

ABSTRACT

As the urbanization trend prevails worldwide, more people are moving to major metropolitan areas, causing housing resources to be in urgent demand. Tiny homes, designed to offer a minimalist lifestyle while also addressing growing housing needs, have become increasingly popular among home seekers. Since the COVID-19 outbreak, individuals primarily spend their time indoors, and with more people adopting work-from-home lifestyles, ensuring a high-quality, sterile, and comfortable indoor environment becomes crucial for indoor occupants. Many studies have highlighted that the activities of occupants significantly influence indoor environmental quality (IEQ) and energy consumption in buildings and applying disinfectants will generate increasing amount of volatile organic compounds (VOCs) which occupants could inhale, causing adverse health effects. Within this thesis, two studies are introduced and discussed. The first study, namely “zEDGE Living Experiments”, conducts a comprehensive evaluation of IEQ satisfaction and energy usage in the Purdue zEDGE Tiny House through survey and measurement analysis. Twenty full-scale experiments were conducted during the winter season. The study first evaluates participants’ perception of IEQ factors, with thermal comfort and indoor air quality (IAQ) emerging as top priorities. It then examined energy adaptive behavior to understand maintenance of comfortable indoor conditions, noting primary adaptive strategies included heating, ventilation, and artificial lighting. The study then measured IEQ and energy consumption, evaluating occupants’ IEQ satisfaction levels. The average energy use was recorded at 10.3 kWh, with occupants generally satisfied with IEQ in the zEDGE Tiny House. Analysis indicated that heating and cooking were significant energy consumers, potentially exposing occupants to high indoor air pollutant levels in such compact living spaces. The second campaign, namely “Performance Evaluation of PID and PTR-TOF-MS”, compares the VOC detection abilities of photoionization detectors (PID) and a state-of-the-art proton-transfer-reaction time-of-flight mass spectrometer (PTR-TOF-MS). 54 controlled emission experiments were carried out among 18 different disinfectant products with main ingredients based on alcohol, lactic acid, peracetic acid/acetic acid, and botanical products. The results from time-series and correlation analyses indicate that the PID and PTR-TOF-MS are able to pick up VOC signals from emission experiments. While the performances of the PID and PTR-TOF-MS were similar under experiments with alcohol-based

products, the PID performed less well with products based on lactic acid and botanical products, and unsatisfactory for peracetic acid/acetic acid-based products.