

# Case Study: Indoor Air Quality Retrofit for Preschool



## Case Study Overview

In January 2016 AirAdvice for Homes tested the indoor air quality at Mrs. Teapot's Tiny Tots preschool in Portland, Oregon. Multiple IAQ issues were discovered and equipment was installed by AirAdvice contractor Neil Kelly to reduce contaminants to within acceptable levels. Post testing was then conducted to measure the effectiveness of the equipment installed.



Mrs. Teapot's Tiny Tots Preschool

## Characteristics of the Building

The structure is a 1950s single-family bungalow with a full, finished basement. A central forced air gas furnace is located in the basement of the home. The main floor is used for a preschool Monday-Friday, and the basement level is occupied by the owners and their two small dogs. Typical occupancy consists of three adults and 7-10 children during work hours, a challenging environment for indoor air quality.

## Results of the First IAQ Test

AirAdvice first conducted an IAQ test to baseline the project. Six IAQ parameters were tested; four were found to have

high levels. Concentrations of particulate matter, airborne chemicals (VOCs), carbon dioxide, and relative humidity were above recommended thresholds established by industry standards.

The contaminants were not detectable without sensors, and the owner was surprised and concerned by the results. She was unfamiliar with the IAQ issues, what the solutions were, or what those solutions might cost, but relieved to learn that affordable solutions could be installed to address the issues.

**Particulate Matter (PM)** – The weekly average level of particulate matter found at the preschool was 17 micrograms per cubic meter ( $\mu\text{g}/\text{m}^3$ ), almost twice the acceptable level. Elevated particle levels are known to trigger asthma and allergy symptoms. Cooking and other combustion activities are the most common sources of PM in homes.

**Airborne Chemical Pollutants (VOCs)** – The average concentration of VOCs were found to be  $2637 \mu\text{g}/\text{m}^3$  – over five times the acceptable level of  $500 \mu\text{g}/\text{m}^3$ . Airborne chemicals can trigger allergies and asthma. Common sources include building materials, furniture and cleaning supplies.

**Carbon Dioxide (CO<sub>2</sub>)** – The weekly average concentration of CO<sub>2</sub> was 1456 ppm – over twice the recommended maximum. High CO<sub>2</sub> environments have been shown to diminish cognitive function in healthy adults. The primary cause of excessive CO<sub>2</sub> is inadequate ventilation.

**Relative Humidity** – The average weekly level was 64%, with daytime peaks nearing 70%. Humid environments can support growth of dust mites and mold. Relative humidity should be kept between 35% - 60% according to ASHRAE.

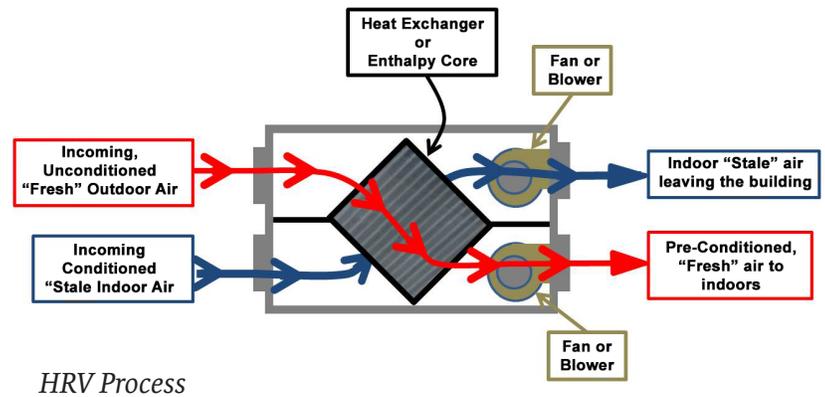


AirAdvice M5200 Monitor

# Solutions for IAQ Pollutants

## New equipment installed:

- MERV 11 Whole House Media Filter
- Heat Recovery Ventilator (HRV)
- Photo Catalytic Oxydizer (PCO)
- UV Treatment System
- Programmable thermostat



High particulate levels were addressed by installing a MERV 11 filtration cabinet designed to capture particles less than 10 microns, the size range that causes health problems. The post-test results revealed the concentration of these particles decreased by more than half.

VOCs were reduced by 99% by using a combination of two different technologies.

- ▶ A heat recovery ventilator (HRV) was installed to bring in outside air, which diluted indoor concentrations of pollutants.
- ▶ A Photo Catalytic Oxidizer (PCO) was installed to break down VOCs as they pass through the air handler.

The HRV also reduced CO<sub>2</sub> levels 46%, from 1456ppm to 726ppm. By bringing in outside air with a CO<sub>2</sub> level of about 400ppm, and exhausting stale air, the HRV diluted CO<sub>2</sub> to acceptable levels. In addition, the HRV recovered heat from the outgoing air stream and transferred that heat to the incoming air stream, providing energy efficient ventilation.

Potential mold growth was addressed by the installation of a UV light in the coil.

## Conclusions

- Particles were brought down by upgrading to a MERV 11 filter and increasing furnace fan run-time.
- The HRV reduces both VOC and CO<sub>2</sub> levels.
- New thermostat allowed for precise control of furnace fan run-time to get maximum benefit from IAQ equipment.
- Solutions installed are both simple and effective.

AirAdvice Test	Pre	Acceptable Level	Post	% Change
Particulates (ug/m <sup>3</sup> )	<b>17</b>	10	<b>9</b>	-47%
VOC (ug/m <sup>3</sup> )	<b>2637</b>	500	<b>33</b>	-99%
CO <sub>2</sub> (ppm)	<b>1456</b>	750	<b>726</b>	-49%
Temp (F)	68	70	69	n/a
RH (%)	<b>64</b>	35-60	<b>51</b>	-13%
CO (ppm)	1	6	0	n/a

## Summary

Four of the six IAQ parameters tested exceeded acceptable levels based on health guidelines. Despite the high levels found, no one recognized the health threat before the testing revealed them. The problems found in the preschool were typical of regular, everyday homes, but were exaggerated by the high level of occupancy. Homeowners may not be aware of health risks associated with indoor air pollutants, the solutions available and how they could benefit from these solutions.

The owner of the preschool noticed the change in air quality immediately after the IAQ equipment was installed. She now touts the new system to parents considering enrollment at the preschool and reassures parents that their children can spend their time in an environment in which they can breathe healthy air.

The added benefit for the owner is energy savings. The HRV installed into the existing ductwork dilutes the concentration of indoor pollutants, but also recovers energy by using the latent heat in the outgoing air to temper the incoming air. This is much more energy efficient than a simple exhaust fan which relies on leaks in the house to bring in outside air.

**“... I stopped taking my two allergy pills before work every day. I also haven’t had to use my inhaler at all. Last year, I used to use it about once a month.”**

*- Full-time teacher at the preschool,  
March 2017.*

## 2017 Update: One Year After Installation

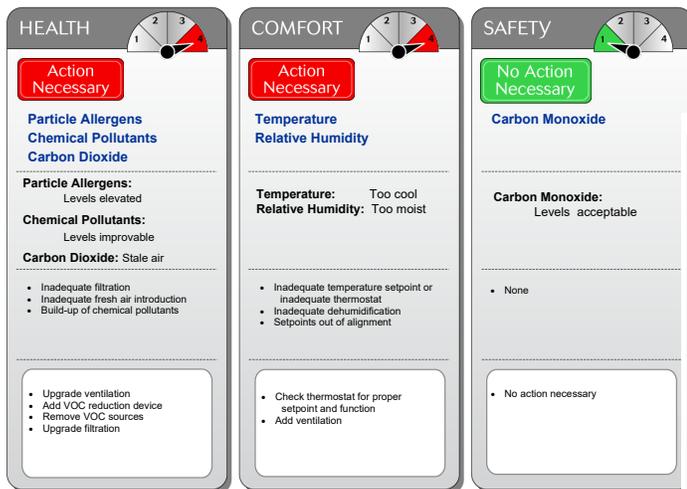
In March of 2017 two teachers were interviewed to discuss results. One full-time teacher stated “I noticed things were different about a month after the project. That’s when I stopped taking my two allergy pills before work every day. I also haven’t had to use my inhaler at all. Last year, I used to use it about once a month.” The other teacher talked about missed work being reduced. “What I noticed ... is that she used to use all of her sick days by March! She doesn’t need to take them anymore.”

The most profound impact, however, may be upon preventing chronic illness for the children that attend the school. Environmental triggers such as VOCs, particulates, and high humidity contribute to the development of asthma and allergies, especially in sensitive populations like children.

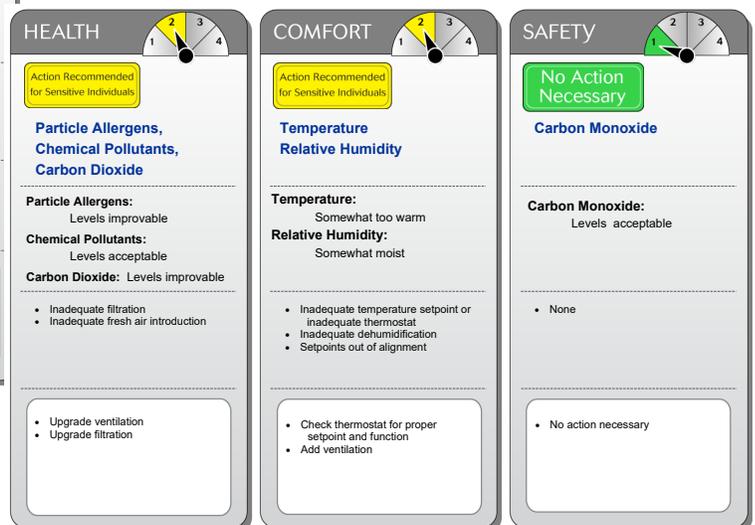
## DayCare Case Study Test Results - Overview

### Before

AirAdvice monitor data is collected and uploaded to a server. AirAdvice contractors can view data and generate reports such as this one. These charts & graphs are from a SmartIAQ report.



### After Solutions Installation

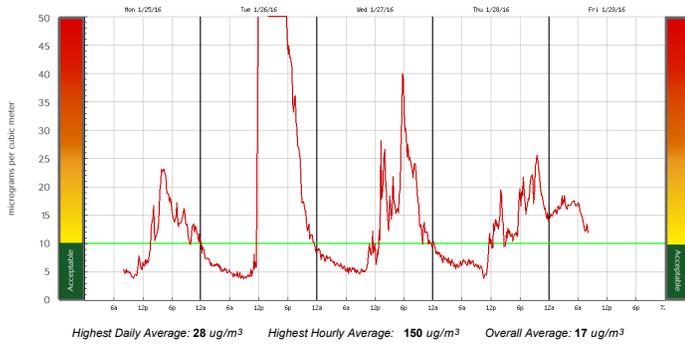


Detailed graphs on the following page, show the Particulate, VOC, CO<sup>2</sup> and Relative Humidity levels for the 5 days each of Before & After testing.

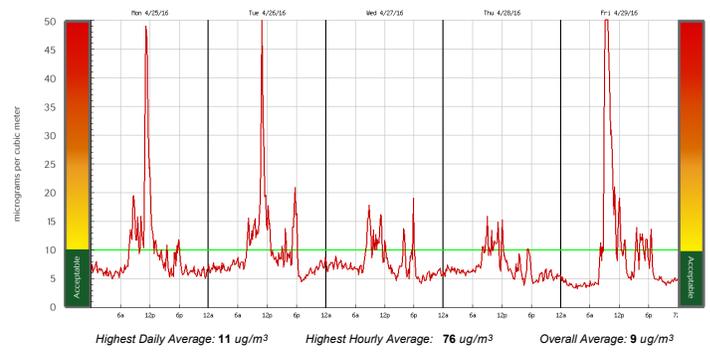
# Preschool Test Results

## Particulates

Before

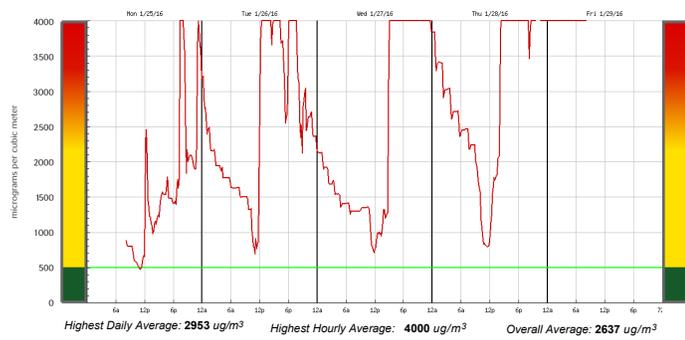


After

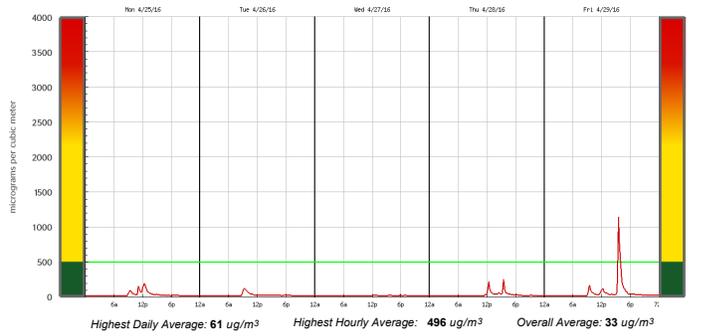


## Chemical Pollutants (VOCs)

Before

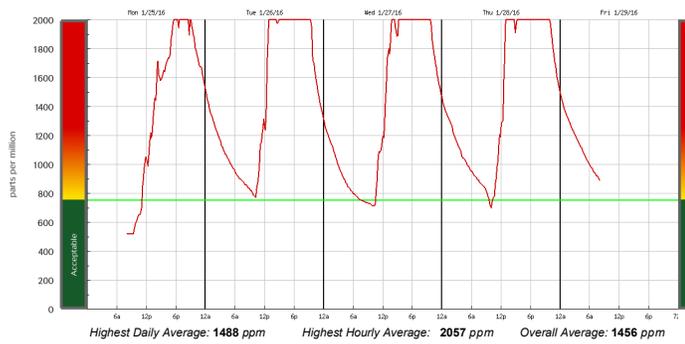


After

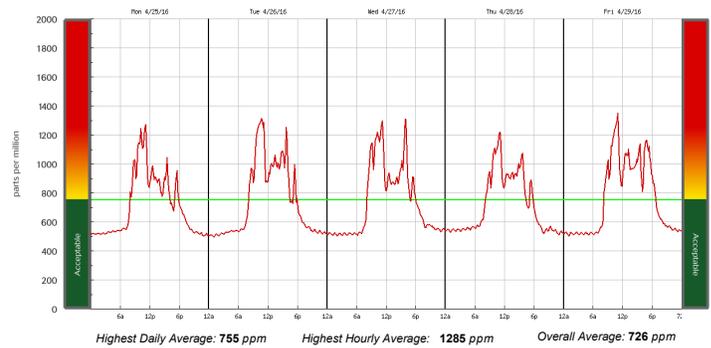


## Carbon Dioxide (CO2)

Before

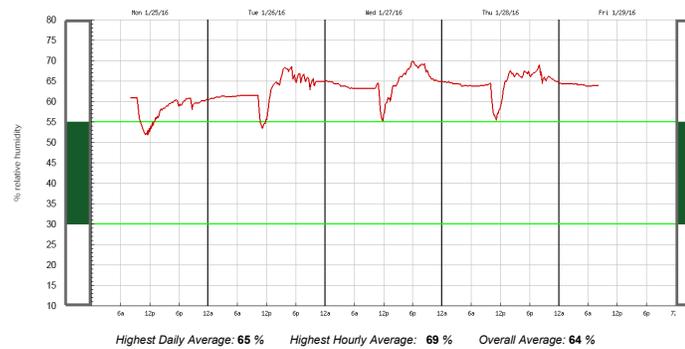


After



## Relative Humidity

Before



After

