Ventilation and Nicotine in Restaurants

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Abstract

Nicotine concentration in air has been measured in several restaurants by different measuring techniques. Several problems of the measuring techniques has to be solved before nicotine measurements can be used for approval purposes.

For approval purposes, the checking of the ventilation may be more fruitful than nicotine measurements.

Key Words
Smoking. Nicotine concentration. Ventilation.

Introduction
A new regulation was enforced on restaurants and other serving premises in Norway on January 1st 1998. This regulation, "the Smoking law", demands that the concentration of nicotine in air shall not exceed 1 $\mu g/m^3$ in non-smoking areas.

On assignment from the restaurant owners association (RBL), SINTEF Energiforskning AS is carrying out a project aimed at finding the best ways of ventilating restaurants with smoking- and non-smoking zones in the same room. The restaurant trade wanted to inquire whether this regulation is possible to fulfil in everyday life. Also, they wanted suggestions on what kind of ventilation that can satisfy the Smoking law and ensure safe working atmosphere for the employees.

The project

Six restaurants were investigated with respect to nicotine concentration, particle content, CO_2-content and air temperature. Also, airflow patterns were recorded.

The results of the measurements have been evaluated, and we are working out a manual on recommended ventilation systems for the various types of restaurant premises. The recommendations will be followed up in practice and evaluated, and if necessary, the recommendations will be modified.

Measurement Methods

Nicotine concentration in the air
The nicotine content in the room air was measured by sampling tubes. Several type of samplers were located in the breathing zone of the guests. The maximum distance between

the samplers at one location were less than 50 mm. Tree different sampling media were used:

- NILU Active: Air being pumped through a collecting medium for a definite period of time. Thereafter, the nicotine content is analysed in the laboratory of NILU (C. Lunder, Norwegian Institute of Air Research)
- NILU Passive: Collecting medium exposed to air with no active air circulation. Nicotine contents analysed by NILU.
- RiT Active: Like NILU Active, but sampling medium and analyses provided by RiT (K. Zahlsen, The central hospital in Trondheim).

Particle content in the air

The particle content in the air was analyse by a particle counter, type "MetOne". Air sucked into the particle counter through plastic hoses of equal length to an intake manifold, and air samples analysed sequentially.

Airflow patterns

Airflow patterns were visualised by smoke (Dräger test tubes), and flow pictures were drawn manually.

Results

Nicotine measurements

Place A, a high-class restaurant

Place A is a high-class restaurant with no physical separation between the smoking- and non-smoking areas. The room has a displacement ventilation system. The nicotine concentrations were measures during lunch time and during the evening hours. See Figure 1.

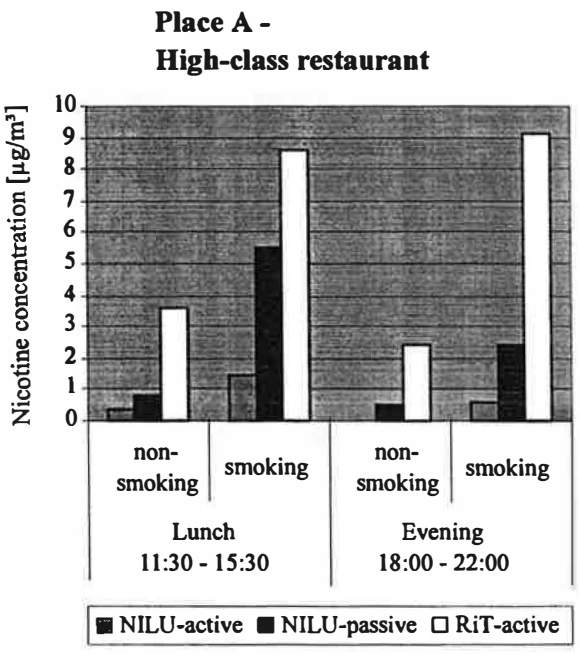

Figure 1. Nicotine measurements in a high-class restaurant

Three different sampling media were used at three of the places, and two sampling media at the forth place.

Place B, a night club

Place B is a night club with two levels inside one large room. There is a smoking zone and a non-smoking zone at the lower level, separated by the bar. The dancing floor is in the non-smoking area. At the top level, there is a smoking area and a bar.

During the measurements, the place was crowded with people, more than three people per m^2 floor area.

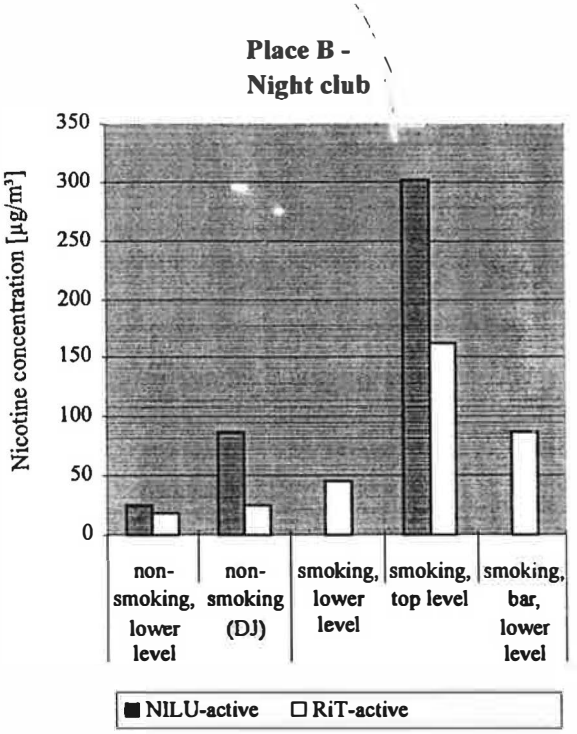

Figure 2. Nicotine measurements in a night club.

Place D, a pub

Place D is a typical pub in the basement of a hotel. The room height is low, and the ventilation system has several deficiencies (low ventilation rate, arbitrary control). The ventilation system is certainly not up to the state-of-the-art, however, this seems to be more the rule than the exception in the pub business.

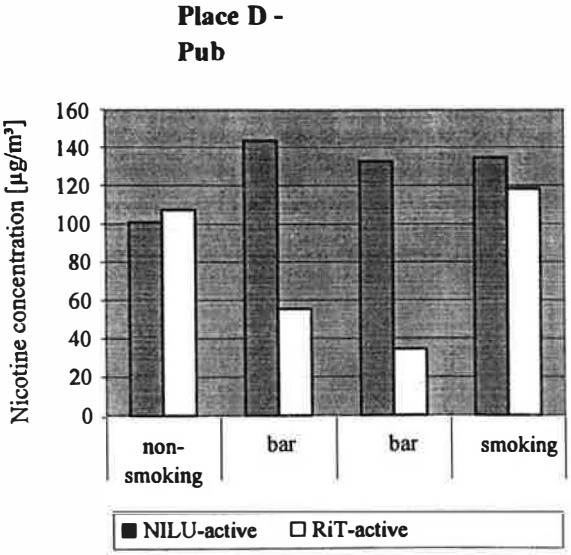

Figure 4. Nicotine measurements in a pub.

Place C, a family restaurant

Place C is a family restaurant with four levels, and large openings between the levels. The non-smoking areas are in the lower part of the restaurants, and the smoking areas at the upper levels. The results are shown in Figure 3.

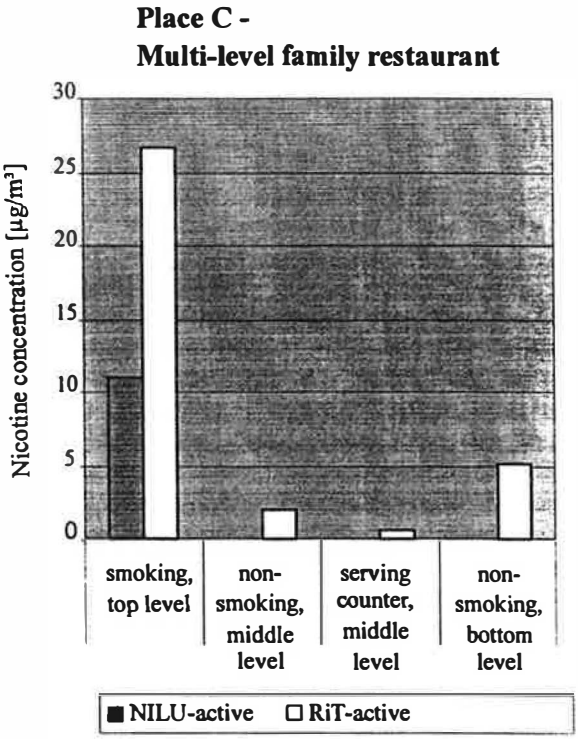

Figure 3. Nicotine measurements in a family restaurant.

Particle content in the room air

Figure 5 shows the particle concentration (size fraction: 0,3–0,5 µm) in the breathing zones in the non-smoking area and the smoking area in place A – the high-class restaurant. We can see how the particle concentrations follow the activity in the room. It is interesting to note that smoking affects the particle concentration far less than that of some other activities in the room. This may be because most of the particles from smoking are smaller than 0,3 µm. Smoking was observed to take place between noon and 1 PM, and between 6 PM and midnight.

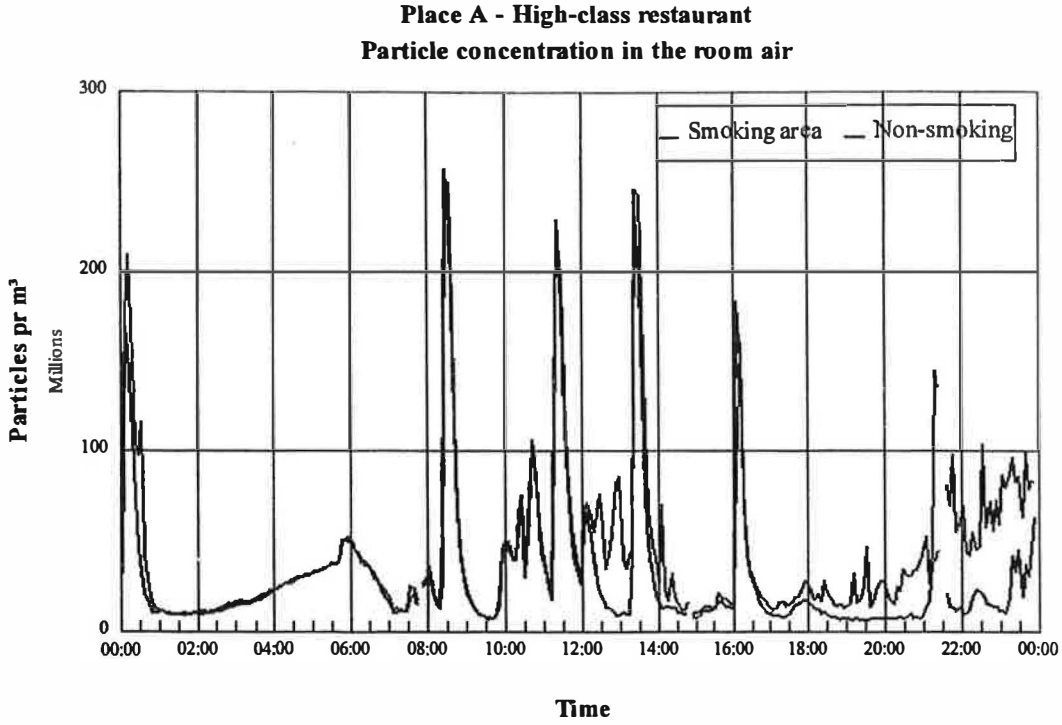

Figure 5 Particle concentration in the breathing zones in a high-class restaurant.

The same tendency was observed in other places; the particle concentration was almost the same in non-smoking and smoking areas, although the nicotine concentrations differed.

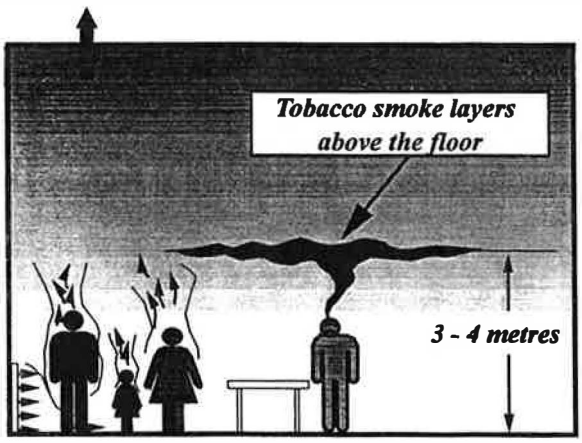

Figure 6 Observed smoke flow pattern in Place A.

areas.(Figure 7). shows a certain nicotine concentration in the bottom zone of place C. This is because smoking was allowed there for two hours during the measuring period.

Discussion

Indicator of smoking in room air

We have not found a better indicator on tobacco smoke in air than the nicotine concen-

Airflow patterns

The airflow patterns were observed in the restaurants where the measurements took place. We noticed that the ventilation in place A clearly showed the displacement effect (Figure 6).

In place C, the family restaurant, we noticed the stratification that prevents smoke to penetrate down into the non-smoking

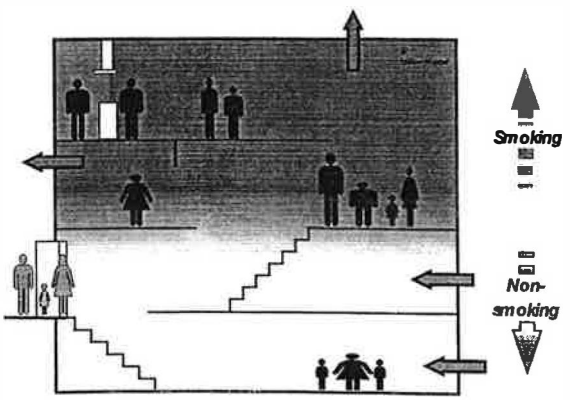

Figure 7. Stratification of the air in place C.

tration. Some people claim that the particle content should be used as an indicator. We find, however, that the particle content is so much influenced by other activities than tobacco smoking, that it can not be used for this purpose.

Maximum allowed nicotine concentrations in non-smoking areas
Based on the nicotine measurements, we do not see 1 $\mu g/m^3$ as a realistic maximum limit value. Place A and place C were chosen as test objects because we found their ventilation and air quality conditions among the best in the trade. A more realistic maximum limit for non-smoking areas in restaurants would be 10 $\mu g/m^3$.

For night-clubs and bars, a more realistic maximum nicotine concentration would be around 50 $\mu g/m^3$.

Nicotine measuring equipment
The measuring devices that we used showed very different results. Moreover, there is no clear correlation between the results from the different methods. The value of 1 $\mu g/m^3$ seems to be about the detection limit of the methods, and the accuracy of the available test methods is not sufficient to check a target value of 1 $\mu g/m^3$.

Test procedures
When nicotine measurements are to be used for approval purposes, measurement procedures are needed that describes at what time of the day, and at what days of the week the measurements shall be made. Also, there is a need of describing at what place in the room the measurements shall be made.

Conclusions

Nicotine measurements
Ideally, we adhere to the idea of measuring the nicotine concentration to check the air quality with respect to tobacco smoke. However, during our investigations we have found several problems that must be solved before nicotine testing can be used for approval purposes.

Adequate ventilation should be the first priority
The overwhelming problem with respect to air quality in restaurants, pubs and night clubs are the lack of adequate ventilation. Before nicotine testing is feasible, one has to check if the ventilation is adequate, i.e.:

- Is the air volume flow rate sufficient in relation to the number of guests?
- Do the air flow patterns prevent tobacco smoke from contaminating the non-smoking areas?
- Is the control system of the ventilation working properly?

Ongoing research

What is adequate ventilation?
It appears to be a considerable lack of knowledge as to what ventilation systems are best suited for ventilating rooms with both smoking and non-smoking zones, or if smoking and non-smoking can go on in the same room at all. So far it looks like non-smoking and smoking areas can be the same room, provided that the ventilation system is adequate.

SINTEF Energiforskning AS is working out a handbook of recommended practice for the design of ventilation in restaurants, pubs and night clubs. The recommendations are tested in laboratory and tried in practice.

Preliminary results from the handbook

- In tall rooms, like place A (the high-class restaurant), displacement ventilation has proved beneficial to air quality (Figure 6).

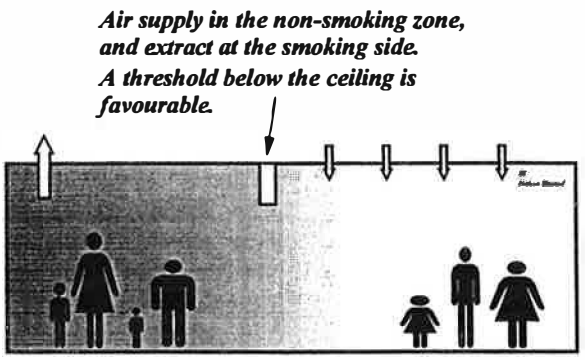

Figure 8. Recommended ventilation in rooms with low ceiling.

- Generally, air should be supplied in the non-smoking areas. This is most important in rooms with low ceilings. A threshold below the ceiling reduces tha flow of tobacco smoke into the non-smoking areas.

- In laboratory tests, an air curtain has proved to give a good separation between the smoking and non-smoking areas (Rydock, Norwegian Building Research Institute 1999).

- In multi-level restaurants, the smoking areas should be in the upper levels (See Figure 7).

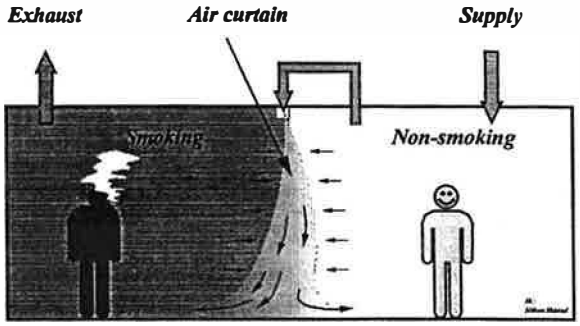

Figure 9. Air curtain between non-smoking and smoking areas.

Acknowledgements

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