NATIONAL ACADEMIES Sciences Engineering Medicine

Why Indoor Chemistry Matters

Summary for Researchers and Research Funders

Although people spend most of their time in indoor locations, many challenges and data gaps remain in the understanding of indoor chemistry and its impact on the environment and human health. Challenges include identifying chemical sources, understanding the partitioning of chemicals and chemical transformations, and having limited information on the health effects or distribution of the chemicals found in the indoor environment.

A report from the National Academies of Sciences, Engineering, and Medicine explores these challenges and data gaps in indoor chemistry and identifies research priorities and recommendations to advance our understanding of this complex field. The report explores many aspects of indoor chemistry, including new findings related to underreported chemical species, chemical reactions, and sources of chemicals and their distribution in indoor spaces.

Complex mixtures of chemicals in indoor environments may adversely impact indoor air quality and human health. Indoor exposure profiles and human exposure to chemical mixtures must be understood to identify and characterize exposure impacts. Furthermore, effective management of chemicals in the indoor environment is critical to human health. Management of chemical contaminants includes removal and chemical transformations.

The report considers several **emerging themes** in indoor chemistry:

1. **Complex Chemical Mixtures and Processes**
   - There is a high degree of chemical complexity and many sources and processes that emit chemicals indoors. However, little is known about how humans get exposed to multiple chemicals across phases and pathways, how these joint exposures interact across timescales, and the cumulative and long-term impacts on human health.
2. **Chemical Reactivity**
   - Many indoor contaminants are chemically reactive via oxidative processes, photochemistry, hydrolysis, and other mechanisms. However, the dependence of multiphase reaction kinetics on oxidant concentrations, condensed-phase water abundance, light levels, and substrate chemical composition is poorly understood.
3. **Distribution of Indoor Chemicals**
   - Accurately describing the phase distribution of chemical contaminants remains a challenge. The integration of knowledge of partitioning processes, transformation chemistry, environmental conditions, human influences, and other parameters is essential to understand these complex processes and enable accurate chemical exposure and health risk assessments.

The report culminates with a vision for the future of indoor chemistry research. This vision relies on an increase in awareness within the scientific community of the challenges and opportunities for innovation in indoor chemistry research as well as the need to fund research in indoor chemistry.

Table 1

A PATH FORWARD FOR INDOOR CHEMISTRY

There is much left to learn and understand about indoor chemistry and the linkages between chemical exposure, air quality, and human health. The report identifies many ways that **researchers** and **research funders** can address critical needs to advance research, enhance coordination and collaboration, and overcome barriers for implementation of new research findings into practice in indoor environments. The consideration of these recommendations will be critical to translate the emerging science of indoor chemistry into a practice that benefits both public health and the environment.

RESEARCHERS SHOULD:

- Further investigate the chemical composition of complex mixtures present indoors;
- Focus on understanding chemical transformations that occur indoors;
- Prioritize understanding the phase distribution of indoor chemicals and incorporate these findings into exposure models;
- Apply and develop new analytical tools that can probe the chemical complexity of gases, aerosols, and surfaces;
- Proactively engage in links that connect research to application throughout the indoor chemistry research process;
- Include environmental justice communities in the wide range of indoor environments they study and engage these communities in formulating research priorities and recommendations for future indoor air quality standards.

RESEARCH FUNDERS SHOULD:

- Prioritize resources toward understanding indoor exposures to contaminants, including those of outdoor origin that undergo subsequent transformations indoors;
- Devote resources to creating emissions inventories specific to building types and to identifying indoor transformations that impact outdoor air quality;
- Make the study of indoor chemistry and its impact on indoor air quality and public health a national priority;
- Invest in developing novel methods and chemoinformatic resources that increase our ability to identify and quantify the abundances of wide classes of indoor chemicals;
- Design and regularly implement an updated National Human Activity Patterns Survey and add survey questions in existing surveys that capture people's activities in indoor environments as they relate to indoor chemistry and indoor chemical exposures;
- Support interdisciplinary research to investigate the impact of products and services on indoor chemistry;
- Prioritize understanding the health impacts from exposure to specific classes and mixtures of chemicals in a wide range of indoor settings.

This document is based on the Consensus Study Report *Why Indoor Chemistry Matters* (2022). The study was sponsored by the Environmental Protection Agency, National Institutes of Health, Department of Health and Human Services, Centers for Disease Control and Prevention, and SLOAN. Any opinions, findings, conclusions, or recommendations expressed in this publication do not necessarily reflect the views of any organization or agency that provided support for the project.

This Consensus Study Report is available from the National Academies Press
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