Filtration and inactivation of aerosolized bacteriophage MS2 with air ions and electric field

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Particles of biological origin, such as bacteria, viruses, fungi, and pollen as well as their fragments that are present in air are referred to as bioaerosols. Bioaerosols can cause serious health hazards when they contaminate a human environment. Influenza virus, severe acute respiratory syndrome (SARS) virus, and the threat of avian and swine flu are natural examples illustrating the profound, everyday impacts of bioaerosols on public health. Filtration is one of the most common methods of removing airborne particulates. It has been applied various situations from personal facepiece respirators to central heating, ventilation, and air-conditioning (HVAC) system of buildings because filtration can archive high removal efficiency of aerosol particles still simple and economical. However, indoor bioaerosols accumulate in large quantities on the filters, where they are able to multiply under certain conditions, especially if high amounts of moisture are present on the filters. Moreover, the organic or inorganic materials deposited on the filter media after air filtration contribute to microbial growth. This inevitably leads to decreased filter efficacy and, probably, to deterioration of the filters and the eventual release of microorganisms.

To inactivate aerosolized microorganism, there are various controlling technologies for this contaminant, including air ions, chemical treatment, photocatalytic oxidation, Ultraviolet Germicidal Irradiation (UVGI) and dielectric barrier discharge. Especially the carbon fiber ionizer, with an ion emission tip consisting of a bundle of micron-sized carbon fibers, produced stable unipolar or bipolar ions in sufficiently high concentrations without generating particulate matter or ozone. Each fiber was supplied with a high voltage, and ions were emitted from the ends of the fiber.

Electrostatic particle capture enhances conventional mechanical filtration mechanisms in the submicron size range without increasing the pressure drop. Electret filter which made of charged filter fiber is widely used because of its high performance yet low pressure drop. Some studied the electrified filter collector coupled with external electrical field and some studied air ionizer to discharge the particles. In Park *et al* (2011) the increase in efficiency (the difference between efficiency with and without ionizers) with ionization gradually decreased as the particle size increased, as has been reported by filtration studies that demonstrated that the increase in efficiency with electrostatic force decreased as the particle size increased. The size of our test virus, bacteriophage MS2, is found 27 nm which would highly affected by electrostatic force.

In this work, we studied the viability of air ions and electric field to virus deposited onto a medium filter. First we discharged aerosolized virus with unipolar ions then deposited onto a medium filter. Electric field was applied to filter for enhancing filtration efficiency. We used MS2 bacteriophage, a 27 nm tailless non-enveloped icosahedral RNA-coliphage, relatively stable against environmental stress, has been used in the past as a simulant of most mammalian viruses, and it is known as an indicator for enteric viruses. After deposition, filter was exposured to unipolar or bipolar ions.

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