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LOWER AIR VELOCITIES AND HIGHER AIR SUPPLY REQUIRED IN VENTILATED SPACES

In ventilated spaces complaints frequently occur on draught and on the quality of the air. This paper reports the major results of two recent investigations on these problems performed at the Technical University of Denmark. In one study a draught chart has been established defining the percentage of the occupants predicted to feel draught when exposed to a certain air velocity and temperature. The other study refers to spaces where body odour is the major contaminant. It defines the percentage of people finding the air quality unacceptable as a function of the ventilation rate.

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Draught

Draught is defined as an unwanted local cooling of the human body caused by air movement. In many ventilated spaces it is a serious problem, often causing complaints even though measured velocities may be lower than prescribed in existing standards. Draught may cause people to stop ventilation or to plug up air diffusers. The occupants may also increase the air temperature to counteract the draught and this may increase energy consumption during the winter.

In ventilated spaces the air velocity in the occupied zone fluctuates in a random manner from second to second (*Fig. 1*). The air flow is turbulent and may be characterized by the mean velocity and the turbulence intensity, i.e. the standard deviation divided by the mean velocity. Field studies have shown that the turbulence intensity in typically ventilated spaces is around 30–60% [1, 2].

In the present study one hundred subjects were in a draught chamber exposed to air velocities with a turbulence intensity of 30–60%. Each subject, dressed to feel thermally neutral, participated in three experiments at an air temperature of 20, 23 and 26 °C. In each experiment subjects were sedentary and exposed during $2^1/_2$ hours to six mean velocities ranging from 0.05 to 0.40 m/s. They were asked whether and where they could feel air movement and whether it felt uncomfortable. Based on the results the draught chart on *Fig. 2* has been evolved. The chart identifies the percentage of subjects dissatisfied due to draught as a function of the mean

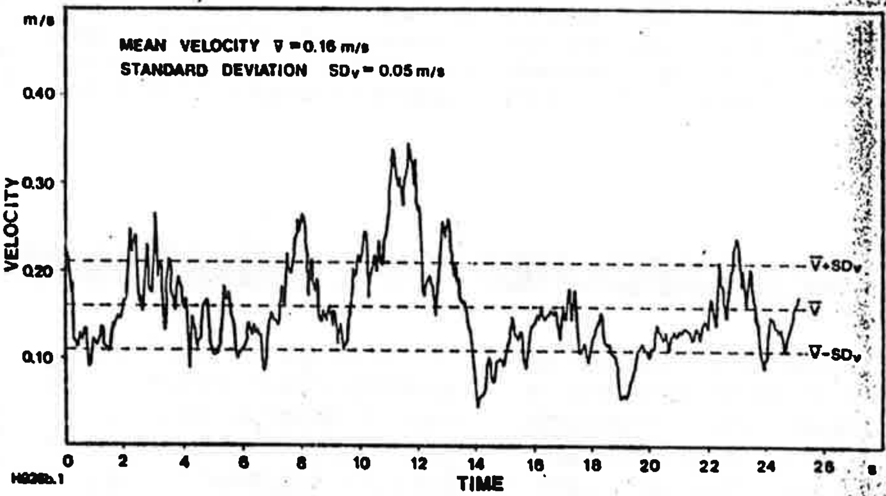

Fig. 1. Typical velocity fluctuations in the occupied zone of a ventilated space

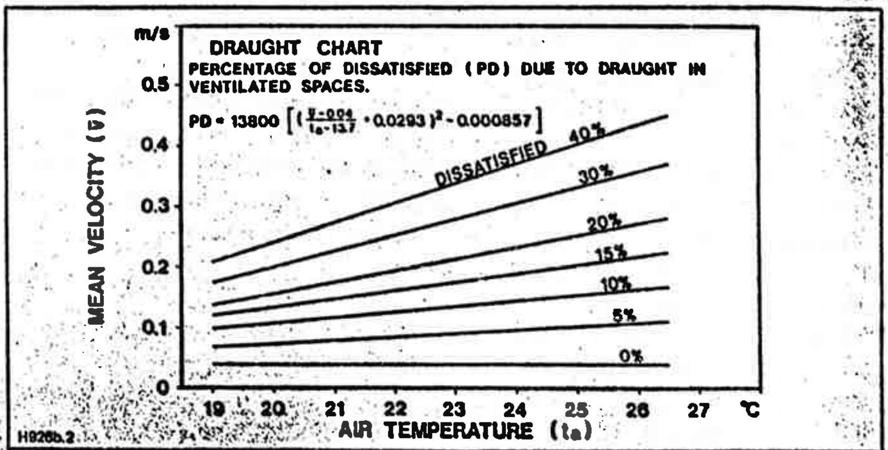

Fig. 2. The draught chart showing the percentage of people feeling draught as a function of mean velocity and air temperature

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velocity and the air temperature. People are more sensitive to draught than was indicated in previous studies with laminar flow.

In the DIN 1946 standard the limit for the velocity is nearly identical to the curve for 20% dissatisfied in the draught chart. A reduction of the draught limit in the standard is required to diminish complaints.

Ventilation

In many spaces body odour is the major contaminant in the air. The purpose of the study [4, 5] was to determine the ventilation required to obtain acceptable air quality.

In two experimental auditoria occupied by up to 200 males or females the ventilation was varied and the air quality was evaluated by the occupants and by 160 male and female judges just after they entered the space (visitors). The odour intensity and acceptance were evaluated.

Fig. 3 shows the percentage of dissatisfied as a function of the steady-state ventilation rate. The occupants were not influenced by the ventilation, while the visitors required more ventilation than most standards specify. A ventilation rate of 8 l/s · person (ca. 30 m^3/h · person) would still make 20% of the visitors dissatisfied. This ventilation rate is 50% higher than the DIN 1946 and four times higher than the ASHRAE 62-81 standard.

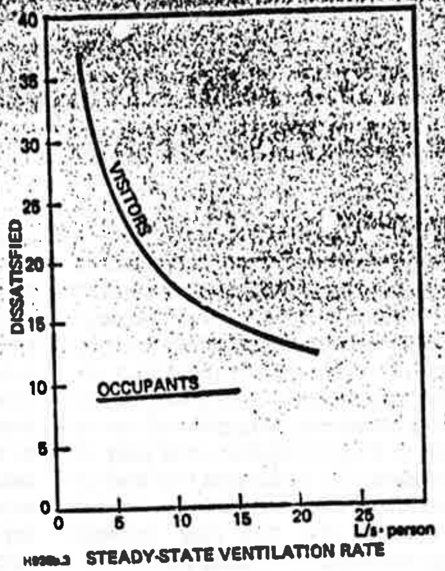

Fig. 3. The percentage of people feeling the odour intensity unacceptable as a function of the steady-state ventilation rate

No substantial difference was found in the ventilation rates required in spaces occupied by women and men. Carbon dioxide was found to be a reasonable index of body odour intensity and acceptance.

Conclusion

To diminish the number of complaints caused by draught and air quality ventilation systems are required which can provide higher ventilation rates and lower air velocities at the same time.

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References

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WÄRMESPEICHER ZUR BETRIEBSOPTIMIERUNG

Generell ist es das Ziel jeder Art von Speicherung im Fachgebiet Heizungstechnik, eine Versorgungsbetriebsweise zu verbessern, oder — wenn die speziellen Prozeßzusammenhänge bekannt sind — zu optimieren. Dabei können vor allem die folgenden drei Aufgaben im Vordergrund stehen:

1. Ausgleich von unterschiedlichen, durch die Eigenart der Prozesse gegebenen Leistungen und Massenströme, jeweils im Erzeuger- und im Verbraucherbereich, um die Erzeugeranlage möglichst unabhängig vom Verbraucher optimal zu betreiben.
2. Deckung einer Spitzenlast beim Verbraucher, um die Erzeugeranlage für den Durchschnittsbetrieb entsprechend klein auslegen zu können. (Ein typisches Beispiel ist die Brauchwassererwärmung.)
3. Trennung der Versorgungszeiten für gekoppelt erzeugte Zielenergien (zum Beispiel Strom und Wärme aus einem Heizkraftwerk), um unabhängig vom Heizwärmebedarf die wirtschaftlich günstigste Stromnachfrage befriedigen zu können.

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Die folgenden Ausführungen konzentrieren sich auf die Heizwärmeversorgung. Für diesen Bereich ist Wasser als Speichermedium im Vergleich zu anderen Medien am günstigsten. Wasserwärmespeicher werden deshalb am häufigsten eingesetzt. Da die angestrebte Betriebsoptimierung eine optimale Ausnutzung des Speichers voraussetzt, wird zunächst auf Betrieb, Konstruktion, konstruktive Ausführung und Netzeinbindung des Speichers eingegangen. Die Be- und Entladung eines Verdrängungsspeichers erfolgt entweder direk durch Wasseraustausch oder indirekt über einen im Speicher angeordneten Wärmeaustauscher bzw. auch kombiniert, z.B. Entladung durch Wasseraustausch und Beladung über einen integrierten Wärmeaustauscher. Dabei können zwei sehr unterschiedliche Temperaturverteilungen über der Höhe auftreten, die den Ausnutzungsgrad stark beeinflussen. Bei vollständiger Durchmischung erhält man eine sich mit der Zeit ändernde Mischtemperatur. Zur Erzielung von