Pathogen ALERT

RAPID Reader

White Paper (NW_14)

Fungi / Mold detection using the RAPID Reader system

Airborne Pathogens and their Analysis

Outbreaks of pathogens, and contamination by pathogenic species are a dangerous and unpredictable occurrence in a variety of institutions, ranging from food and beverage plants to healthcare facilities. Current bio-contamination systems are insufficient in a variety of respects, often relying on timed or periodic sampling of areas. Stringent hygienic practices, and careful disinfection of surfaces and work spaces has gone a long way to decreasing the chances of harmful outbreaks in many facilities, but unfortunately airborne dispersion of microbes and spores remains a problem. Currently the most widely used and effective monitoring methods for airborne contaminants are;

Settle plate analysis – a qualitative method used to isolate airborne species present in the environment for differential assessment (Figure 1)

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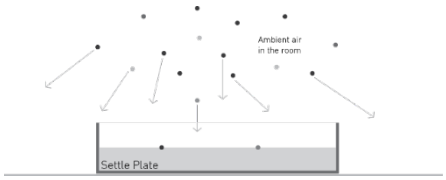

Fig 1 – Settle plate Experiment

Impactor sampling – Impactors are systems that sample a specific volume of air per use, giving both qualitative and quantitative data from an environment (Figure 2)

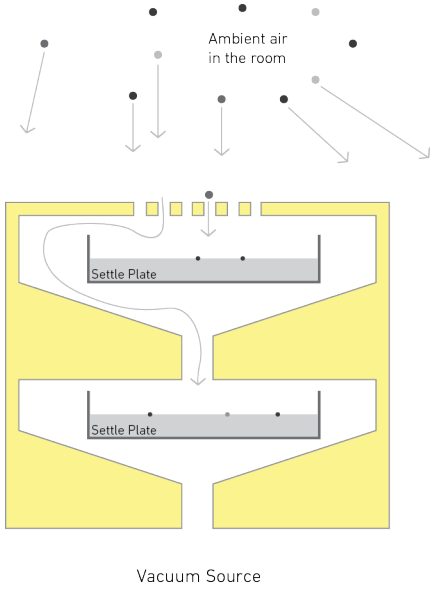

Fig 2 – Impactor with 2 chamber setup

Each method is similar, in that they both incorporate the use of nutrient medium to provide spores/microbes with a habitable environment to thrive and grow. Both methods however suffer from several drawbacks.

Measurements using impactors and settle plates involve sampling air in an area for several minutes, to a couple of hours, at specific lengthy intervals (possibly days to weeks apart). During this time the air in the tested environment can change dramatically, and the likelihood of sampling at the exact time of an elevated pathogenic load is greatly reduced. Therefore, although sufficient for testing a facilities nominal day to day air quality, these methods leave a significant gap in delivering a reliable pathogen monitoring solution.

The RAPID Reader system goes well beyond the state of the art of current routine monitoring

practices. The RAPID Reader samples the air several times an hour, continuously, and is in constant dialogue with a cloud based monitoring and machine learning system, which alerts the user to positive growth events.

Fungi / Mold

Mycology is the study of fungi, which are eukaryotic organisms that are ubiquitous in nature, ranging from moulds, to yeast, to mushrooms. Although mostly harmless, research has shown there are certain pathogenic species of fungi that present a significant health risk to individuals, especially those that suffer from immune deficiencies and breathing disorders.

Take the Aspergillus family of moulds as an example. Over 180 species of Aspergillus fungi have been identified, and a variety of these have been found to be harmful to humans and animals alike. A. flavus, A. brasiliensis (A. Niger), and A. fumigatus have been shown to be some of the more harmful species to humans, as they create mycotoxins that can be extremely detrimental to a person's health. A. fumigatus for example has been attributed with roughly 90% of all invasive aspergillus infections in people, and has a high (50-95%) mortality rate. Immunocompromised patients are most at risk from infection, but even healthy individuals run the risk of infection if constantly exposed to elevated levels of Aspergillus species. [1, 2]

As these fungi are ubiquitous [2, 3], and the prevalence of spores is highly dependent on a range of factors, both external and internal, spot check monitoring for these pathogenic organisms does not give a real estimation of their presence.

Although large similarities exist between many fungi variants, differences in the structure of the species can allow for closer examination and differentiation. Molds spread using a mycelium, a web like mesh that grows from the initial spore, whereas yeasts typically adopt a single cell growth mechanism. In molds, sporangia form from the mycelia mesh, and conidia are produced. These conidia spores are what can then spread to surrounding areas on air currents or on insects, and are often characterised by a specific opaque colour. Figure 3 shows this growth process for Aspergillus species.

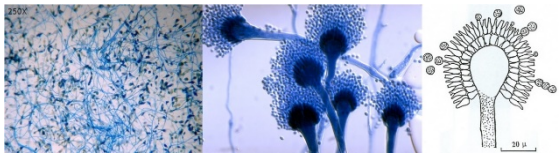

Fig 3 – (Left) Collection of hyphae forming a mycelium, (Middle) Conidia forming on conidiophores in the mycelia, (Right) diagram of conidiophore [4-6]

The morphological changes of the mold as it grows can be monitored by optical sensors, as light interacting with the growing mass will be affected in a variety of ways as the fungi develops. This modulation of the optical signal can develop very early in the life cycle of the growth, allowing for analysis and detection before visible growth has been witnessed, and enabling rapid detection of events. This is the scientific basis on which the RAPID Reader system is based.

RAPID Reader System

The RAPID system shown in Figure 4 is designed to be wall mounted or self-standing, and contains the pathogen detection technology, wireless communication, and signal processing electronics. To function, the unit must be loaded with a cartridge (Figure 4). When the cartridge is inserted, and the system activated, monitoring begins for the specified organism immediately. Different cartridges are used for different targeted pathogens. The cartridge contains a nutrient agar which can be selective to specific pathogenic species. This forms a core component of the pathogen sampling system, which in turn is integrated with the detection and alert systems.

Fig 4 – Activated RAPID system, sampling air

The system is designed to ensure no cross contamination is possible between cartridges. Sterilised cartridges contain the growth medium, and once loaded the cartridge is isolated, creating an internal environment that promotes the stability of the agar and enhances growth of the pathogenic species. Air is pulled through the cartridge to help remove any chance of contamination from the unit itself.

The RAPID Reader system can be loaded with a range of cartridges that monitor for different pathogenic species. Mold specifically presents an attractive target; as indoor prevalence of some mold species can be detrimental to human health.

Experiments performed using A. brasiliensis samples have shown the RAPID system to return results within 6 to 11 hours from initial infection. Incubation of sampled species occurs in situ, with the cartridges isolated localised environment providing a constant hospitable environment for rapid growth.

References

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[4] Adapted from http://thunderhouse4-yuri.blogspot.ie/2010/06/alternaria-alternata.html (accessed on 2nd June, 2016)

[5] Adapted from http://www.pfdb.net/photo/mirhendi_h/box020909/standard/a_fumigatus_s.jpg (accessed on 2nd June, 2016)

[6] Adapted from http://mycota-crcc.mnhn.fr/site/genreDetail.php?lang=eng&num=4&n=Aspergillus (accessed on 2nd June, 2016)