

A Strategic Research Initiative on Research Data Visualization and an Online Data Portal

Chemical Insights Research Institute (CIRI) is developing an open-source online tool that shares data from its research initiatives in an interactive portal.

Introduction

Open-source data helps raise awareness and improves access to information, allowing stakeholders to better understand situations, make informed decisions, and support effective problem-solving. In addition, free access to research data encourages researchers to explore innovative ideas and develop new methods. Open sharing of data also reinforces the robustness of the research by assisting other investigators in validating and reproducing the research and analysis methods. In addition, open-source data can serve as an educational and capacity building resource, which helps students, teachers, citizen scientists, and other researchers to gain practical experience in data analysis.

CIRI conducts research on emerging environmental health issues and generates reliable research data using a quality-assured analytical chemistry laboratory, established laboratory, and field sampling protocols. Volatile organic compound (VOC) and aldehyde samples are collected and analyzed based on standard sampling protocols and analysis methods.¹ The laboratory-quality program enables the accuracy of the identification and quantification of analyzed VOCs and aldehydes. The general quantitation level of VOCs and aldehydes is 0.5 $\mu\text{g}/\text{m}^3$. Airborne particulate matter (PM) levels are monitored with real-time instrumentation, scanning mobility particle sizers and optical particle sizers, for nominally 10 nm to 10 μm particles. In addition to internal quality assurance, quality control, and review processes, key research findings from each research initiative have been published in peer-reviewed journals. The extended research data is stored online in CIRI's data portal.

Study Objectives

This study aims to create an online interactive data tool that is open to all users free of charge. Based on research initiatives, CIRI gathers and organizes research data, including internally generated data and reported data from other reliable resources. There are two types of research data available within CIRI's data portal: source data and location data. Source data involves emission characterizations obtained from laboratory chamber studies, including VOCs and PM from products and activities that people typically find in indoor environments.

These products and activities have the potential to release hazardous chemicals that may adversely affect the health of the occupants. In this case, the CIRI data portal allows users to identify the source of specific emissions of interest or broadly evaluate emission profiles from specific products and activities. On the other hand, data collected in a field setting – location data – involves measured chemical levels that represent real-world situations of air quality in various indoor and outdoor environments. This data allows users to identify common or unique existing chemical agents abundant in different environments and the range of their levels due to variations in locations, time, settings, and activities. This data portal is beneficial for a wide range of stakeholders, including consumers, manufacturers, researchers, policymakers, educators, and the general public.

Scientific Outcomes

The data portal presents source and location data separately for the following research topics and can be cross-referenced for specific VOCs.

- **3D printing emissions² (source data):** 3D printing, an emerging technology that has been widely used in industrial, educational, and residential setups, emits high levels of ultrafine particles and numerous hazardous VOCs. PM and VOC emissions from 3D printing are measured and evaluated according to the standard testing method ANSI/CAN/UL 2904.³ The CIRI data portal provides an overview of emissions for various printing conditions, including printing type and material. This dataset will be useful for manufacturers, users, educators, researchers, and others who are involved in 3D printing to understand the basic facts of 3D printing emissions, specific VOCs released from certain types of material, variation of emissions for given printing conditions, and the emission criteria from ANSI/CAN/UL 2904. This dataset will further help the planning and designing of exposure mitigation strategies.
- **Electronic nicotine delivery systems (ENDS) emissions⁴ (source data):** ENDS devices have gained popularity, especially among young adults and adolescents. Even though ENDS is promoted by the industry as a safe alternative to traditional cigarettes, studies have found that ENDS generate aerosols that contain harmful components. VOC emissions from each puffing activity are evaluated using validated exposure chambers that operate at static status. This database provides VOC emission profiles from popular ENDS devices that are available on the market, including pod types, mod types, and disposable types, with various e-liquid flavors. This database can be used as general information for learning the facts of vaping. In addition, this primary emission information can be used for conducting further health-related studies and estimating second-hand exposure.
- **Furniture and building product emissions⁵ (source data):** Furniture and building materials are a major source of VOCs indoors. In the data portal, studied products include several types of upholstered chairs and cushions, carpets and flooring materials, paints, panels and boards, and other materials. These products are commonly seen in residential and commercial buildings, which contribute to the background VOC levels at normal room conditions, and occupants are exposed to these VOCs when indoors.
- **VOC emission factors are characterized by using chamber studies based on established testing standards.** This database provides VOC emission information from different indoor products and materials. Homeowners, builders, designers, and facility managers can gain knowledge on VOC emission levels from various material sources, which will further guide material selection, planning, and design.
- **China and India household VOC levels^{6,7} (location data):** This database is taken from the global air pollution research initiative undertaken in collaboration with Duke University. Air pollution is one of the major contributors to adverse health effects; therefore, it is important to know the contaminants in air that people inhale in indoor and outdoor environments. This database provides information on indoor and outdoor VOC compositions and levels from Asian countries. Data from China also includes a comparison for the impact of filtration (portable air cleaner with high efficiency particulate air and carbon filters) on indoor VOC levels. Data from India also includes comparisons of diurnal (morning vs. afternoon) and seasonal (summer vs. winter) differences of VOCs at the same location. This database helps in understanding the variation of indoor and outdoor VOC species in different countries and regions, the potential sources of indoor and outdoor VOCs, and the trends of VOCs under different spatial and temporal variations.
- **United States (U.S.) household VOC levels⁸ (location data):** This database is taken from the research initiative on wildfires and public health undertaken in collaboration with the U.S. Environmental Protection Agency (EPA). The studied region in California is a rural, agriculturally intensive county that is frequently impacted by wildfire smoke. Wildfire brings a mixture of hazardous contaminants due to combustion and photoreaction, which may penetrate indoors and elevate the VOC levels. This database provides information on indoor and outdoor VOC compositions and on levels without the impact of wildfire. It can be used as a baseline to compare with the air quality impacted by wildfire or wildland-urban interface activities. This database also provides source information of indoor and outdoor VOCs, such as those related to agriculture and cleaning and cooking activities, which can be used for further research topics.

- **Building Assessment Survey and Evaluation (BASE) Study⁹**
(location data): This study was conducted by the U.S. EPA to characterize indoor air quality and occupant perceptions in representative public and commercial office buildings across the U.S. This database provides baseline information of indoor air quality (IAQ)-related parameters in typical office spaces as compared to previous studies on office buildings with reported IAQ complaints. The CIRI data portal collects the observed target VOC levels in various locations from the BASE study. This database is useful for research, building professionals, and policy-making communities to further understand office environment conditions and health symptoms.

The CIRI data portal provides an interactive way of viewing and screening data by selecting the parameters of interest. Users can download the data as needed. The data portal will be continually maintained and updated as new data becomes available.

Research Partner

- **HabitatSeven (data visualization)**
- **Georgia Institute of Technology (3D printing source dataset)**
- **Georgia State University (ENDS source dataset)**
- **Duke University (China and India location datasets)**

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