Performance of Laboratory Fume Hoods

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Abstract

Many hazardous chemicals are used in research laboratories. Fume hood is the most efficient and common single equipment used in prevention of chemical exposure of laboratory workers. Totally 303 fume hoods were inspected at the University of Kuopio laboratories and 295 of them were tested for their performance. The most important properties affecting occupational safety due to the fume hoods were tested. The general recommendation for face velocity (0.4–0.6 m/s) and the Finnish building regulations for exhausted air flow from laboratory fume hood (140 l/s m), were met only by 27 % and 22 % of fume hoods measured, respectively.

Materials and Methods

The University of Kuopio comprises three main buildings, the oldest of which was built in 1978. The other two buildings were finished in 1982 and in 1990. According to premises registry, there are 356 laboratory rooms at the University. In this study, 303 fume hoods were inspected. Face velocity was not measured from 8 fume hoods because they were removed from use. Usually 6 to 12 fume hoods were connected to the same exhaust fan. All fume hoods had vertically opened front sash and a bypass opening at the top of the hood. Bypass opening is designed to prevent excessive increase of face velocity when the sash is lowered.

Complete testing was performed for 220 fume hoods according to British Standard BS 7258 (1). Face velocities were measured with thermo-anemometer (Airflow TA5) connected to data logger (DataTaker 50). The probe of thermo-anemometer was attached to a stand to eliminate errors due to probe movement and position. Face velocity was measured at 9 points in the opening of the sash set at height of 30 cm for 30 seconds at each point. The mean and standard deviation of air velocity and mean air temperature were calculated for each measurement point. For 75 fume hoods a simpler investigation method was used because large objects placed inside the fume hoods prevented the use of the standard method, when face velocity readings were taken at 6 to 9 points with handheld thermo-anemometer at the plane of the sash.

Nominal face velocity was calculated as the average of mean velocities of each measure point. General recommendation for fume hood face velocity is 0.4–0.6 m/s (1,2). Spatial variation should not exceed ±20% of the nominal face velocity. The coefficients of variation of face velocity data were used to indicate the turbulence of the airflow at the face of the hood. Significant turbulence is considered to occur when it exceeds 15 % (1,2). Exhaust air flow of a fume hood is required by Finnish building regulations to be at least 140 l/s m. Exhaust air flow was obtained by multiplying nominal face velocity of fume hood (m/s) by area of sash (m^2). Air leaks through bypass opening and other gaps were estimated to be about 10 % total flow of exhausted air which was taken into consideration (3).

Results

Only 79 (27 %) of fume hoods measured met the general specification for the face velocity (0.4–0.6 m/s) and 65 (22 %) of the hoods met the Finnish building regulations for the exhaust airflow (140 l/s m). The mean nominal face velocity was 0.35 m/s (Figure 1). There were 22 (7 %) fume hoods with nominal face velocity less than 0.2 m/s and use of these hoods was prohibited until repairs were carried out.

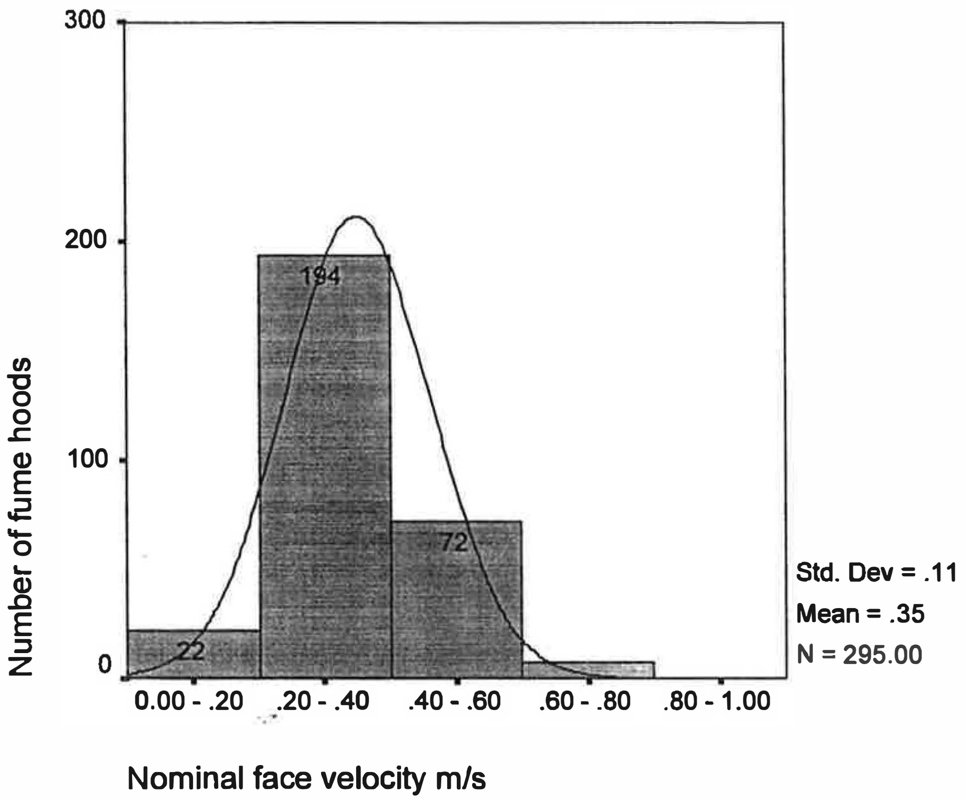

Figure 1. Nominal face velocity distribution of 295 fume hoods at the sash height of 30 cm

Velocity profile was even enough in 60 (27 %) fume hoods. Only 12 (5 %) of the hoods met the turbulence criterion. (Table 1) When all the parameters were considered, only 8 fume hoods of 295 inspected would pass all the test requirements.

Table 1.

	Specification	Fume hoods measured	Meets specification %
Nominal face velocity m/s	0.4 – 0.6 m/s	295	27
Total exhaust air volume l/s m	140 l/s m	295	22
Velocity profile	Max ± 20 % of nominal face velocity	220	27
Turbulence	SD max 15 % of face velocity	220	5

Discussion and Conclusions

Most fume hoods investigated originated from late 1970s and early 1980s. Over the years new fume hoods have been connected to the old exhaust duct systems and fans and ducts were also slowly worn down. These two reasons are probably the main cause for the commonly observed insufficient airflows. Also, jammed dampers and obstructive debris inside ductwork were found.

Turbulent air flows were also a common problem. Misplaced and wrong types of supply air diffusers were found to cause cross draft and turbulence near fume hoods in many laboratories. Most turbulent conditions were observed in the oldest building, where supply air diffusers caused air velocities up to 3 m/s near fume hoods. Many hoods were also located near the doors.

Fume hoods are not regularly inspected at most laboratories in Finland. Maintenance and repairs have usually been made only if someone had complained. Results of this study indicate clearly that fume hoods performance should be controlled regularly in order to keep the risk of chemical exposure in laboratories as low as possible. As a result of this study, all the fume hoods that were found defective are being repaired and more effective procedures for monitoring fume hoods are being developed.

Acknowledgements
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References
1. British Standards Institution: British Standard 7258. Laboratory fume cupboards. 1990
2. Prudent Practices in the Laboratory. Handling and Disposal of Chemicals. National Research Council. National Academy Press. Washington DC 1995
3. Suomen rakentamismääräyskokoelma.(RakMK) D2, Rakennusten sisäilmasto ja ilmanvaihto. Määräykset ja ohjeet 1987. Ympäristöministeriö 1987.