Environmental Health Committee (EHC) Emerging Issue Brief:

Potential Microbial Contaminants in Biowall Water and Soil Systems

What is the issue?

Potential Benefits

Increasingly, plant-based features called biowalls, or greenwalls, are being installed in buildings as architectural features (Arsenault and Darlington, 2013). Biowall systems can be *passive*, consisting of potted plants arranged vertically on a wall, and may include both automated watering and lighting systems. Biowall technologies can also be *active*, with air pushed or pulled through the soil media, which can humidify and clean the air (Wang and Zhang, 2011; Abdo, 2017). Active biowalls can be installed as stand-alone recirculation units or as part of the supply or return air in a mechanical ventilation system (Aydogan, 2012; Soreanu et al., 2013; Torpy et al., 2015).

While the mechanisms of air cleaning in biowall systems continue to be investigated (Wolverton et al., 1989; Wood et al., 2006; Yang et al., 2009; Kim et al., 2010; Wang et al., 2012; Llewellyn and Dixon, 2011; Kim et al., 2016), removal efficiency testing demonstrates these systems can reduce concentrations of volatile organic compounds (VOCs, Darlington et al., 2001; Orwell et al, 2006; Tarran et al., 2007; Guieysse et al., 2008; Irga et al., 2013; Waring, 2016; Torpy et al., 2017) and particulate matter (Pettit et al., 2017; Irga et al., 2017b). There are also psychological benefits (e.g. mood) associated with exposure to nature (Brooks et al., 2017; De Young et al., 2017; Frumkin et al., 2017; Korpela et al., 2017; Wyles et al., 2017; Zhang et al., 2017).

Potential Risks

Investigations have demonstrated how soil microbial communities respond to VOC absorption (Orwell et la., 2004; Huang et al., 2012; Irga et al., 2013; Russel et al., 2014; Weyens et al., 2015; Sriprapat and Strand, 2016) however, there are currently no studies describing or quantifying the potential for pathogen proliferation and transmission in biowall water and soil systems. There is a lack of knowledge about how commercially available biowall water systems are designed to limit water- and soil-borne pathogen proliferation and how these systems are tested to ensure they operate as intended. While fungal bioaerosol emissions from biowalls were found to be low in previous studies, the potential for bacterial emissions from biowall systems has not be characterized and the emission rates of microbes from biowalls remain poorly parameterized (Zhang et al., 2010; Mahnert et al., 2015; Irga et al., 2017b). Further, many treatment approaches for controlling microbial contaminants may not be conducive with use in a plant watering system (e.g. chlorination, high water temperature, ozone; Prussin et al., 2017).

Given the long history of *Legionella* outbreaks associated with aerosolization of the pathogen from water-based building features (Prussin et al., 2017), it is critical that the potential for transmission of water-borne pathogens from biowalls be characterized. Other water- and soil-borne pathogens, such as nontuberculosis mycobacteria, are also of concern (Johnson and Odell, 2014). Active biowalls are of specific interest, as the potential for aerosolization of microbes from contaminated water and soil is suspected to be higher with this design.

What does it mean to ASHRAE?

Biowall systems are being considered by building engineers as a component in the humidification and air cleaning strategies in buildings. As other architectural features with water systems have repeatedly been implicated in outbreaks of water-borne pathogens, such as *Legionella*, it is imperative to assess the potential for biowalls to act as a reservoir and vector for water- and soil-borne pathogen transmission in buildings.

What action should be considered?

As biowalls are a relatively new technology, it is important that ASHRAE actively participate in expanding the scientific understanding of the health and safety concerns associated with biowall water and soil systems. To accomplish this, ASHRAE should:

1. Develop an understanding of the range of biowall designs, specifically a description of water, soil, and air movement systems, and how these systems are treated to reduce the risk of water- or soil-borne pathogen proliferation.
2. Develop an understanding of the risk of microbial contamination and pathogen transmission from active and passive biowall systems.
3. Develop an emission rate parameterization for the aerosolization of particles and bioaerosols (e.g. bacterial and fungal) from biowall systems.
4. Develop recommendations for the design, management, and cleaning of biowall systems in buildings, specifically biowall water and soil systems, to reduce the risk of water- and soil-borne pathogen proliferation and transmission.
5. Develop recommendations for how biowall systems can be safely leveraged by architects and building engineers as architectural features and possibly supplemental humification and air cleaning systems.

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