

THE ROLE OF NATURAL VENTILATION FOR INDOOR CLIMATE CONTROL
IN AUSTRIAN BUILDINGS

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In the course of the last 15 years, many complaints about unacceptable high indoor air humidity, mould growth on surfaces of building elements and deterioration of indoor air quality have been registered.

As a part of the search to show the reasons for these phenomena, the role of natural ventilation for indoor air quality control was investigated.

Air change rate is the dominating factor for the indoor air quality in residential and commercial buildings, besides other important factors such as the number of inhabitants, kind of utilization of space, building materials, furniture, etc.

In a representative number of Austrian residential and commercial buildings

- long-term measurements (from 1 week to 4 months) of air change rates,
- observations of window-airing behaviour,
- measurements of indoor air humidity, CO₂-, Radon- and HCHO-concentrations

were made between 1982 and 1985.

The results of the measurements of the infiltration rates are summarized in fig. 1:

- In poorly maintained old buildings, mostly built before 1918, relatively high infiltration rates ($n_i \approx 1.03 \pm 0.57 \text{ h}^{-1}$) were found. Flats in these buildings are very often overventilated - even without window airing. Higher wind velocities lead to draft complaints of the inhabitants; indoor pollution in these buildings was found acceptly low.
- In well-maintained "massive" buildings with windows (wooden frames) without special tightning appliances, air change rates (as a result of air infiltration) of $n_i = 0.31 \pm 0.07 \text{ h}^{-1}$ do exist. This infiltration serves as a "basic ventilation system" and has an overwhelming influence on the indoor pollution control.
- Most of the buildings erected since 1970 have very tight building envelopes and infiltration rates of $n_i = 0.15 \pm 0.07 \text{ h}^{-1}$. If in these buildings no proper duct-ventilation system (natural or mechanical) exists, the normally practised window airing is not sufficient to meet the hygienic needs for ventilation in winter time:



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CO ₂ -concentration	≤	0.15 vol %
HCHO-concentration	≤	0.1 ppm
relative humidity	≤	60 %

Relative high concentrations of CO₂ (in bedrooms ~ 0.5 vol %), of HCHO (in new furnished flats ~ 1.5 ppm), mould growth and higher concentrations of Radon (in distinct regions of Austria) are found.

- Residential buildings in wood construction are far more penetrable than massive buildings; wood construction buildings, erected in the past 5 years show an average infiltration rate of $n_1 = 0.62 \pm 0.07 \text{ h}^{-1}$.

The comparison of infiltration data, resulting from tracer gas measurements, with air infiltration calculations, based on M.H. Sherman's (lit. 1) formula and estimation of the air-leakage areas (over/under-pressure method), shows good agreement.

The same holds true for the comparison of measured and calculated data of window airing (fig. 2, 3).

The investigation of the window airing frequency in residential habitats showed significant influence of

- heating systems (single stove versus central heating),
- billing of the heating costs,
- impact of traffic noise,
- outdoor temperature and global radiation

on duration and frequency of window airing.

Following Lyberg's suggestion (lit. 2) to plot the fraction of windows in airing position (turned or tilted) x temperature difference between in- and outdoor (fig. 4), the importance of environmental factors (noise, heating system) as well as the monotonous regularity of window-airing behaviour becomes evident.

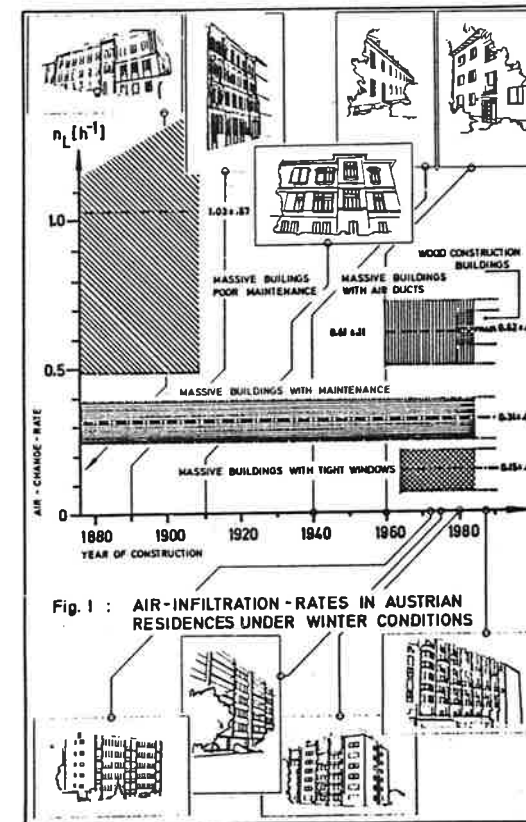
Calculations of the long-term (or diurnal average) effect of air infiltration and airing (for indoor pollution or indoor humidity control) show that

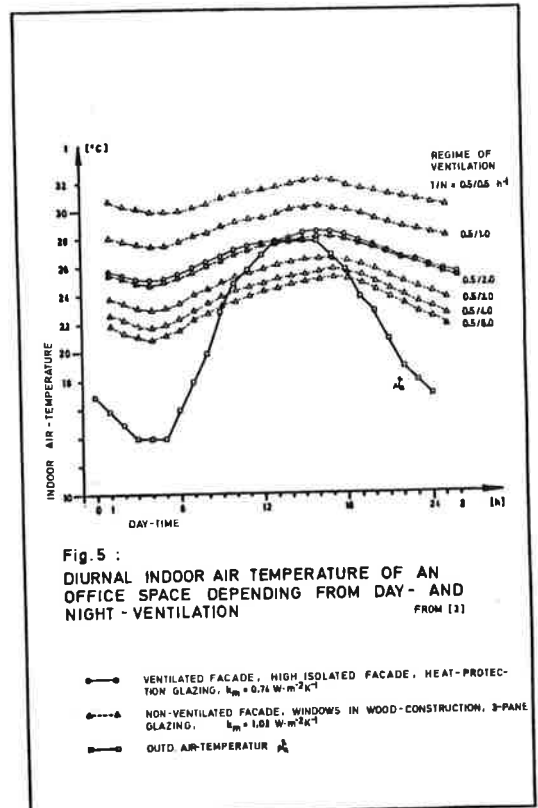
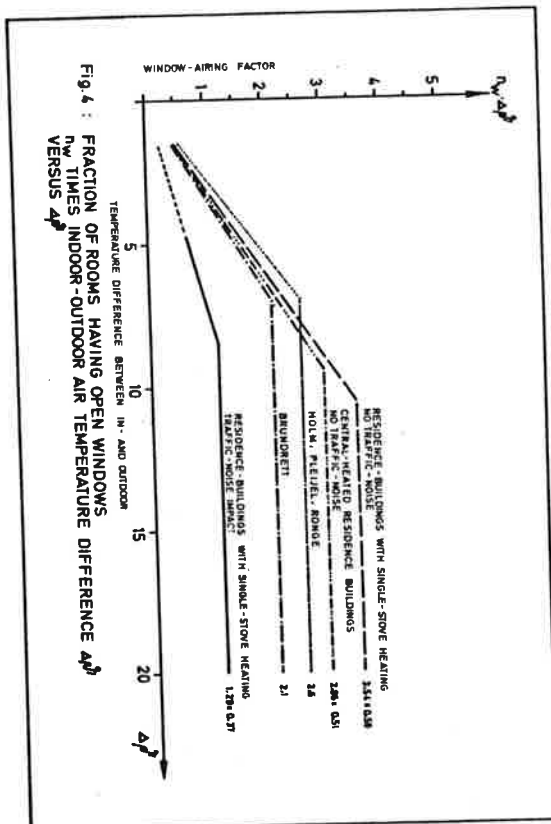
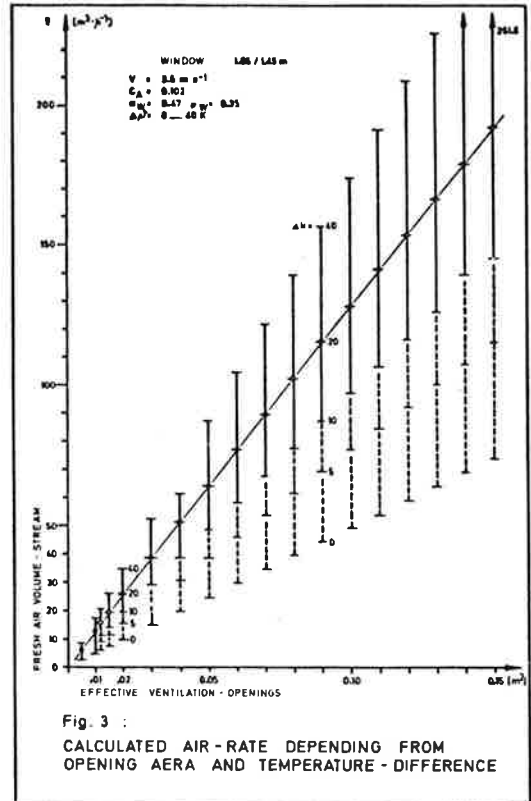
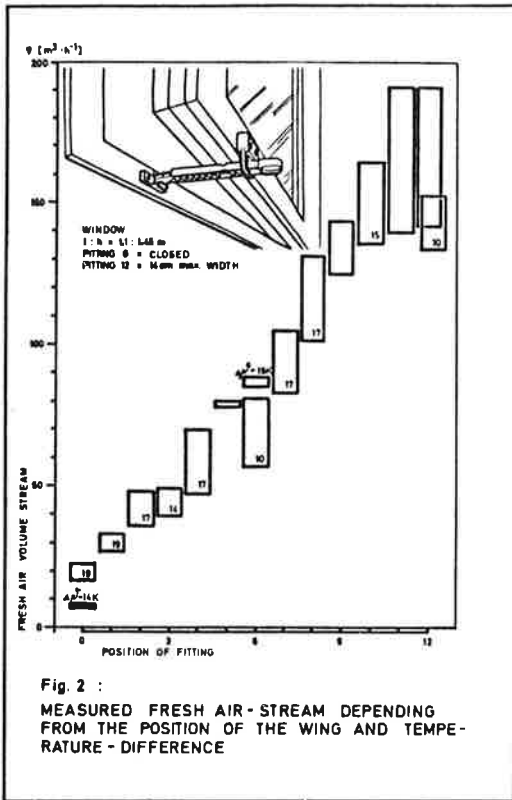
- air streams by infiltration and exfiltration are the dominating factors in pollution control;
- window airing gets the function of "comfort ventilation" and also plays an important role from the psycho-hygienic point of view, especially during the heating season; in addition, it is an important means for indoor temperature control in summer time (fig. 5).

For buildings with "air-tight" building envelopes, the possibility of fine-step tilting/turning of ventilation windows is essential for energy saving indoor pollution and air humidity control.

References

- (1) Sherman, M.H. Air infiltration in buildings. LBL-report, LBL-10712
- (2) Lyberg, M.D. Energy losses due to airing by occupants. Proceedings of CIB W67, Third International Symposium, Dublin 1982
- (3) Panzhauser, E., Fail, A., Heiduk, E., Ertl, H., Schwarz, K., Ertl, T., Kaderle, A. Die Luftwechselzahlen in österreichischen Wohnungen. F 827 T.U. Wien, 1984





SUMMARY

E. PANZHAUSER: The role of natural ventilation for indoor-climate control in Austrian buildings. The influence of air infiltration and window airing on the indoor air quality in Austrian domestic buildings was investigated. During heating seasons air-infiltration plays a main role in securing hygienic conditions of indoor air and acts in most buildings/flats as "basic ventilation". Air tight windows, which are installed in new or renovated buildings deprive the inhabitants from this familiar "basic ventilation" and can give rise to poor indoor air quality, unless acceptable fittings for permanent ventilation are provided. Window airing normally can not replace the effect of permanent ventilation but plays a role as "comfort ventilation".

RESUME

E. PANZHAUSER: Le rôle de ventilation naturelle dans le domaine du contrôle climatique intérieur. Il a été étudié quelle est l'influence de l'infiltration d'air d'une part, et de l'aérage par les fenêtres, d'autre part, sur la qualité de l'air à l'intérieur des bâtiments d'habitation en Autriche. Pendant les périodes de chauffage, l'infiltration d'air joue un grand rôle et contribue largement à assurer des conditions hygiéniques de l'air intérieur et elle constitue la "ventilation de base" dans la plupart des bâtiments/logements. Des fenêtres fermées hermétiquement à l'air installées dans des bâtiments nouvellement construits ou remis à neuf privent les habitants de cette "ventilation de base" habituelle pouvant avoir pour conséquence une mauvaise ventilation intérieure, à moins qu'il n'y ait des dispositifs assurant une ventilation permanente. L'aération par les fenêtres ne pourra remplacer, en général, l'effet d'une ventilation permanente qui joue le rôle d'une "ventilation de confort".

KURZFASSUNG

E. PANZHAUSER: Die Bedeutung der natürlichen Lüftung für die Beeinflussung der Innenluftqualität. Die Untersuchung bezieht sich auf die Rolle der Luft-Infiltration und der Fensterlüftung für die Innenluftqualität in österreichischen Wohnhäusern und zeigt, daß die Infiltration während der Heizperiode für den Hygienezustand der Innenluft bestimmend ist und in der Regel als "Grundlüftung" der Wohnungen/Wohngebäude anzusprechen ist. Luftdichte Fenster, die in Neubauten oder bei der Renovierung von Altbauten eingebaut werden, berauben die Bewohner dieser vertrauten "Grundlüftung" und führen in der Regel zu hygienisch bedenklichen Innenluftzuständen, sofern nicht geeignete Einrichtungen zur Ermöglichung einer regelbaren Dauerlüftung vorgesehen werden. Fensterlüftung allein kann die Dauerlüftung nicht ersetzen, spielt jedoch eine wichtige Rolle als "Komfortlüftung".