COMPONENTS OF THE AIR HANDLING UNIT AND AIR QUALITY

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ABSTRACT

In this study, the odor generation of various components of air handling units was investigated. Results show that air handling system really can deteriorate the perceived air quality of the supply air. Almost all components seem to be sources of pollution, but differences between the components were significant. Used fiber filters seem to be the worst. A major reason for the pollution seem to be oily, dusty, and dirty surfaces. Increase of the air flow did not improve the air quality in downstream of the component which indicates a significant increase of emission with air flow or non-linear dose-response relation between the perceived air quality and pollutant concentration.

INTRODUCTION

The aim of the study was to investigate the effect of various components of air handling units on perceived air quality. The components selected for the tests represented typical components used all over Europe in the air-handling systems. They included filters, typical coils, heat recovery heat exchangers, fans, and silencer.

The cleanliness of the air handling units is also important for the air quality. The effect of cleanliness on the perceived air quality was investigated using an old (app. 10 years) air handling unit which was measured before and after cleaning.

One of the most important questions for the modeling of the supply air quality is: how to deal with the multiple sources. In order to test if pollution sources are additive, indivitually tested components were installed after each other and the air was flowing through the whole set of components. The perceived air quality was measured after each component.

METHODS

Measurements in the initial phase of the European Data Base project (1) showed that HVAC components did not emit significantly chemical compounds which are captured by Tenax TA absorbent. Based on this finding the chemical measurements were excluded from the final measurements. The measurements were done according to the protocol developed in the Data Base project. Temperature and humidity seemed to have some effect on the emission from the HVAC components. The temperature was selected to be 23±1°C. The humidity seemed to have even less effect on the results than temperature and during the measurement it can be ambient. The velocity seemed to have the largest effect on the emissions. To increase the concentration of compounds in the air, the air flows for the measurements were selected to be only one forth and half of the nominal air flow. All measurements were done using a trained sensory panel.

Testing of the HVAC components differ significantly from the testing of building materials. The components have to be installed as a part of the system were temperature and air flows can be controlled, the components cannot typically be tested in small samples as materials but as an entity. This sets special requirements for testing. In the test the clean air flows through the component, and the perceived air quality is measured before and after the component. The air sample is continuously taken from the air flow passing through a tested component and supplied to the exposure cone for sensory evaluation. The emission of the compound is calculated from the difference of the perceived air quality before and after the component.

The age of the components

The building materials are tested when they are three days and four weeks old to get an representative emission rates for practical purposes. Typically the emission decreases with the age of the material. This is not the case with the HVAC components. Measurements have shown that, for example, the dust accumulated on a filter causes an increase in emission rates, as well as the dust in the ducts. This was well recognized during the project, but because the operation conditions of air handling units vary a lot with the location and other conditions, it was decided that the components to be tested should be new and less than four weeks old. The components should be conditioned with air flowing through them at the nominal rate 72 hours before the tests. If the tests are performed in several conditions and the environmental parameters are changed, the conditions have to be constant in respect of the temperature and air flow at least 30 minutes before the measurements.

Tested components

The components which were selected to the tests represented typical components used all over Europe in air handling systems. They included

- glass fiber filters: EU 7 and EU 8
- synthetic filters: EU 4 and EU 8
- odor filter (active carbon)
- new cooling coil (before and after cleaning)
- silencer
- axial fan

The tests were made with 0.25 m³/s and 0.5 m³/s air flows. Nominal air flow of the unit is 1 m³/s. The odor emission was estimated from the perceived air quality. The cooling coil was tested twice: before and after cleaning with detergent and a pressure washer.

Tests for modeling

One of the most important questions for the modeling is how to deal with the multiple sources. The problem is: can the sources be added, and how do they interact with each other? In the case of the air handling system, air polluted by one component flows to the next component, which may be a source or sink depending on the air quality entering it and on the strength of the source. This was already indicated with the cleaning test done with the old air handling unit (Fig 2). To study further this phenomenon a test was performed with the components listed

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RESULTS

The results showed tha generated odor even th was intended to be use fins generated odor pro process and because it cleaned with pressure silencers was low.

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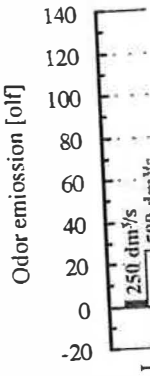

Figure 1. The odor

Effect of cleaning

Because the cleanli was performed with 10 years) air handli installed. The result to cleaning.

above. The components were installed after each other (only one filter at time) and the air was passing through the whole set of components. The perceived air quality was measured after each component.

RESULTS

The results showed that most components were significant sources of odor. The filters generated odor even though they were new. It was surprising to notice that the filter which was intended to be used to remove the odor actually generated it most. The coil with aluminum fins generated odor probably because its surface was not cleaned after the manufacturing process and because it was oily. The odor generation decreased significantly after the coil was cleaned with pressure washer and an industrial detergent. The odor generated by fans or silencers was low.

The air flow had only a modest influence on perceived air quality in the down stream of the component, and was almost independent on the air flow. The emissions calculated from the air quality showed significant increase with the air flow (Figure 1). The effect may be explained either with the increase of turbulence in the air flow and increase of the mass transfer, or due to the non linear dose-response relation between concentration in the air and sensory effects.

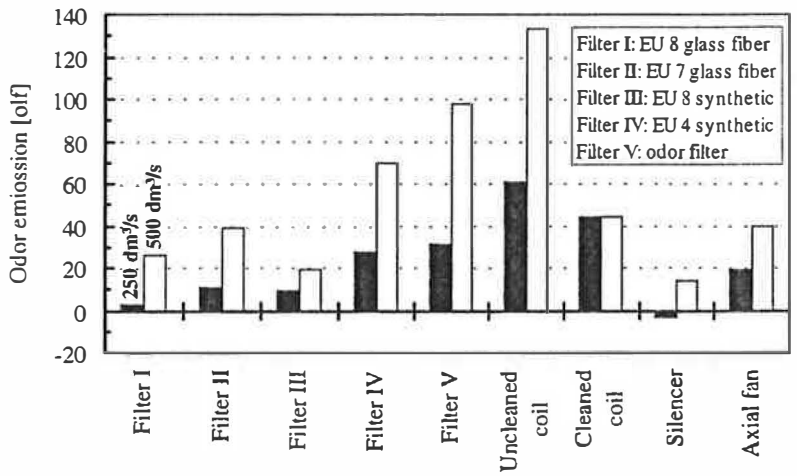

Figure 1. The odor emissions of the new components of air handling systems with the air flow of one quarter and a half of the nominal air flow.

Effect of cleaning

Because the cleanliness of the air handling units seem to be critical for the air quality, a test was performed with an old air handling unit in Finland. The perceived air quality in an old (app 10 years) air handling unit was measured before and after cleaning. A new filter was also installed. The results of the test showed a significant improvement of perceived air quality due to cleaning.

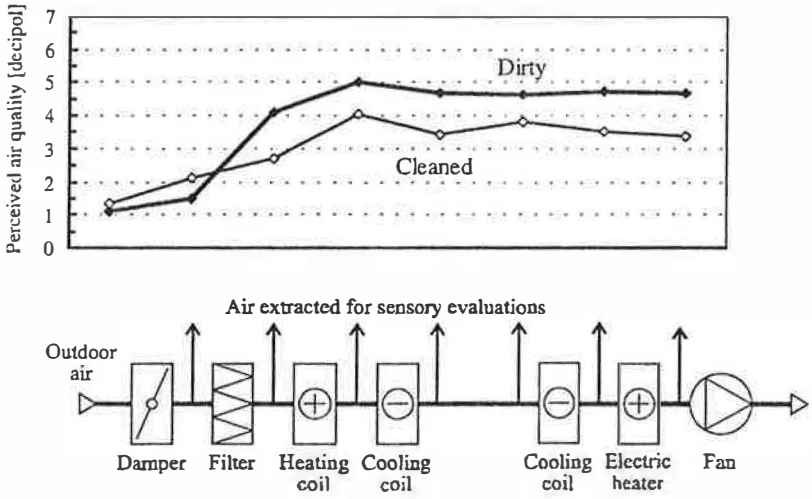

Figure 2. Perceived air quality in an air handling unit before and after cleaning, and the influence of clean and uncleaned duct on the perceived quality.

Ensembled unit

The results of the test with EU 8 glass fiber filter are shown in the Figure 3. Tests with other filters gave similar results. The perceived air quality in the ensembled air handling system did not follow the air quality predicted from the measurements of individual components. This might be caused by non linear dose-response relation between the perceived air quality and pollutant concentration, adsorption in the following components or both. Simple addition of sources gives exaggerated results (Fig. 3).

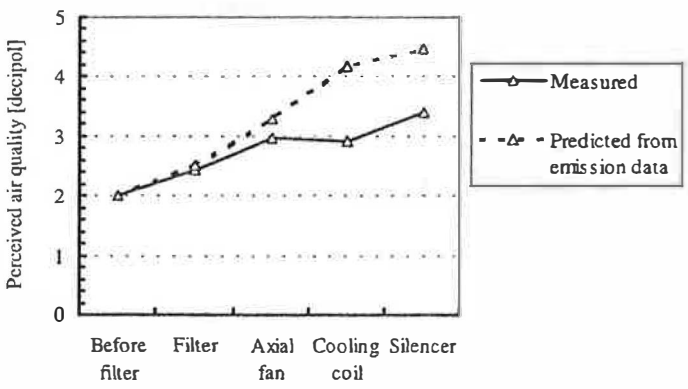

Figure 3. Perceived air quality as predicted from the measurements of the individual components and as measured from the air handling unit ensembled from the components.

DISCUSSION

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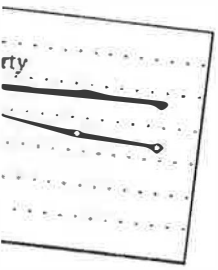

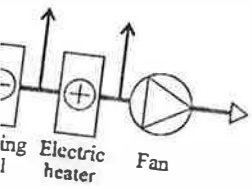

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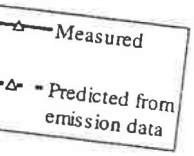

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DISCUSSION

The measurements with the components showed that air handling system really can pollute the supply air. However, the concentrations of compounds are so low that the methods used to test material emission are not sensitive enough or they do not catch the odorous compounds. The odorous compounds may have lower boiling point than those caught typically with Tenax TA absorbent. Almost all components seem to be sources of pollution, however, fiber filters which have been in use seem to be the worst. Significant differences were found between components. A major reason for the pollution seem to be oily, dusty, and dirty surfaces of the components. The cleaning of the components reduced significantly the pollution of the components. Increase of the air flow through the components did not improve the air quality in downstream of the component which indicates a significant increase of emission with air flow or very non linear dose-response relation between the perceived air quality and pollutant concentration.

When the components are installed in series as an air handling system, a single component can be either a source or a sink. The sources cannot be added. The best approximation at this point is to use the source strength of the worst polluting component to represent the pollution of the whole system. No data is available to predict the influence of air handling system on the concentration of chemical compounds, but it seems that sorption effect cannot be neglected for accurate calculations in the future.

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