Local Exhaust Ventilation with REEXS

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Introduction

Although the REEXS-principle (Reinforced Exhaust System) has been the object of numerous investigations, who found substantial improvements compared to ordinary local exhaust ventilation hoods, it is far from being generally accepted and used. A Swiss team consisting of researchers of the ETHZ (Swiss federal institute of technology), the EMPA (Swiss Federal Laboratories for Materials Testing and Research) and the company Sulzer Infra have started a project for further investigations of REEXS hoods in the frame of the COST G3 action Industrial Ventilation. The project aims to overcome the barriers, that prevent planners from applying the REEXS-principle.

General Aspects of Local Exhaust Ventilation (LEV)

It is a fundamental characteristic of LEV hoods that their capability to capture polluted air is extremely limited in distance. Around 1930 Dalla Valle and Hatch (1) found an equation for the centre line velocity curve that has become generally known and used.

$\frac{v_x}{v_0} = \frac{1}{12.7 \cdot n^2 + 1}$, where n is the number of diameter units: $n = \frac{x}{D}$

The velocity decreases almost inversely with the square of the distance. With the REEXS-principle the capture range can be largely improved.

The REEXS – Principle

The REEXS-principle was invented by C. P. Aaberg, Denmark, who has hold the patent rights in the greater part of Europe, as well as in U.S.A. and Canada, since 1965. Therefore, in some literature the REEXS is named Aaberg hood. Today the patent is expired and the idea can be used by everybody.

The REEXS-principle combines the inlet and exhaust in the same hood. The inlet air is ejected radially with high velocity, thereby entraining air on both sides of the jet. The volume in front of the REEXS is divided into two parts. In one part, the capture zone, the air flows directly towards the exhaust opening. This part is surrounded by a zone where the flow is entrained by the jet.

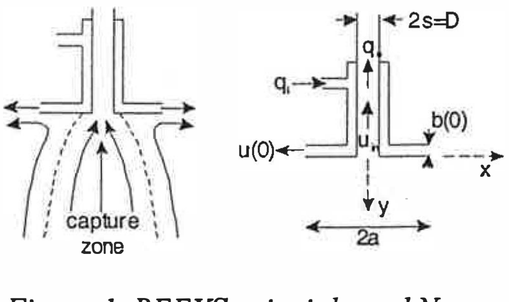

Figure 1. REEXS principle and Nomenclature

Compared to normal exhaust hoods the capture zone becomes narrower and thus the air velocity directed towards the exhaust becomes higher.

Previous Investigations

Høgsted (2), Pedersen and Nielsen (3) and Saunders and Fletcher (4) have made laboratory experiments, whereas Høgsted describes also numerous industrial field tests. They found, that with an increasing " I ", the momentum ratio between the jet and the exhaust flow ($I = \frac{u_{in} \cdot q_i}{u(0) \cdot q_e}$), the capture zone becomes smaller and the centre line velocity increases. Hunt and Ingham (5) could find the same correlation with a mathematical model of the REEXS. In addition, they are able to show, that there are at least 3 independent parameters, which affect the velocity field. The momentum ratio " I " can be calculated by $I = \frac{4K}{S^2V^2}$ where $K = \frac{b(0)}{2a}$, $S = \frac{s}{a}$ and $V = \frac{u_{in}}{u(0)}$. (Nomenclature see Figure 1) The influence of these theoretically found parameters have not been measured.

Barriers That Prevent People From Applying the REEXS – Principle

The following three main barriers that prevent people from applying the REEXS were found:

1. The missing of simple design guidelines,
2. a lack of information about successful industrial applications (Examples in Denmark with reports in Danish only), and
3. the missing of good REEXS constructions that avoid extensive noise (caused by the high jet velocity) and high pressure drop.

Aim and Investigative Procedure of the Swiss REEXS Project

The final aim of the project is to develop an instrument that helps to plan the application of REEXS and to give valuable input to the designing engineers. After the collection of already existing findings, further investigations are made both with experiments and with CFD to get a deeper understanding of the basic parameters and to support the development of new types of REEXS.

What Has Been Done Until Now

A first measurement campaign has been undertaken in the laboratory of the EMPA using an existing REEXS-construction (Figure 2). Absolute velocity values have been taken with an automatic x-y-table and the capture efficiency has been measured with tracer gas technique. The CFD-simulation made for the same REEXS-construction showed good agreement with the measurements. (CFD-simulations under the frame of this project are presented in a separate paper.) A new REEXS-prototype has been constructed using numerous nozzles to generate the jet instead of the slot used in previous constructions (Figure 6). This construction allows easy parameter variations and could reduce noise dramatically compared to the previous construction.

First Measurement Results

Figure 3 shows the air velocity with increasing distance from the hood (on the centre line) compared to the results of Pedersen and to the equation from Dalla Valle. The difference in velocity between Pedersen and EMPA can be explained with different air volume flows used.

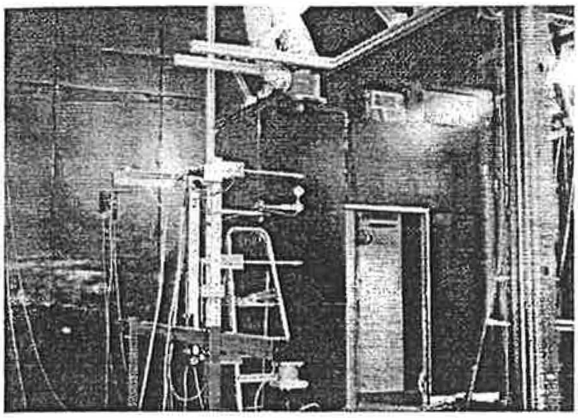

Figure 2. Measurement arrangement

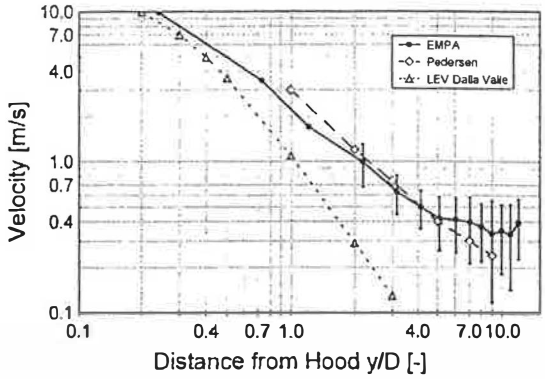

Figure 3. Air velocity on the centre line

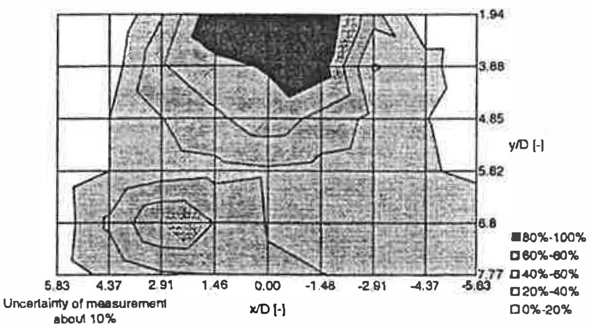

Figure 4. Capture efficiency on the x-y plane

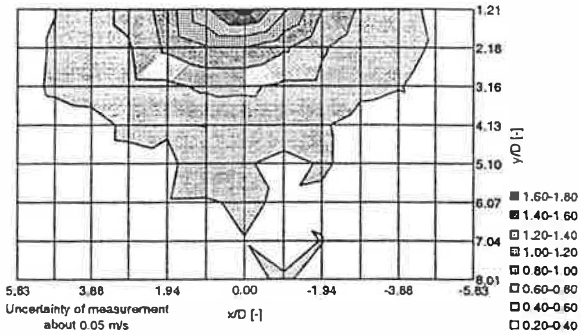

Figure 5. Air velocity on the x-y plane

All measurements showed here were taken with I =0.9. x/D is the distance from the axis of symmetry in diameters, y/D is the distance in diameters from the inlet opening (D = 2s, see Figure 1).

Figure 4 and Figure 5 show the capture efficiency and the air velocity on the same x-y plane containing the centre line. It is visible, that efficiency and velocity don't have the same structure, especially 4 diameters and more away from the inlet opening.

Next Work

There will be a second extended efficiency and velocity measurement and visualisation at the EMPA with the new REEXS-prototype. New findings and results will be presented in June at the Ventilation 2000.

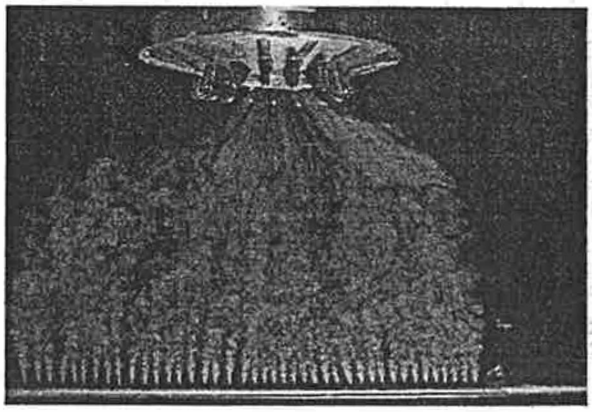

Figure 6. Smoke test with the new REEXS-prototype

References

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