

Firm Joins Emission Testing with Animal Bioassay

Air Quality Sciences Inc. (AQS), Atlanta, Georgia, USA, has added a toxicology facility to its already established environmental chamber testing facility.

AQS is known for its small and large testing chambers for measuring emissions from various products and substances (see *IAQU*, February 1993). Its latest addition will couple advanced dynamic chamber testing with animal testing to detect the irritation and toxicological potential of even low-level emissions.

Dr. William Muller, formerly with the Institute of Environmental Medicine at the University of Pennsylvania and director of the new Life Sciences Center, said the new joint testing will allow

manufacturers to determine whether the emissions from their products can be characterized as potential sensory or pulmonary irritants.

This type of testing has recently become important with developments such as the carpet studies now going on (see story on page 1). By monitoring a product's emissions and simultaneously monitoring animal responses, AQS can predict whether the products might produce irritation in humans.

For further information, contact Dr. Muller, Air Quality Sciences, 1331 Capital Circle, Atlanta, GA 30067, USA; (404) 933-0638, Fax: (404) 933-0641.

CASE STUDY

[In each issue IAQU presents a case study on an investigation of indoor air problems in a particular building. The editorial staff relies on information provided by the environmental consultants involved in the investigation. IAQU presents a variety of approaches to investigation and mitigation implemented by consultants with a broad range of experience, philosophies, and expertise. Inclusion of a particular case study in the newsletter does not imply IAQU's endorsement of the investigative procedures, analysis, or mitigation techniques employed in the case. IAQU invites readers to submit comments, suggestions, and questions concerning any case. At the discretion of the editors, correspondence may be presented in a future issue.]

Humidifiers Breed Microbial Growth in Residential HVAC System

Not all IAQ problems occur in commercial buildings. While many residences also have indoor air worries, most differ significantly from commercial space, both in the scope of the problem and the type of equipment involved.

This case, however, involves a residence as large as a small commercial building, in which humidifiers have provided a breeding ground for high levels of microbial growth.

Located in the northeastern US, the home originally contained 2,000 square feet (ft²) of living space, but the owners recently expanded it to 11,000 ft². During the renovation, in the summer months, one of the rooms suffered a fire. After that, workers cleaned the mansion's air conditioning ducts.

The renovation work was completed in early fall and, from the beginning of the heating season, the home's three occupants suffered a variety of upper respiratory irritations, including a sinus condition and dry cough. All three, two adults and a child, reported that their symptoms were

long-lasting, but disappeared when they were away from the home for extended periods.

In early February, the owners called in IAQ consultants to investigate the situation. The team consisted of an industrial hygienist and a mechanical engineer.

Building and HVAC Description

The residence is heated and cooled by all-air HVAC systems. Of a total of eight units, two are in the original section of the house and are located in a mechanical space in the basement. Six units serve the new addition and are located in various spaces.

All units use sheetmetal ducts with acoustic/thermal fiberglass insulation. The investigators inspected the lining through the floor supply air outlets and reported that it appeared to be in good condition.

Electrostatic filters clean the air for each of the HVAC units. The home's caretaker reported that the filters are cleaned approximately three times

a year, and investigators noted that at the time of their inspection the filters appeared to be clean.

Only the squash court and fitness room air handlers were set to bring in outside air (O/A). They are controlled by an enthalpy system, an energy-saving feature that measures return air (R/A) temperature and compares it to the outside ambient temperature. If, during cooling mode, the outside ambient air temperature is below the R/A temperature, the damper opens to allow maximum O/A into the system. The squash court has a dedicated exhaust fan.

In other areas of the house, due to the low occupancy, O/A did not normally enter the systems. The lack of O/A meant that nonoccupant-generated pollutants — such as from cleaning chemicals and gases given off by construction products and new furnishings — could build up in the residence.

Each air handler unit has a central control thermostat. However, the occupants reported that after the fire some of the thermostats had been acting erratically. This was most likely

due to the particulate matter from the smoke interfering with the electronic circuitry.

The investigators also discovered a storm-water drain pipe that was leaking directly above the supply ductwork serving the living room and the bedrooms. The caretaker reported that this leaking usually occurred during heavy rain or snow. Investigators noted that the water was penetrating the duct, bringing up the possibility of biological growth inside.

Each of the HVAC units in the new addition, except for the squash court and fitness unit, contained an ultrasonic humidification system. These sprayed a fine mist of tap water into the air handler in the cooling coil section. Investigators noted visible biological growth on the coils and duct lining insulation.

The units in the original section of the house had humidification units in the supply ductwork downstream of the supply fan. In these units, brushes rotate through a reservoir into the air stream, where the moving air picks up the moisture. Investigators noted signs of

Table 1 — Air Samples

Location	Type of Sampling	Organism	Concentration in cfu/m ³	Description
Master Bedroom	Quiescent	Bacteria	353.4	<i>Sarcina, Bacillus, and others</i>
		Fungi	35.3	<i>Penicillium</i>
	Aggressive	Bacteria	883.4	<i>Sarcina, Staphylococcus/Micrococcus, and others</i>
		Fungi	282.7	<i>Cladosporium, penicillium, Aspergillus niger, Alternaria, paecilomyces</i>
Bedroom 2	Quiescent	Bacteria	459.4	<i>Sarcina, Staphylococcus/micrococcus, and others</i>
		Fungi	35.3	<i>Aspergillus versicolor</i>
	Aggressive	Bacteria	1,519.4	<i>Sarcina, Staphylococcus/Micrococcus, Bacillus, and others</i>
		Fungi	70.7	<i>Aureobasidium</i>
Library	Quiescent	Bacteria	2,614.8	<i>Sarcina, Staphylococcus/Micrococcus, Flavobacterium, Pseudomonas, and others</i>
		Fungi	600.7	<i>Cladosporium, Penicillium, Absidia, Rhodotorula, and yeasts</i>
	Aggressive	Bacteria	14,134.3	<i>Sarcina, Staphylococcus/Micrococcus, Flavobacterium, and others</i>
		Fungi	812.7	<i>Cladosporium, Absidia, Epicoccum, Penicillium, yeasts, and sterile fungi</i>
Family Room	Quiescent	Bacteria	318.0	<i>Sarcina, Staphylococcus/Micrococcus, and others</i>
		Fungi	35.3	Yeasts
	Aggressive	Bacteria	1,060.1	<i>Sarcina, Staphylococcus/Micrococcus, Flavobacterium, and others</i>
		Fungi	353.4	<i>Cladosporium, Penicillium, Aspergillus versicolor, Aureobasidium, and yeasts</i>

biological growth in the reservoir, but were unable to access the duct interiors.

In addition to these, the family members had stand-alone humidifiers in the bedrooms. Based on these observations, investigators decided to sample for bioaerosols.

Microbial Sampling

Investigators sampled for both bacteria and fungi, using quiescent and aggressive techniques. They focused on four areas: the child's bedroom, the master bedroom, the library, and the family room.

All samples showed elevated levels of both fungal and bacterial organisms, although the samples taken during aggressive sampling were higher.

Analysis of the samples, shown in Table 1, revealed *aspergillus versicolor*, and *aspergillus niger*, both of which can cause respiratory distress. These were found in all areas.

Eight bulk samples, mostly water from the humidifier reservoirs, showed high levels of bacterial growth. One of the personal humidifiers had 346,000 colony forming units per milliliter (cfu/ml), and another, 13,600 cfu/ml, also a level of concern. Bacterial levels are considered low to moderate at levels below 10,000 cfu/ml. Bulk sampling results are shown in Table 2.

Other IAQ Monitoring

Carbon monoxide levels, temperature, and relative humidity were all within acceptable limits on the day of the investigation.

However, the investigators noted that the fitness center has a swimming pool that uses bromine (Br₂) as a biocide for the water. There was a strong odor from the bromine, which is a powerful irritant to the lungs.

A member of the same halogen family as chlorine and iodine, Br₂ has a permissible exposure limit (PEL) of 0.1 parts per million. The US Occupational Safety and Health Administration sets PELs for workplace exposure. While these are not applicable to a residential setting, the low PEL shows the hazard potential of the chemical.

Recommendations

Investigators have made a number of recommendations for alleviating the problems found during the evaluation.

The first is that the occupants cease using both the personal humidifiers and those contained in the HVAC systems. They also suggest that, before replacing these humidifiers, professional duct cleaners inspect and clean all duct work to remove any microbial growth downstream of the humidifiers.

The engineer suggests installing direct steam injection humidifiers in the air handling systems and placing them downstream of the coils to limit condensation.

Because outside air would help remove the build-up of internally generated pollutants, the investigators recommend that all air handlers be adjusted to accommodate O/A, a capability they already have.

Table 2 — Bulk Samples

Location	Organism	Concentration in cfu/ml	Description
Master Bedroom - Humidifier 1	Fungi	None	
	Bacteria	242,000	<i>Flavobacterium</i>
Master Bedroom - Humidifier 2	Fungi	7,000	Yeasts
	Bacteria	346,000	<i>Flavobacterium</i>
Bedroom 2 - Humidifier	Fungi	None	
	Bacteria	13,600	<i>Flavobacterium</i>
Attic HVAC Unit - Zone 8	Fungi	200	Yeasts
	Bacteria	164,000	<i>Flavobacterium</i>
Attic HVAC Unit - Zone 7	Fungi	None	
	Bacteria	68,000	<i>Flavobacterium</i>
Old Basement HVAC Unit	Fungi	None	
	Bacteria	156,000	<i>Flavobacterium</i>
New Basement HVAC Unit	Fungi	700	<i>Cladosporium</i>
	Bacteria	368,000	<i>Flavobacterium</i> and others

Thermostats that are acting erratically should be replaced to eliminate the problem caused by the earlier fire.

The bromine in the swimming pool should be replaced with a different biocide or the air from the fitness room should be exhausted directly to the outside and not recirculated through the rest of the house.

Before using air handling units again, the residents should have them cleaned with a biocide. The investigators said this should be done with the units shut down and while areas served by the units are unoccupied.

They also recommend that the entire house be cleaned with high efficiency (HEPA) vacuum cleaners. All carpets and furniture need to be vacuumed repeatedly.

They also recommend that the residents consult with appropriate medical authorities on the pos-

sible health effects from exposure to the bacteria and fungi found in the home.

Conclusions

Poor moisture control leads to many problems in a variety of buildings. In this instance, the combination of leaky pipes, poorly functioning humidification systems, and poorly maintained personal humidifiers provided a dangerous situation for the occupants.

Recommendations from the Consumer Products Safety Commission urge that personal humidifiers operate on demineralized water and be cleaned with a biocide every day or two. This is something most users don't do.

For more information, contact John Tiffany or Howard Bader, Tiffany-Bader Environmental, Inc., 25 Hickory Place, Suite F-28, Chatham, NJ 07928, USA; (201) 966-1909, Fax: (201) 765-9225.

NEWS AND ANALYSIS

US Congress Tries Once More to Pass IAQ Legislation

Hearings have begun in the US Congress on two bills dealing with indoor air quality. Senator George G. Mitchell (D-ME), filed the Senate version, designated S 656, while Representative Joseph P. Kennedy (D-MA), filed the House bill, designated HR 1930.

The Senate passed the Mitchell bill last year, but the Kennedy legislation failed to get out of committee. Both bills have been reintroduced this year — with some modifications. The bills are similar in that they call for research, technology demonstration programs, public health advisories, and model building programs, among other things.

The Senate version differs in that it requires the US Environmental Protection Agency (EPA) to set up an Office of Indoor Air and a Council on Indoor Air Quality. It would also require the EPA to develop and publish a list of contaminants, along with health advisories on the individual items on the list. Some of the provisions of both bills cover programs that are already in place, but give them the force of law.

The hearings on the bills began in late May in the Senate Environment subcommittee with testimony on the Mitchell bill. The previous administration opposed IAQ legislation, but the Clinton administration has indicated initial sup-

port for both bills. The annual cost of each bill is similar. The Senate version has a price tag of US \$48,500,000, while the House version calls for US \$47,000,000.

Key points of both bills are as follows:

- The bills call for the EPA to do or facilitate research on assessing and characterizing indoor air contaminants, their effects on human health, and exposure of individuals. They also would require the EPA to identify populations at risk, contaminants sources, and building types associated with different IAQ situations. The research would include developing methods to predict IAQ problems and techniques for improving the air in buildings.
- Technical demonstration programs would help to show the feasibility and cost effectiveness of new, improved, or unproven technologies in the IAQ field. Under the provisions of the bills, the EPA administrator would regularly solicit proposals for the demonstration projects, and the EPA would furnish up to 75% of the funding.
- The EPA would have to conduct exposure assessments and consider such assessments when making ambient air quality regulations.