EFFECTIVENESS OF HVAC DUCT CLEANING PROCEDURES IN IMPROVING INDOOR AIR QUALITY

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Abstract. Indoor air quality has become one of the most serious environmental concerns as an average person spends about 22 hr indoors on a daily basis. The study reported in this article, was conducted to determine the effectiveness of three commercial HVAC (Heating Ventilation Air Conditioning) duct cleaning processes in reducing the level of airborne particulate matter and viable bioaerosols. The three HVAC sanitation processes were: (1) Contact method (use of conventional vacuum cleaning of interior duct surfaces); (2) Air sweep method (use of compressed air to dislodging dirt and debris); (3) Rotary brush method (insertion of a rotary brush into the ductwork to agitate and dislodge the debris). Effectiveness of these sanitation processes was evaluated in terms of airborne particulate and viable bioaerosol concentrations in residential homes. Eight identical homes were selected in the same neighborhood. Two homes were cleaned using each procedure and two were used as controls. It was found that both particle count readings and bioaerosol concentrations were higher when cleaning was being performed than before or after cleaning, which suggests that dirt, debris and other pollutants may become airborne as a result of disturbances caused by the cleaning processes. Particle count readings at 0.3 micron size were found to have increased due to cigarette smoking. Particle counts at 1.0 micron size were reduced due to HVAC duct cleaning. Post-level bioaerosol concentrations, taken two days after cleaning, were found to be lower than the pre-level concentrations suggesting that the cleaning procedures were effective to some extent. Homes cleaned with the Air Sweep procedure showed the highest degree of reduction in bioaerosol concentration among the three procedures investigated.

Keywords: airborne particulate matter, bioaerosol, duct cleaning, HVAC, indoor air quality

1. Introduction

As a consequence of the energy crisis during 1973–1974, increased public awareness of the need to conserve energy in homes led to the design and construction practices for energy efficient buildings. The energy efficient design and construction practices involved ‘sealing up’ of many older homes, implementation of additional sealing measures during the construction of new homes and alterations to ventilation system (Bayer, 1990). The energy saving design and construction practices included provisions such as vapor barriers within the walls, added insulation, caulking of outside windows, and sealing of outside doors. The sealing up of buildings significantly reduced the infiltration rate of outside walls, resulting
into deteriorated indoor air quality in the newer homes (Mansdorf, 1993). The average person spends about 22 hr a day indoors. The old and very young spend almost all day indoors (Moschandreas, 1981). In an average home, the indoor air contains between 100 and 200 different air contaminants (Delaney, 1991). These contaminants include volatile organic compounds from plywood and other building materials; bacteria, molds and fungi from a variety of sources; chemical fumes from cleaning products and dry cleaned clothes; carbon monoxide and nitrogen dioxide from furnaces, gas ranges, wood burning stoves, fireplaces, gas fueled and kerosene heaters; animal dander from house pets; fumes from air fresheners; pesticides from the spraying process; and cigarette smoke.

Indoor air quality (IAQ) is one of the most serious environmental concerns along with lead poisoning and hazardous wastes (Krafcision, 1993). In large cities, the indoor air quality has been reported to be as much as five times worse than the outdoor air quality (Krafcision, 1993; NAS, 1981; Maserjian, 1993). A complex combination of structural characteristics of buildings, environmental conditions and the building occupants contribute to the indoor air quality. Possible causes of indoor air quality concerns include installation and design of the cooling and heating equipment, building design and construction, number of occupants, activities of the occupants, airborne pollutants and human physiological factors (Materson, 1992; Triplett, 1992). The subjective nature of the complaints due to poor indoor air quality complicates the management of the indoor air quality. Temperature variations, high carbon dioxide levels, humidity, microbial and chemical pollutants have been linked to IAQ complaints (Ritter, 1993). Proper design, operation, and maintenance of HVAC (Heating Ventilation Air Conditioning) systems and ductwork can significantly improve indoor air quality.

Indoor air quality of residential houses can become a significant problem and is perhaps responsible for several kinds of allergic and respiratory diseases of occupants. Improper design, installation and maintenance of HVAC systems and ductwork can contribute to this problem. HVAC units can become sources of mold, fungi and other microbial pollutants. Dirt, dust and fibrous material can accumulate inside the ductwork. One way of keeping the indoor air quality of a residential house good is to clean its HVAC unit and ductwork on a periodic basis.

In this article, we present findings of a study conducted on a number of residential homes. The objective of the study was to determine relative effectiveness of the three most common commercially available HVAC duct cleaning procedures. The effectiveness was measured in terms of the two major parameters of indoor air quality: airborne particulate matter and viable bioaerosols.

It should be noted here that due to budgetary constraints, only two homes were investigated for each procedure. As such, we did not attempt to present any statistical analysis of findings. We present these results as case studies indicating general trend and suggesting guidelines for elaborate experimental design. Findings of this study will help identify the specific parameters for further investigation and will lead to more intricate research studies.