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Technical Note

Uncertainties of the frequency response of wet microphone windscreens

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ABSTRACT

During outdoor measurements, specific windscreens are often used to prevent rain water to penetrate into the microphone and to damage its components, but some water can nevertheless remain in the foam of the windscreen. This paper presents an extensive experimental study of the influence of water in the foam of a windscreen on its frequency response. It is concluded that the presence of water inside a windscreen can significantly change the sensitivity of the system only for rain amount higher than 1 mm and for frequency above 1 kHz. Some disparities can be found between the different types of windscreens. Bias correction values, together with uncertainty estimations are given for different types of windscreens and an estimation of the duration during which correction and uncertainty must be applied is also proposed for several types of common windscreens.

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1. Introduction

Environmental noise measurements often take place over long periods during which acoustic sensors and their outdoor protection are exposed to rainfall. Such situations are very common for example in noise monitoring stations around transport infrastructures. In standards, the influence of rain is only considered by the rain-induced noise that can strongly degrade the signal to noise ratio of the measurement, and common practice is to invalidate the data recorded during a period of rain. Unfortunately, very little information can be found in the literature on the influence of the water that can remain inside the foam of the windscreen, after a rain period, on the frequency response of the windscreen. Currently, this influence is ignored but it could lead to a larger uncertainty in the measurement results.

Very few authors have addressed this issue: Nelson and Godfrey [1] has concluded that there is no significant difference between the frequency response of a wet windscreen and of a dry windscreen. This conclusion was nevertheless based on an experimental study that was concerning only one type of windscreen, that no longer exists now, and only road traffic noise was considered. Moreover, no information on uncertainties is provided in this study.

The purpose of the present paper is to investigate: (a) if the presence of water inside the foam of a windscreen has a significant effect on the frequency response of a windscreen, (b) the significant parameters that could influence this effect (rainfall rate, amounts of precipitation, type of the windscreen ...), (c) the uncertainties on an acoustic measurement result to be taken into account for this effect, and finally (d) how long this effect remains after a rainfall period.

An extensive experimental study has been made in the facilities of the Laboratoire National de métrologie et d'Essai (Trappes, F) in order to measure the change in system sensitivity for measurement conditions consistent with dry and wet windscreen. This campaign includes many types of currently available commercial windscreens. The results given here do not depend on a specific environmental noise source and can be applied for any kind of environmental noise measurement for frequencies from 80 Hz to 10 kHz.

The first section deals with the relative frequency response of a wet/dry windscreen and with parameters that can influence this response. The second section presents how to correct measurements in order to take into account the influence of water inside the foam, and also the associated uncertainties due to disparities in windscreens. Many experimental numerical values are provided for practical applications. The last section provides some information about the time span during which correction and uncertainties must be considered after a rain period.

2. Frequency response of a wet windscreen

2.1. Introduction

Commercial windscreens can widely differ as much for their size, as for the type of foam used in the windscreen, or for the

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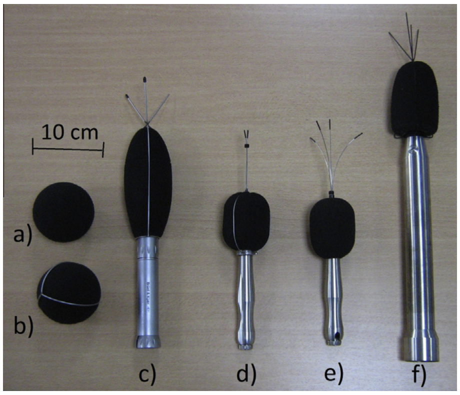

Fig. 1. Types of windscreens measured: (a) BAV112, (b) UA 1650, (c) UA 1404, (d) BAP21 new, (e) BAP21 old, and (f) 41 AM.

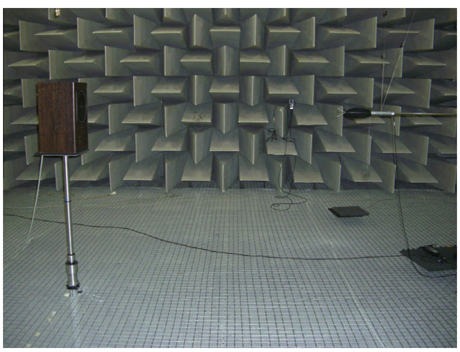

Fig. 2. Frequency response measurement setup.

shape design of the windscreen (sphere, ellipsoid ...). These differences lead to different sensitivities of the frequency response after a rain exposure because (a) the type of the foam of the windscreen influences the water absorption capacity of the foam, (b) the size or the shape design of the windscreen can modify the water flow at the surface of the windscreen and then the amount of water absorbed by the windscreen, (c) the size or the type of the foam can strongly influence the drying behavior of the windscreen.

In order to take into account the wide variety of existing windscreens, 6 types of windscreens from different manufacturers have been tested (Fig. 1): four windscreens can be classified as all-weather systems (rain and wind: B&K UA 1404, 01dB BAP 21 old, 01dB BAP 21 new, GRAS 41AM) and two protections as simple wind protections (BAV112, B&K UA 1650). Note that the '01dB BAP21-old' model is no longer available from the manufacturer, but it was nevertheless tested because it is still widely used. The variability due to manufacturing disparities for each type of windscreen has also been investigated by measuring systematically at least three to seven different samples of each type.

2.2. Experimental protocol

The experimental setup is presented in Fig. 2. For each type of windscreen, the frequency response of the wet windscreen has been compared with the frequency response of the same windscreen but dried. The frequency response is measured in 1/10 octave bands, from 80 Hz to 20 kHz, according to the standard IEC 61672-2:2002 [3]. This standardized procedure consists in measuring, in an anechoic environment, the frequency response of a standard calibrated microphone equipped with the windscreen, normalized by the frequency response of the same microphone without windscreen. The microphone equipped with the windscreen has been placed horizontally and the incident wave coming from a loudspeaker was directed along the axis of the microphone (see Fig. 2).

Windscreens were impregnated with water by using a system for artificial rain generation that complies with the standard IEC 60529:1989 [4]. They have been placed vertically under the artificial rain. The quantity of water soaked by the foam has been estimated by weighting successively the wet and the dry windscreen. Seven levels of precipitations have been tested: 1 mm, 2 mm, 4 mm, 7 mm, 12 mm, 17 mm and 40 mm. Values from 1 to 12 mm cover more than 90% situations of French metropolitan rain precipitations per day; while higher values account for tropical situations. Two flow rates have also been tested in order to investigate the influence of the rainfall strength: 1 mm/min, and 3 mm/min for heavy rain. A situation of 'water saturation' has also been tested for each windscreen: it refers to the case where the foam has reached its maximum absorption capacity. For that, the foam was soaked in water, and then squeezed slightly in order to

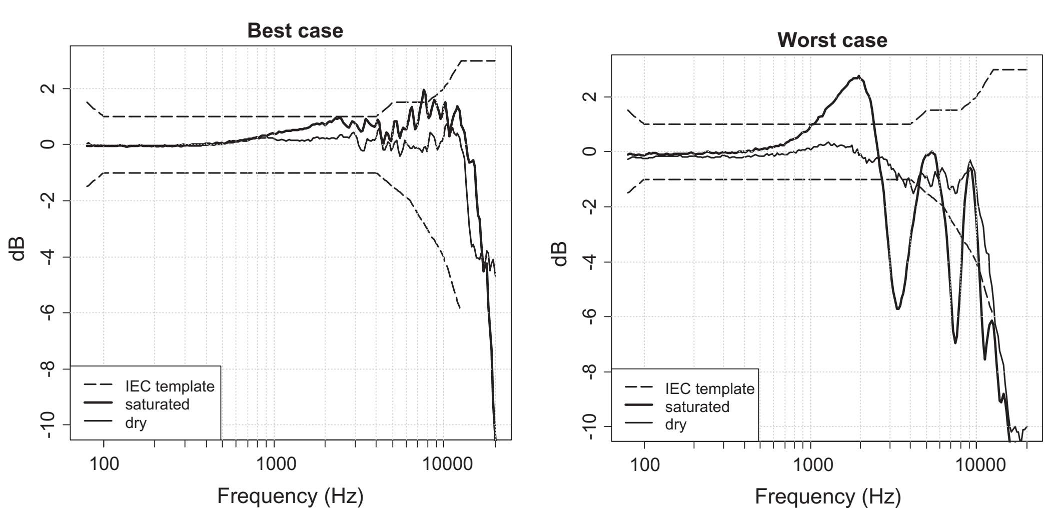

Fig. 3. Frequency response of a dry windscreen and of a water saturated windscreen (ref: reference microphone without windscreen). Best case (left), worst case (right). Dashed lines: Class 1 IEC tolerance template.

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