Microbiological monitoring in air-conditioned buildings

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Introduction

Microbiological monitoring in air-conditioned buildings not only prevents or reduces the likelihood of those buildings' users being contaminated by biological pollutants, it can also help detect the source of complex diseases.

People who work in air-conditioned environments frequently manifest a range of symptoms, including allergies, irritations, poisoning, and infectious diseases. Although these symptoms are familiar and readily identifiable, it is often more difficult to determine their origin and their occupational character. Outbreaks of Sick Building Syndrome (which is linked to air-conditioning) and Legionnaire's Disease (a bacterial infection that also occurs under these conditions) are complex because they involve both a number of environmental parameters and individual sensitivity.

Studies have been carried out on many of the physical parameters (air quality, humidity, ambient temperature, etc.) and on amounts of chemical pollutants (solvents, mineral dust, pesticides, etc.) present in a variety of air-conditioned working environments. The results of this research have been used to draft purification rules and standards. However, monitoring of these parameters and pollutants is still not sufficient to enable the risk of infection to be properly understood and reduced. Other parameters have been added to those listed above, including biological pollutants like moulds, spores, mites, viruses, and bacteria. Yet in many cases, building managers are not familiar with these factors, not least because the few regulations and standards that exist in this area are not sufficiently specific.

Equipment and methods

A microbiological study of air-conditioning systems in several buildings in Brussels began in October 1995, coinciding with the upgrading of the humidifiers. Seven humidifiers were selected: 2 of the 'Amazone' type, which are relatively recent (commissioned in 1995) and have a capacity of approximately 27,000 m^3/hour, 3 of the 'vaporiser' type, one of which is very large, with a capacity of 470,000 m^3/hour, and dates from 1978, and 2 of the 'honeycomb' type, which are also fairly recent. The 'Amazone' and vaporiser types are equipped with UV germicidal systems.

The primary objective of this initial phase of the study, which concentrated on the humidification process in the period 1995/1996, was to monitor the day-to-day operation of the air-conditioning systems and the activities of maintenance personnel. Microbiological tests carried out before and after cleaning and disinfection enabled us to evaluate the efficacy of these operations, to improve them where appropriate, and to determine the required frequency with greater accuracy.

Results

In one of the two 'Amazone' humidifiers, we discovered bacterial concentrations close to 12,000,000/ml barely a month after the system was brought back into operation, and water with a

conductivity of 10,000 µS (significant crystallisation of salts on the wires and corrosion of the inner walls of the water-collection tanks). After correction of the dilution, thorough cleaning of the wires and the walls of the tank, and institution of fortnightly chlorination, the microbiological situation returned to acceptable levels in January. Another example concerns a very large vaporisation humidifier, the water in which contained up to 4,500,000 bacteria/ml one week after the device was brought back into operation. Once again, the conductivity of the water was too high, with values approaching 4,500 µS. The situation was considerably improved by increasing the supply of make-up water and by alternating cleaning and chlorination at weekly intervals.

On the basis of the obtained results and of the experience we have accumulated through working on numerous air-conditioning systems, we have been able to draw up a preliminary series of microbiological maintenance procedures and monitoring measures capable of ensuring that humidified air is healthy.

The frequency of cleaning and disinfection is crucial. A microbiological maintenance book containing a schedule for these operations and a record of microbiological analyses proves to be an indispensable tool. The collection tanks should be drained at least once a month to allow thorough cleaning, during which the inner walls should be cleansed of any trace of organic reside. Accessing the tank is relatively straightforward in the case of vaporisation humidifiers and so cleaning (high-pressure cleaner and vigorous rinsing) may be carried out on a more regular basis (once a fortnight or month), alternating, where appropriate, with disinfection procedures.

Disinfection of the tanks was introduced in the course of this study. Chlorination of the water followed by two vigorous rinses (frequency to be determined according to the microbiological status of the humidifier, its age, capacity, etc.) proved effective. One advantage of chlorination is that there is no need for bactericidal or fungicidal substances in the water while the system is operating. If the system has a UV steriliser, the tubes and filters have to be maintained regularly and the water exiting the UV tube ought to be subjected to regular bacteriological checks (provide a purge valve for removal). It is also very important that the maximum number of hours for tube operation is not exceeded. This system does, of course, provide an effective support to the operations we have described. The water should also be tested regularly for conductivity ($< 1{,}500$µS), pH (< 9.0): the amount of make-up water (at least once a week), formation of deposits, hardness, etc. As far as the microbiological status is concerned, estimating the total number of bacteria ($< 50{,}000$ CFU/ml, using IHE methodology) is a process that can be readily introduced at regular intervals. Other microbiological tests should be performed once a year, or in the event of health problems manifesting themselves in the building: thermoactinomyces, moulds, protozoa, algae, endotoxins, etc.

Other air-conditioning systems were examined during the second phase of this study. The growing demand for microbiological investigations has allowed the development of new microbiological testing methods, including tests to ensure that the filtration system is properly sealed and to detect the level of ATP in humidifier water and endotoxins in the office air supply. The results obtained have enabled us to extend our recommendations to filtration systems, batteries, extraction and supply chambers, fans and shafts, and the extraction and supply ducts and convectors located in the offices.

Conclusion

Overall, this study has allowed a series of recommendations to be drawn up for the first time with a view to improving the microbiological status of air-conditioned buildings.