WATER & ENVIRONMENT

AECOM

Examining COVID-19 and its Impact on Water and Wastewater

Knowledge related to the COVID-19 virus is evolving quickly. We are continuing to update this document regularly, as new information and insights become available.

Introduction

This technical brief addresses questions regarding the potential exposure of water and sanitation practitioners and the general population to the Coronavirus disease (COVID-19) through potable water and wastewater. COVID-19, a new virus previously unknown before its outbreak in December of 2019, belongs to the large family of coronaviruses which may cause illness in humans or animals. In humans, some coronaviruses are known to cause respiratory infections ranging in severity from mild to potentially fatal. Currently, there is no specific information about the occurrence and survival of the COVID-19 virus in drinking-water or wastewater. However, COVID-19 is similar to other human coronaviruses for which there are available studies of survival in water and wastewater and effective inactivation measures.

Routes of COVID-19 Transmission

The two main routes of transmission of the COVID-19 virus are respiratory and through contact with infected surfaces. The World Health Organization (WHO) considers the risk of contagion from the feces of an infected person to be low (WHO, 2020) and there is no evidence to date that the COVID-19 virus has been transmitted via contaminated water with or without treatment. Although speculation varies, one hypothesis is that the COVID-19 outbreak (and the 2002-2003 SARS outbreak) originated from the feces or saliva of bats. Therefore, infection through wastewater, or surface water contaminated by wastewater, cannot be excluded and should be treated as a potential health hazard.

COVID-19 Survival in Water and Wastewater

There have been laboratory studies on the survival of surrogate coronaviruses in well-controlled environments. The results of these studies indicate these viruses can survive in water contaminated with feces for days to weeks, and that the inactivation of coronaviruses is highly dependent on water temperature and quality. Compared to other viruses known to be stable in water, coronaviruses have a relatively quicker reduction in concentration.

For example, a study using two surrogate coronaviruses, transmissible gastroenteritis (TGEV) and mouse hepatitis (MHV), showed that these viruses remained infectious in water and sewage for long periods. In distilled water at 25ºC (77ºF), the time for 2-log (99 %) concentration reduction was 22 days for TGEV and 17 days for MHV. In previously pasteurized settled sewage, the times for 2-log reduction were 9 days for TGEV and 7 days for MHV. The reduction in infectivity of both viruses at 25ºC follows typical first-order kinetics. Under colder water conditions, the decline of infectivity was considerably slower. Experiments conducted at 4ºC (39.2ºF), showed a 2-log decrease for both viruses of 200 days in distilled water, and over 40 days in pasteurized sludge (Casanova et al., 2009).

Another study conducted using representative coronaviruses feline infectious peritonitis virus, and human coronavirus 229E showed a similar correlation between water temperature and inactivation as the virus concentration in tap water decreased by 3-log in 10 days at 23ºC (73.4ºF) and 100 days at 4ºC. This study also showed that coronaviruses die off more rapidly in wastewater at 23ºC, with a 3-log reduction in 2–3 days possibly due to the presence of predatory bacteria. The survival of the coronaviruses in primary effluent wastewater was slightly longer than in secondary effluent wastewater, probably due to the higher concentration of suspended solids that may offer protection to the virus from inactivation. The concentration of organic matter also affected the survival of coronaviruses as inactivation was greater in filtered tap water than unfiltered tap water (approximately 12 versus 10 days to reach 3-log removal). Finally, this study compared the reduction of the concentration of coronaviruses versus Poliovirus 1 LSc-2ab (PV-1), a human virus known to be very stable in the water. Under most conditions, Poliovirus survived longer than coronaviruses (Gundy et al., 2009).

In March 2020, Dutch government researchers found traces of the COVID-19 virus in wastewater samples from five treatment plants, confirming what experimental observations have suggested (Medema et al., 2020). The positive samples were detected three weeks before the first case was reported in the Netherlands.

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In summary, the persistence of coronaviruses in water as reported in these findings suggests that water contaminated with these viruses may pose an exposure risk to workers, and to a less extent, the population.

Expected Removal of COVID-19 Virus Through Water and Wastewater Treatment

COVID-19 viruses are spherical particles with diameters ranging from 50 to 200 nm in size (0.05 to 0.2 microns) with distinctive spikes of approximately 10 nm (Chen et al. 2020). Coronaviruses are enveloped and contain single-stranded RNA.

Removal Through Physical-Chemical Processes

Because of their submicron size, COVID-19 particles are subject to Brownian motion and their removal is expected to be challenging through coagulation/flocculation/sedimentation and media filtration unless adequately destabilized through the addition of coagulant and polymer. On the other end, the viral envelope of COVID-19 is expected to be hydrophobic, making it less soluble in water and increasing its tendency to adhere to surfaces such as precipitating solids, flocs, and media grains—thus increasing opportunities for its removal.

- **Cloth filters** in tertiary applications have a typical size rating of 10 microns and their effectiveness for removing COVID-19 virus is expected to be contingent on upstream treatment and the stage of accumulation of the filter cake on the cloth.
- **Microfiltration** with a pore size of approximately 0.1 to 5 microns is not an absolute barrier to viruses such as COVID-19. Although, because of the potential adsorption of COVID-19 to larger solids, a certain level of removal may be expected.
- **Ultrafiltration** with a tighter pore size range of 0.01 to 0.1 micron is expected to be effective in removing COVID-19.
- **Nanofiltration** (pore size range of 0.001-0.01 microns) and Reverse Osmosis (pore size range of 0.0001 – 0.001 microns) are expected to provide a highly effective barrier to COVID-19, unless the integrity of the membrane is compromised.

Removal Through Biological Treatment

Biological treatment is expected to have a marked impact on the removal of COVID-19-like viruses. Initially, viruses may be removed from water through adsorption onto flocs. Then, viruses may be further removed through predation by other microbes, i.e. protozoa or metazoan (Tae-Dong Kim, and Hajime Unno, 1996).

WHO has indicated that lagoons (or biological treatment with sludge retention time greater than 20 days) are generally effective for the removal of viruses. This, however,

does not account for hydraulic short circuiting or airborne contamination. In general, secondary wastewater treatment may be credited with removing 1-log (90%) of viruses, though broad studies suggest the level of virus removal is highly variable between insignificant removal to greater than 2-log removal (Hewitt et al., 2011; USEPA, 1986).

Disinfection

As previously discussed, the COVID-19 virus is an enveloped virus. The outer membrane is expected to be relatively fragile and more susceptible to oxidants—such as chlorine and other oxidant disinfection processes—than many other viruses, such as coxsackieviruses, adenoviruses, norovirus, rotavirus and hepatitis A (WHO, 2020). Appropriate residuals should be maintained through the water or recycled water distribution system.

Exposure to Risk

According to the U.S. Centers for Disease Control and Prevention (CDC), exposure risk to the general population is thought to be minimal (2020). Standard water and wastewater treatment and disinfectant processes are expected to be effective in inactivating COVID-19. For drinking water customers and recreational users of water bodies fed with recycled water, a well-operated plant achieving free chlorine and maintaining residual should address any virus, including the COVID-19 virus.

Potential Exposure for Water/ Wastewater Workers

- **Drinking Water Facilities**
  For workers at drinking water facilities, the risk of exposure to the COVID-19 virus is thought to be low. Some risks may be present in the handling of pre-treatment processes and residuals that may not have received an oxidation or disinfectant dose. Perhaps, using safe work practices, and personal protective equipment (PPE) normally required for work tasks when handling untreated wastewater should be adopted as added measures.
- **Wastewater Facilities**
  The main concern at wastewater facilities is protracted

exposure to elevated aerosol concentrations in closed spaces and in the proximity of processes such as screening, primary treatment and aeration upstream of disinfection. The handling of untreated sludges and the use of unchlorinated plant water raise additional concerns.

CDC recommends that workers should follow best practices to prevent exposure to wastewater, including using engineering and administrative controls, safe work practices, and personal protective equipment (PPE) normally required for work tasks when handling untreated wastewater. Workers at wastewater facilities should wear appropriate PPE, which includes protective outerwear, gloves, boots, and goggles or face shield masks; wash their hands frequently; and avoid touching eyes, nose and mouth with unwashed hands. In addition, as of April 3, 2020, the CDC is expected to recommend that all Americans utilize cloth face masks when in public. Wastewater workers should follow this directive as well.

MORE INFORMATION

How can we help? Please let us now if you have questions or would like additional information.

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ADDITIONAL RECOURCES

American Water Works Association
Coronavirus and Water

Centers for Disease Control and Prevention (CDC)
Coronavirus (COVID-19)

Centers for Disease Control and Prevention (CDC)
Water Transmission and COVID-19

Occupational Safety and Health Administration (OSHA)
COVID-19

USEPA Enforcement Policy
Enforcement Policy, Guidance & Publications

Water Environment Federation
Current Priority: Coronavirus

World Health Organization (WHO)
Coronavirus disease (COVID-19) Pandemic