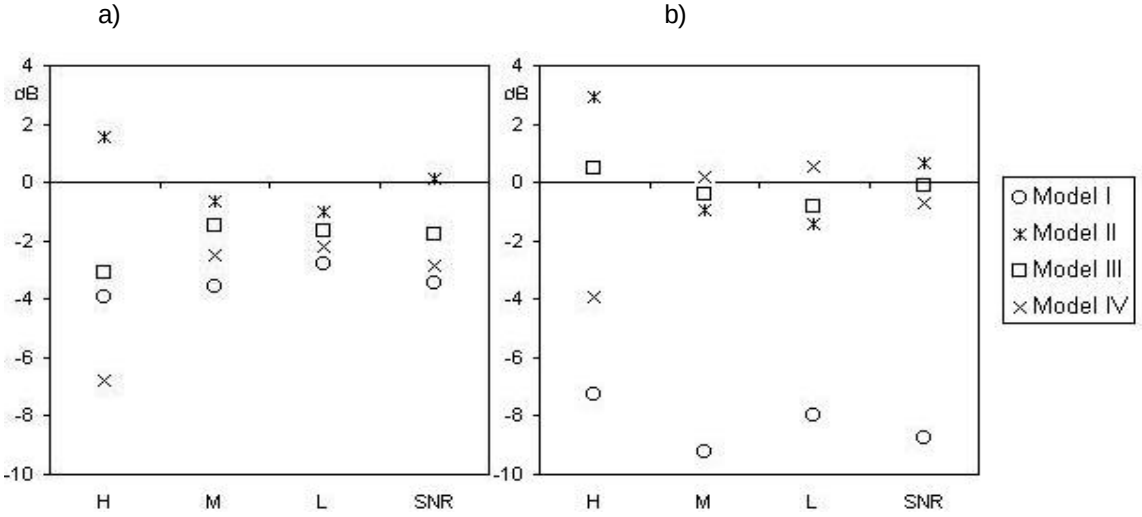


Fig 4.Changes in attenuation, H, M, L, SNR of ear-muffs exposed to natural atmospheric conditions a) after a one-year exposure, b) after a two-year exposure.

In Figure 5, the histograms of temperature and humidity of the air in the environment where the tested samples of ear-muffs were exposed for one and two years are presented a) temperature data, b) humidity data.

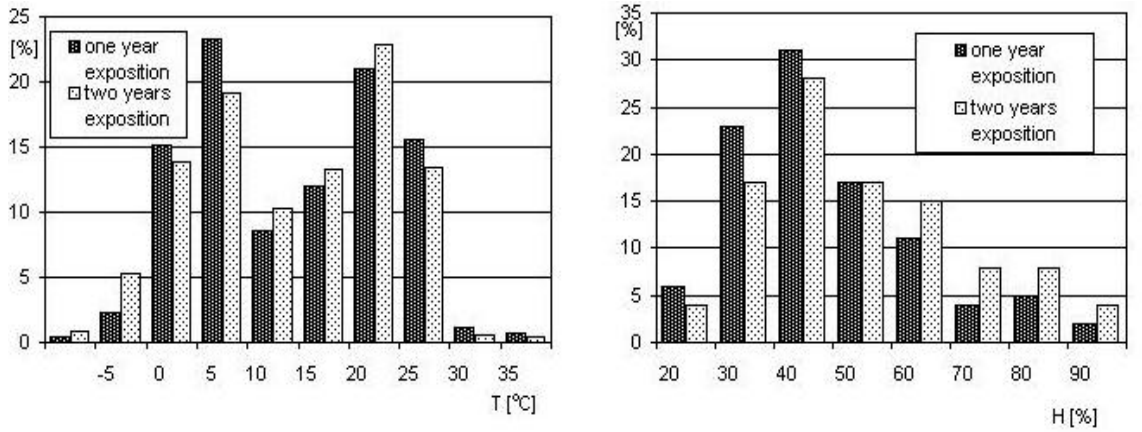


Fig. 5 Histograms of temperature and humidity of the air in the environment where the tested samples of ear-muffs were exposed for one and two years are presented a) temperature data, b) humidity data.

The natural atmospheric conditions affected mostly the attenuation values of ear-muffs of model I. After the first year of exposure, the maximum decrease was observed, regarding the manufacturer's data, for medium-frequency attenuation M – 4.8 dB. After two years of exposure attenuation M decreased by 9.2 dB. Significant changes were also observed in case of model IV after one year of exposure; the estimated high attenuation value was by 6.4 dB lower than that given in the manufacturer's information. The influence of natural atmospheric conditions on the attenuation of ear-muffs of models II and III was rather small in case of models II and III.

RESULTS OF TESTING OF EAR-MUFFS AFTER A TWO-YEAR STORAGE

Figure 6, presents the differences between estimated attenuation data of H, M, L and SNR of hearing protectors after a two-year storage and the values given in the instructions for users.

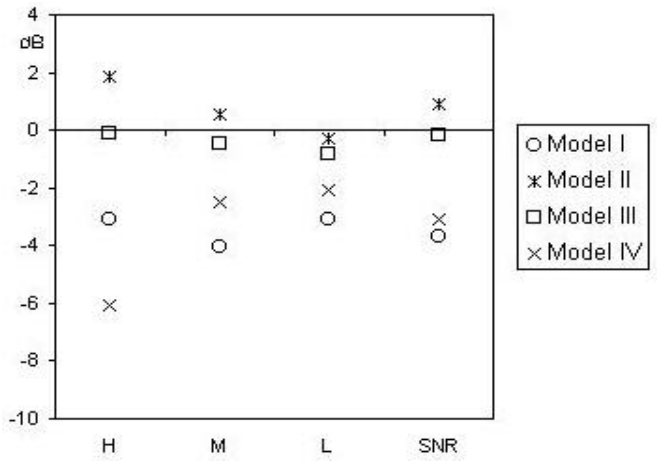


Fig. 6. Changes in attenuation H, M, L, SNR of ear-muffs due to a two-year storage.

A two-year storage did not affect attenuation of hearing protectors of models II and III. A significant influence was observed in case of modes I and IV. The attenuation values of model I were lower than the manufacturer's data about 4 dB on average. In model IV, the high-frequency attenuation decreased by 6.1 dB.

CONCLUSIONS

The investigation of changes in attenuation of ear-muffs due to the duration of use and storage, as well as of the effect of natural atmospheric conditions revealed that the reduction in attenuation H, M, L, and SNR, may be significant and do vary from product to product.

The maximum decrease by 9.2 dB, respective to manufacture data supplied to users, was observed for medium-frequency attenuation of model I of ear-muffs after two years of exposure to natural atmospheric conditions.

The presented results of the investigation indicate the need to continue more extensive research in this field.

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