Ventilation and a Healthy and Comfortable Indoor Environment

– *What is the rationale behind the requirements?*

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Given the increasing airtightness of buildings, occupants have to more and more on their ventilation systems to ensure a comfortable and healthy indoor air quality. We trust that ventilation standards address this concern. However, significant disparities exist between countries regarding the requirements and regulations for ventilating various spaces, including dwellings, offices, and classrooms. In fact, the variation in prescribed minimum ventilation flowrates for similar building types among different countries can exceed a factor of five (see **Figure 1**).

Keywords: Residential ventilation, indoor air quality, ventilation standards.

To address this issue, the AIVC has recently released Technote 72: "Ventilation Requirements and Rationale behind Standards and Regulations of Dwellings, Office Rooms, and Classrooms." [1]. This document aims to elucidate the rationale behind diverse international ventilation standards. Additionally, extensive research conducted over the past decade, notably detailed in Technote 68 "Residential ventilation and health" by the AIVC, has identified the primary pollutants impacting indoor air quality and health [2].

An examination of Technote 72 with data from 29 countries reveals significant disparities in ventilation requirements for dwellings, including living rooms and "wet rooms" such as kitchens, toilets, and bathrooms. To facilitate cross-country comparisons, we have expressed all requirements in dm^3/s. The rationale behind ventilation requirements encompasses factors such as human odours (often CO_2 concentration is used as a marker), moisture from activities like washing and cooking, health impacts, formaldehyde emissions, cooking fumes, bacteria, viruses, sick building syndrome symptoms, and radon.

Many ventilation regulations date back to the early 1990's and lack comprehensive scientific reports explaining their rationale. Instead, they are often based on expert opinion or information from other standards. Historical differences may stem from energy efficiency and health concerns, such as those related to formaldehyde. Despite commonalities in rationale, there remains a wide range of ventilation requirements, particularly for kitchens.

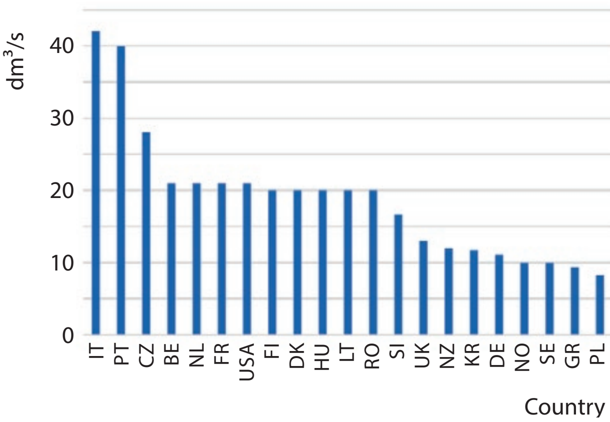

Figure 1. The minimum flow rate for kitchens. [1]

Experts generally agree that removing cooking byproducts is the primary rationale for kitchen ventilation, while moisture control drives requirements for bathrooms. For toilet rooms, preventing the spread of contaminants and odours is dominating human bio-effluents predominantly dictate ventilation requirements for habitable rooms. Notably, variations in ventilation requirements are more pronounced for habitable rooms than for office spaces and classrooms, reflecting differences in occupancy and activities.

AIVC Technote 72 underscores that ventilation standards are rooted in pollutant mitigation to prevent discomfort and health risks. Technote 68 identifies key indoor and outdoor pollutants based on concentration and associated health impacts, and describes effective ventilation strategies.

Ventilation strategies should be designed to minimize health hazards and prevent unwanted odours. To achieve this goal, it is essential to identify the pollutants that pose health risks and determine the most effective control strategies for those pollutants. High concentrations of pollutants do not necessarily indicate a health risks. Merely relying on pollutant concentration data is insufficient for identifying the pollutants that drive health hazards. Toxicity levels vary significantly among pollutants, and extensive research has been conducted to establish links between exposure levels of specific pollutants and particular adverse health outcomes.

Several studies have attempted to prioritize pollutants for mitigation in the indoor environment based on the prevalence of disease in the community, occupant exposure estimates, and the research-derived links between exposures and health outcomes. The key pollutants identified as driving chronic health impacts include $PM_{2.5}$ (particulate matter with a diameter less than 2.5 microns), mold/moisture, radon, environmental tobacco smoke (ETS), formaldehyde, and acrolein. To reduce exposure to contaminants, different control strategies can be applied. The most effective strategies [3] are 1. avoiding the emission of contaminants by source elimination and 2. enclosure and encapsulation of sources with e.g. a cooker hood. The remaining contaminants can be diluted with in most cases mixing ventilation by supplying fresh air. An excellent example of the first strategy is to replace gas cookers with electrical hob, minimizing the exposure to NO_2, acrolein, CO and ultrafine particles. Ventilation plays a key role in reducing exposures that can't be controlled by these measures. Effective local ventilation, such as cooker/range hoods with effective capture efficiency, is critical for removing pollutants from periodic high-emission sources such as cooking. Other unavoidable contaminants such as human odours, can be removed by using mixing ventilation or displacement ventilation. The correct amount of ventilation is still a topic of debate.

Therefore, there is a need to evaluate and develop new advanced ventilation strategies based on health and comfort criteria, but let's not forget the document factor of active involvement of building occupants in the creation of a healthy and comfortable indoor air quality.

References

[1] AIVC Technical Note 72 Ventilation Requirements and Rationale behind. https://www.aivc.org/sites/default/files/TN72.pdf .

[2] AIVC Technical Note 68: Residential Ventilation and Health. https://www.aivc.org/resource/tn-68-residential-ventilation-and-health.

[3] Jacobs et all, Indoor air quality in Nearly Zero Energy Buildings, reduction of exposure, AIVC conference 2019.

[4] Logue et all, A Method to Estimate the Chronic Health Impact of Air Pollutants in U.S. Residences, LBNL 2012. ■

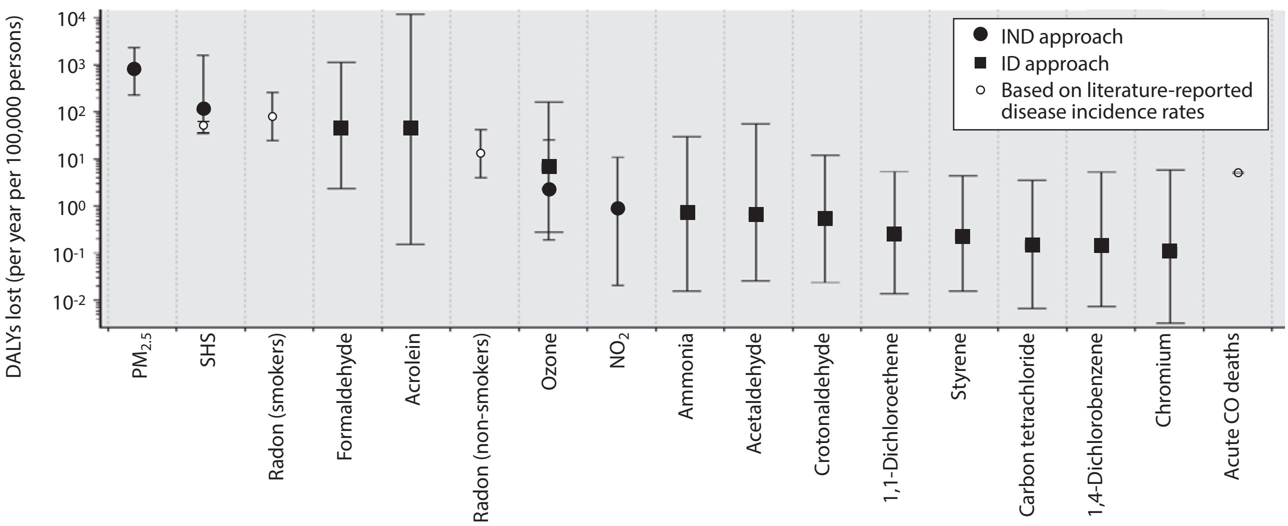

Figure 2. Estimated population averaged annual cost, in DALYs, of chronic air pollutant inhalation in U.S. residences; results for the 15 pollutants with highest mean damage estimates. Logue at al. 2012 [4]