Drinking water infrastructure as a source for biofilms - A survey of the current situation in Germany

Völker, S., Franke, C. and Kistemann, T.

Institute for Hygiene and Public Health, University of Bonn, Sigmund-Freud-Straße 25, D-53105 Bonn, Germany

The provision of microbially safe drinking water is one of the main requirements of drinking water supply infrastructures. Therefore, the monitoring of drinking water from source to tap is an essential step towards hygiene safety. As a result of the amendment to the German Drinking Water Ordinance in 2001, local health authorities are obliged to monitor the water supply in installations providing water for public use (§ 18 German Drinking Water Ordinance). With a systematic and nationwide survey of locally available data relating to drinking water quality and the existing drinking water infrastructure in buildings, the extent of microbial contamination of in-building distribution systems in Germany can be determined. The identification of specific factors giving rise to biofilm formation, such as building use, should subsequently be possible.

In order to gain an overview of the microbial contamination of drinking water in public buildings all 419 local health authorities in Germany were contacted in the middle of 2007. Their methods of prioritization of inspections were evaluated as well as their sampling routines in public buildings. The questionnaire completed aimed to find authorities willing to provide data about microbiological, chemical, physical and technical parameters gained from in-building distribution system. The available data were collected, cleaned and entered into an electronic database for further statistical analysis.

To obtain an overview of the extent of microbial drinking water contamination within in-building distribution systems, basic queries were generated from datasets in the relational database. In a first step, the drinking water parameters were combined with regard to the total number of analyses and the absolute number as well as the percentage of objections. Objections were classified as failure to comply with the German Drinking Water Ordinance, DVGW technical regulations and Federal Environment Agency recommended limits. The highest rates of samples exceeding these limits were found for the parameter *Legionella* sp. with 5.1 % of all samples (n=9222; limit: 100 CFU/100 ml), followed by heterotrophic plate count at 36°C (3.1 %, n=5726; limit: 100 CFU/1 ml) and *Pseudomonas* sp. (2.2 %, n=1204; limit: 0 CFU/100 ml).

In a second step, one district was selected for more detailed analysis. Drinking water data from 1615 samples in 290 buildings covering the years from 2003 to 2007 were analysed. In this dataset with a heterotrophic plate count at 36°C (11.1 %, n=1245), *Legionella* sp. (2.9 %, n=1284) and *Pseudomonas* sp. (2.8 %, n=397) exceeded the quality limits most frequently.

To determine further effects the microbial condition of the drinking water was differentiated with regard to different building types, e.g. childcare facilities. The number of samples ranged from 25 in kindergartens to 559 in nursing homes. Overall, sports facilities had the highest number of contaminations exceeding guideline values. These amounted to 10.6 % for *Legionella* sp. (n=311), 6.3 % for *Pseudomonas* sp. (n=32) and 4.5 % for heterotrophic plate count at 36 °C (n=288). In rehabilitation clinics and kindergartens the highest overall number of contaminated samples containing *Legionella* sp. (> 100 CFU/100 ml) was detected, exceeding in 22.2 % (n=36) and 11.1 % (n=9) of samples, respectively.

As the results show, with regard to the hygienic-microbiological contamination of in-buidling distribution systems in buildings in Germany as well as in the sample district, the most frequently detected parameters in excess of guideline limits were *Legionella* sp., *Pseudomonas* sp. and heterotrophic plate count at 36 °C. However, the whole dataset does not show regional congruence for these parameters, so further research is required.

The number of samples ranged broadly within all kinds of buildings and with regard to the different authorities responsible for sampling. This is also reflected in the prioritization of inspections and sampling in the institutions surveyed. With reference to specific building types, hygiene-relevant microorganisms with the potential for biofilm formation and growth can primary be identified in buildings such as rehabilitation clinics, sports facilities and

kindergartens. Further data analysis may reveal whether this contamination is related to stagnation where there is only sporadic use or whether other factors are involved in the process of microbial growth in installation systems.

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