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# INDOOR AIR QUALITY IN A LAUNDRY.

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The aeromycoflora of a mecanically ventilated laundry was studied. Ventilation systems were investigated in detail during an aerofungal evaluation, and the activities intrinsic to the premises were also considered.

Two types of sampler were used, namely the Burkard sampler for the evaluation of the fungal score content of the ventilation systems and the outdoor air, and the Andersen sampler for the evaluation of the different rooms of the building.

Abnormally high quantities of fungi were found inside ventilation systems and in some workstations of the premises. After the initial sampling, accessible areas inside the ventilation systems were cleaned with sodium hypochlorite (5%) and water. Air samples from ventilation systems after cleaning confirmed the effectiveness of the cleaning. However cleaning did not influence the concentration of airborne fungi at workstations.

The activities inside a laundry can influence the dissemination of microorganisms in the ambiant air. Laundry handling is an important source of fungal pollution and the installation of a local exhaust ventilation is an effective control measure.

## INTRODUCTION

Molds, in indoor air, originate from various sources. Under certain conditions, ventilation and air conditioning systems can become centers for the growth of microorganisms [1-11]. In addition, some methods of system operation such as a shutdown when the premises are unoccupied can, in certain cases, increase the growth of microorganisms [4,6].

Although mechanical ventilation must be investigated in detail during an aerofungal evaluation, the activities intrinsic to the premises must also be considered. When the sources of fungal proliferation inside a building are clearly understood, effective control methods are easily applied.

The objective of this research is to evaluate the extent to which the cleaning of ventilation systems is effective in controlling microbial pollution. The environment under study is a laundry in Quebec City where certain health problems (hepatitis B) have been detected. Evaluation of the air quality in a laundry is especially important because the activities on the premises can be sources of pollution. Consequently, air sampling was also carried out at the different work stations in the laundry.

## MATERIAL AND METHOD

In the study, three ventilation systems and five workstations were investigated. The ventilation systems admit 100% outdoor air and do not operate when the premises are unoccupied. No maintenance has been performed on the ventilation systems for almost ten years. The workstations in the laundry evaluated for aerofungal pollution were the following:
- the washing machines
- the storage room
- the reception room
- the dry laundry room
- the soiled laundry sorting room.

The samplers used for estimating the aerofungal content at the workstations were the Andersen N-6 and the Burkard's Jet Spore. The Andersen sampler draw a volume of approximately 28 litres per minute and was used at the workstations [12]. The ventilation systems and outside air were evaluated with the help of the Burkard, with an air flow of 600 litres per minute. The sampling time used for the Andersen was two minutes, with two devices operating simultaneously; and 15 minutes for the Burkard. The fungi were collected on a 15 X 100 ml. Petri dish containing 30 ml. of Sabouraud dextrose agar (SDA). The results obtained are therefore expressed as concentrations of colony forming units (CFU) per cubic meter of air ($m^3$).

In order to determine the daily variations of the air spora, the sampling carried out in the morning was repeated in the afternoon. All the culture media were incubated for five to seven days at room temperature.

Certain control measures were implemented in the contaminated areas on the basis of the first results. An area is believed to be contaminated when the indoor aerofungal flora from both the qualitative and quantitative standpoints is both different and greater than that outdoor one. Therefore, after the first aerofungal evaluation, the mixing chambers plenum of the air handling unit were cleaned using a mixture of 5% sodium hypochlorite (javel water) and water. This cleaning was done with ventilation systems turned off. In addition, a major change in laundry handling was implemented, their impacts were evaluated through a second investigation of the fungal flora.

After the second evaluation, more modifications and control techniques were implemented with the goal of maximum attenuation of the fungal pollution in the laundry. By means of a third evaluation of the fungal flora, it was possible to evaluate the impact of the installation of a local exhaust ventilation in the most contaminated work station as well as the thorough cleaning of the ducts. The ventilation system ducts, not accessible in previous investigations, were aspirated using a vacuum equiped with high efficiency filters (HEPA) and cleaned with a 5% solution in sodium hypochlorite in water.

## RESULTS

In the ventilation systems, three aerofungal evaluations in the mixing plenum of air handling units were performed, namely:
- before cleaning
- after cleaning the plenum
- after cleaning the ducts.

In the first evaluation (before cleaning), some air handling units were contaminated i.e. the concentrations measured in the air of the mixing plenum were much greater than those outdoor air (table 1). This observation was valid in the morning, when the systems #1 and #2 were started up. However, once the cleaning program for the mixing plenum as well as an additional cleaning of the ducts had been carried out, concentrations of airborne fungi were greatly reduced and were all below those in outdoor air.

After the second cleaning program (consisting mainly of ducts cleaning), aerofungal concentrations were practically identical to those found after the first cleaning of the mixing plenum. Nevertheless, it is important to consider the outdoor fungal flora. Aerofungal concentrations were higher outdoor in the afternoon and had only a slight effect on the fungal flora found in the mixing plenum. The effectiveness of cleaning the air handling units, by attenuating the fungal concentrations of the air coming from the outdoors, can therefore be observed. From the qualitative standpoint, the species of molds found in the air of the systems are practically identical to those found outdoors. The most frequently identified molds were A. alternaria (23.5%) and P. cyclopium (23%).

Furthermore, of all the workstations studied, the soiled laundry sorting room gives the best example of the effectiveness of the control protocol. The first results in this area showed the greatest amounts of airborne molds (table 2). The modifications made to this work station are associated with a progressive reduction in the airborne fungi. The most effective control method proved to be the installation of a local exhaust ventilation.

For the other workstations, the results of the various evaluations show that the quantities of airborne molds are independant of the cleaning carried out in the ventilation systems (table 3). At workstations where laundry is handled (washers, reception of dry laundry), mold concentrations in the air increase in the afternoon. The diversity of fungi at the work stations is similar to the one already shown for the ventilation systems and outdoor air, with only a few additional species added (mainly Penicillium sp.).

## DISCUSSION

Aerofungal analyses in the mixing phenum on air handling units, in the morning, at system start-up, detected higher quantities of microorganisms. Higher concentrations can be found in ventilation systems where maintenance has been neglected and shutdowns are frequent. When systems are shut down, molds develop more easily on system components due to a reduction in air velocity. During these quiet periods, molds proliferate rapidly and form large quantities of spores. When the air handling units are later started up, elevated quantities of spores are often found in the air disperses from ventilation systems [4,6].

Therefore, an aerofungal analysis at the time of ventilation system start-up allows the extent of the internal fungal contamination to be evaluated. In the case where a contaminant is identified, system maintenance is an effective means of attenuating fungal pollution. Cleaning of six handling units with (5%) sodium hypochlorite in water, effectively reduce the concentrations of fungi in the air. Air sampling after cleaning confirms the effectiveness of the techniques used.

With regard to thorough cleaning of the ducts, our results show little change with respect to the previous evaluation. This can be explained by the quantity of outdoor air admitted (100%), which reduces considerably the risk of promoting microbial growth as long as outdoor air is not humid. Conversely, higher amounts of recirculated air inside a building is associated with the presence of dirty ducts and can contribute to increasing the concentration of indoor fungi.

A second source of dispersal for aerofungal particles is through the laundry processes. Some activities performed in the laundry can be favorable to the dissemination of microorganisms in the ambiant air [13].

Our first results have shown that at some workstations, where there is considerable laundry handling, the air quality can be poor because of elevated concentrations of fungi. In these cases, local ventilation can be an effective control measure.

## CONCLUSION

The sampling of fungi in the air of the studied laundry identified two potential sources of microbial emission, namely: the handling of laundry, and the ventilation system.

The operating of the ventilation systems as well as the maintenance of the premises can greatly affect mold proliferation. Air treatment systems that do not operate during periods of inoccupancy and a lack of maintenance are reasons for aerofungal pollution. A cleaning program using (5%I) sodium hypochlorite in water can effectively eliminate the propagation of molds in the air.

Laundry handling is the second source of fungal pollution found in the studied laundry. Where aerofungal pollution is created by the activity intrinsic to the premises, the means of control are more specific. Installation of a local exhaust ventilation limits the emission of fungi into indoor air. Finally, any means of controlling fungal pollution should be checked, to verify the effectiveness of the techniques used. This follow-up is easily performed by sampling the fungi in the air before and subsequent to the implementation of corrective measures.

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| | | Before cleaning CFU/m³ (June 1988) | After Cleaning Mixing Plenum of Air Handling Unit (December 1988) | After cleaning ducts CFU/m³ (September 1989) |
|---|---|---|---|---|
| System #1 Mixing air chamber | AM | 319 | 20 | 40 |
| | PM | 106 | 20 | 27 |
| System #2 Mixing air chamber | AM | 712 | 27 | 33 |
| | PM | 73 | 13 | 20 |
| System #3 Mixing air chamber | AM | 20 | 7 | 7 |
| | PM | 7 | 13 | 7 |
| Outdoor | AM | 100 | 73 | 47 |
| | PM | 147 | 47 | 240 |

Table 1: Airborne counts of molds sampled inside the ventilation systems.

| TRIAGE | Before cleaning | Decrease of handling | Local ventilation system |
|---|---|---|---|
| Before work | 138 | 52 | 155 |
| Work AM | 529 | 529 | 277 |
| Work PM | 22794 | 218 | 294 |

Table 2: Airborne counts of molds sampled in the studied laundry soiled room.

| LIEUX | | Before cleaning CFU/m³ (June 1988) | After Cleaning Mixing Plenum of Air Handling Unit (December 1988) | After cleaning ducts CFU/m³ (September 1989) |
|---|---|---|---|---|
| Washing machine | AM | 9 | 44 | 27 |
| | PM | 25 | 172 | 18 |
| Storage room | AM | 18 | 112 | 108 |
| | PM | 18 | 52 | 27 |
| Reception room | AM | 257 | 99 | 260 |
| | PM | 310 | 198 | 152 |
| Dry laundry room | AM | 174 | 9 | 9 |
| | PM | 472 | 35 | 45 |

Table 3: Airborne counts of molds sampled at the different workstations in the studied laundry.