論文 / 著書情報
Article / Book Information

題目(和文)	住宅特性と換気システムが室内VOC濃度に及ぼす影響
Title(English)	Influence of Residential Characteristics and Ventilation Systems on Indoor VOC Concentrations
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論 文 要 旨
THESIS SUMMARY

系・コース： Department of, Graduate major in	建築学 建築学	系 コース	申請学位（専攻分野）： Academic Degree Requested	博士 Doctor of （工学）
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要旨（英文 800 語程度）
Thesis Summary（approx.800 English Words ）

Volatile organic compounds (VOCs) are a large group of carbon-based chemicals that easily evaporate at room temperature. They are characterized by their high vapor pressure and low boiling point, which enable them to disperse quickly into the air. VOCs are commonly found in both natural and synthetic sources and are present in a wide range of indoor environments. VOCs in indoor can originate from numerous sources including building materials, furnishings, household products, personal care items, cooking and smoking. Poor ventilation exacerbates the accumulation of VOCs indoors, as it limits the dilution and removal of these compounds from the indoor environment. Consequently, understanding and controlling the sources of VOCs, alongside ensuring adequate ventilation, are critical for maintaining healthy indoor air quality and reducing potential health risks associated with long-term exposure to these compounds. Twenty years after the issue of sick house syndrome in the 1990s, it is necessary to continuously monitor the impact of indoor VOCs on the health of residents in homes where people spend significant amounts of time. Additionally, there is a lack of data on various housing types and a paucity of research on the impact of indoor VOCs relative to different ventilation systems.

Chapter 1 provides a comprehensive overview of the study, beginning with the background and motivation for researching indoor VOCs. It delves into the physical and chemical characteristics of VOCs, outlining their common properties, sources, and potential health impacts. The chapter also reviews VOC guidelines and regulations in major countries around the world, highlighting the differences and similarities in standards aimed at protecting indoor air quality. A thorough summary and analysis of previous studies on VOC levels in both new and existing houses are presented, identifying trends, differences, and inconsistencies in the current body of research. Based on this literature review and the identified differences in research and data, the chapter explains the purpose of this study, which aims to fill these gaps (Characteristics, types and ventilation systems of housing) by providing new insights and comprehensive data on indoor VOC concentrations across various housing types and ventilation systems.

Chapter 2: This study involved field measurements conducted in different types of housing (custom-made homes, built-for-sale homes, private rentals, and apartments) during both winter and summer to assess VOC concentrations. The study sampled indoor air quality in 116 houses in winter and 66 in summer, using data from questionnaires about housing type, residence period, and ventilation systems to understand factors influencing VOC concentrations. The findings revealed that 12% of the houses exceeded guideline values for formaldehyde and acetaldehyde. A notable observation was that houses with frequent alcohol consumption showed elevated acetaldehyde levels. While the living room generally had slightly higher VOC concentrations than the bedroom, no significant seasonal differences were found. However, there were statistical differences in VOC concentrations by housing type and ventilation system, with apartments showing the highest levels and a marked difference in concentrations depending on the ventilation balance and heating systems used.

Chapter 3: Building on the insights from Chapter 2, further surveys and field measurements focused on the impact of ventilation systems. The study differentiated between homes with balanced and unbalanced ventilation systems, measuring in 16 homes with balanced ventilation and 17 with unbalanced during both seasons. The results showed that both balanced and unbalanced ventilated homes measured lower VOCs than the guidelines, but balanced ventilation tended to have higher VOC concentrations than unbalanced ventilation. When looking at the correlation between VOCs and air change rates in living rooms and bedrooms in winter and summer, certain VOCs varied in season and space, both positively and negatively, but there were no consistent results overall. Residential buildings with balanced ventilation systems tend to have more consistent and higher air change rates and are more effective at maintaining lower concentrations of VOCs, which helps manage indoor air quality.

Chapter 4: In Chapter 3, the VOC concentration in the unbalanced ventilation system was measured as higher than that in the balanced ventilation system. There are several factors, but given the possibility that VOC concentrations may flow into the room from enclosed spaces, the VOCs of the insulation material, one of the important materials for the airtight performance of the building, were evaluated. The emissions of VOCs and formaldehyde from various insulation materials were measured using the small chamber method. The materials tested included glass wool, mineral wool, expanded polystyrene (EPS), extruded polystyrene, phenolic foam, rigid polyurethane foam, cellulose, and cork. Specifically, EPS and cork exhibited higher emission rates for toluene, styrene, and acetaldehyde. This indicates that in homes using only unbalanced ventilation, where indoor spaces are under negative pressure, VOCs can infiltrate from enclosed spaces and impact indoor air quality.

Chapter 5 (Conclusion): This study highlights the need for ongoing monitoring of VOCs in both new and existing homes to understand the variations in VOC concentrations across different housing types. Comparisons between balanced and unbalanced ventilation systems have shown that unbalanced systems often lead to higher VOC concentrations, necessitating further research into the impact of ventilation on indoor air quality. Additionally, in homes with unbalanced ventilation, VOCs can infiltrate from enclosed spaces, underscoring the importance of ensuring sufficient and appropriate ventilation.