

The verifying concept for the cleanliness of HVAC systems

Introduction

Dust and other contamination accumulate on the surfaces of HVAC system during its construction and operation. HVAC systems should be cleaned at regular intervals, especially if the system conveys very combustible material such as grease or organic dust. The national regulations and guidelines give time periods to inspect cleanliness of HVAC system, limit values for dust accumulation and time periods to clean HVAC system. The aim of this study was to develop a verifying concept to control and verify the cleanliness of HVAC systems.

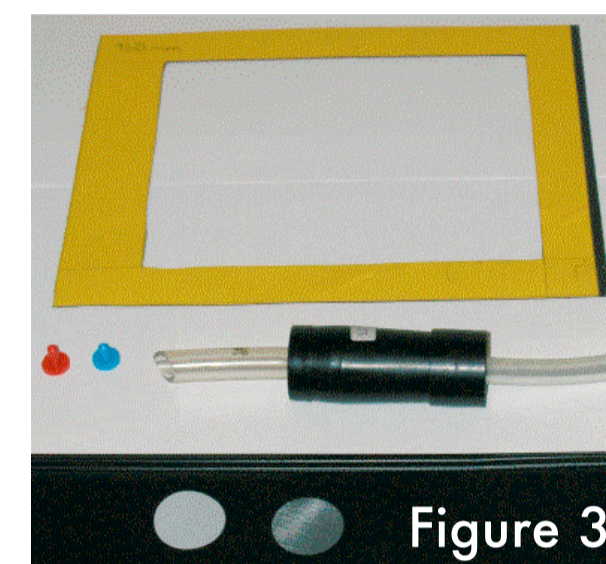
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Contaminations and their measuring methods



Microbe contaminations

The contact method and the swabbing method were studied to measure the microbe concentrations on the duct surface. The laboratory and field studies showed that the microbial concentrations measured with the contact method were lower than with the swab method. The upper detection limit of the contact method was 5–10 CFU/cm².

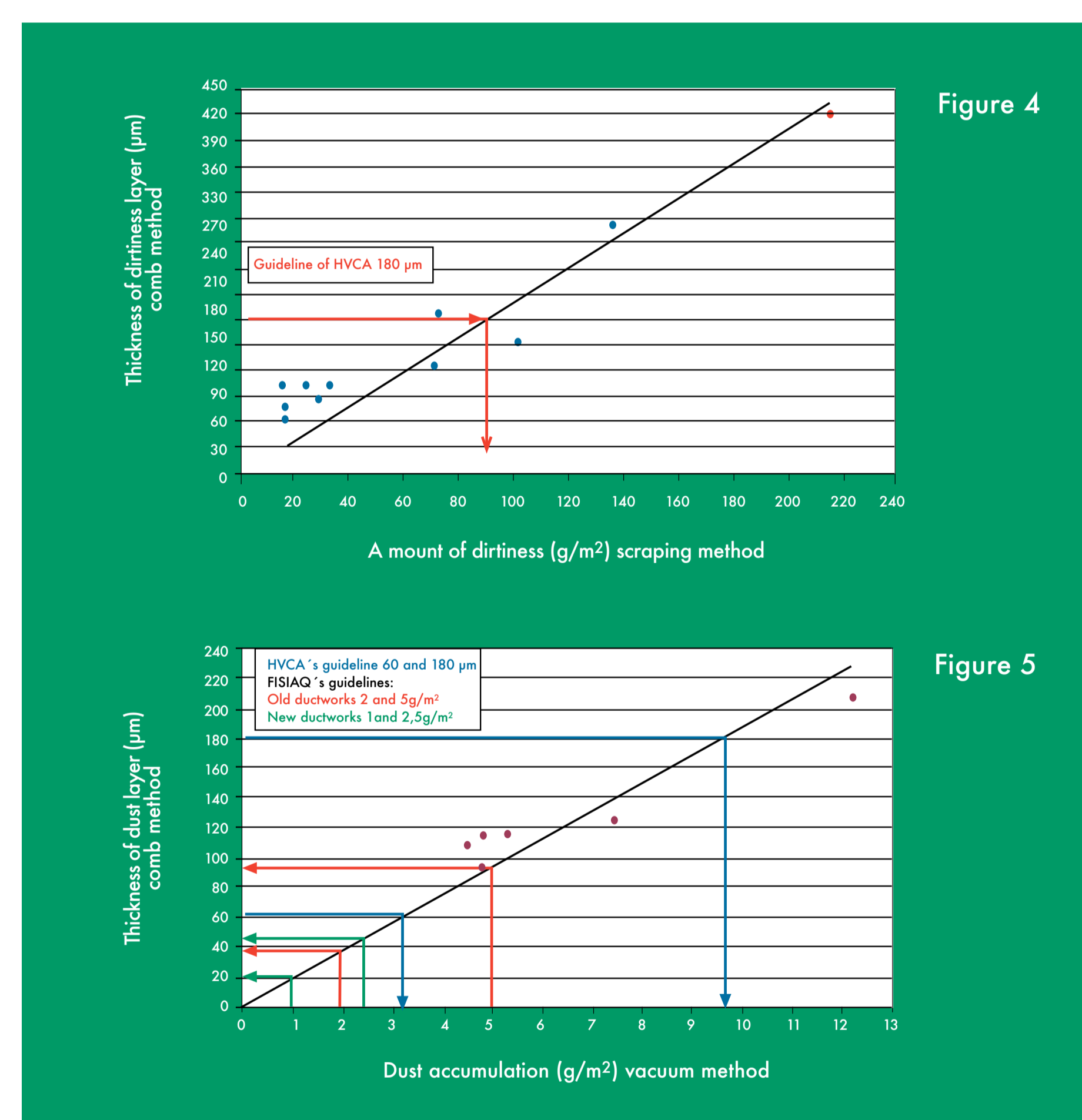
Mineral fibres

Two tape sampling methods, the gelatine and the carbon tape, were studied to measure mineral fibre contamination on ventilation ductworks. The samples were collected from the duct surfaces and analysed with an optical and a scanning electron microscope (SEM).

The gelatine tape was found to be suitable for light microscopic analyses and it allows counting the fibres on the surface. The carbon tape was applicable to SEM analyses and the method allowed the analysis of the chemical composition of fibres. The mean fibre concentration of the studied HVAC system was 112 fibres/cm² (11–1490 fibres/cm²) measured with the gelatine tape.

Visual evaluation

The visual evaluation method with a visual cleanliness scale and an visual inspection form has been designed to use it as a primary method to evaluate the cleanliness of HVAC system. A robot with a video camera is used to reach the visual inspection into the whole ductwork.



Dust and grease

A simple comb method (Figure 1) was developed to evaluate the thickness of dust and debris layer on the duct surface. The developed comb and the deposit thickness test (D.T.T.) method introduced in the British guideline (Figure 2) were tested in the laboratory and in the field. The results of the deposit thickness methods were compared with the vacuum test method (Figure 3).

The laboratory tests showed that the dust accumulation measured with the comb method correlated with the vacuum test method ($R^2=0.5-0.9$) when the dust layer was homogeneous. However, no correlation was found when dust accumulation was heterogeneous.

In the field test, the mean amount of the grease layer varied between 34–142 g/m² measured with the vacuum test method and 0.1–1 mm measured with a comb method. The correlation between the comb and the vacuum test method (Figure 4) and between the D.T.T. and the vacuum test method (Figure 5) was 0.84 and 0.9, respectively.

Conclusion

A visual cleanliness scale, a visual inspection form and a simple deposite thickness comb have been developed for the systematic visual evaluation of the cleanliness of air ducts. A robot video camera is used to reach the visual inspection into the whole ductwork. The amount of dust and debris is measured with the vacuum test method and the thickness of the grease layer with the D.T.T. method if the cleanliness level of the ducts is not clear enough visually. The microbial contamination will be measured with the contact method and the fibre contamination with the tape sampling method.

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