COVID-19 present in wastewater?

Recent information suggests that COVID-19 may be transmitted through the fecal-oral route. The virus RNA was detected in patient stool after scientists noticed that some patients infected with the COVID-19 virus experienced diarrhea in the early stages of infection instead of a fever, the latter being more common. A recent paper, "First Case of 2019 Novel Coronavirus in the United States," in the *New England Journal of Medicine* also confirmed the virus RNA detection in feces. OSHA recommends that workers handle solid waste contaminated with COVID-19 as they would other regulated Category B medical waste, corresponding with the recommendations of other organizations. If the recovery of infectious particles from feces or wastewater at potentially infective doses is confirmed at a future date, this recommendation may have to be revised.

Detection of viruses by molecular techniques provides no indication that the virus is infectious. It remains to be seen if infectious virus particles are excreted in patients' feces and urine, and if so, how well the viruses are able to survive in wastewater.

Previous studies investigating persistence of coronavirus surrogates and SARS in wastewater highlight that in the absence of disinfection, the virus can survive in wastewater from hours to days. In 2003, research on SARS had suggested that sewage was implicated in the infection of a cluster of cases in the Amoy Gardens apartment block in Hong Kong. A recent report indicated possible COVID-19 transmission through sewage pipes in a building in Hong Kong, but this remains to be confirmed.

However, previous work also highlights that SARS can readily be disinfected when chlorine dosing produces a free chlorine residual between 0.2 and 0.5 mg/L for municipal wastewater. While Ebola virus is different, it is reassuring that the article, "Persistence of Ebola Virus in Sterilized Wastewater," similarly showed that no virus was recovered at doses of 5 and 10 mg/L of chlorine and a 3.5 log reduction was achieved in the presence of free chlorine residual of 0.16 mg/L for 20 seconds. These results imply that standard municipal wastewater system disinfection and hyper (or shock) chlorination practices may be sufficient to control the virus provided utilities monitor free available chlorine during treatment to ensure it has not been depleted.

Treatment and COVID-19

Disinfection systems at water resource recovery facilities (WRRFs) and the associated regulatory requirements were developed to be protective of a broad spectrum of potential pathogens. The recent coronavirus serves as another example of the importance of this infrastructure for protecting public health. On Feb. 5, 2020, the U.S. Occupational Safety and Health Administration (OSHA) released its new wastewater worker guidance stating that current disinfection conditions in WRRFs, such as oxidation with hypochlorite or peracetic acid, and inactivation by ultraviolet irradiation, are expected to be sufficient to protect wastewater workers and public health. The recommendation is based on coronavirus disinfection data from healthcare settings and corresponds with OSHA's position on the susceptibility of coronaviruses to disinfection.

These recommendations are likely to be broadly applicable, although more research may be warranted for disinfectants such as peracetic acid and combined chlorine (chloramines), where coronavirus specific data is lacking or evidence suggests higher bacterial susceptibility to disinfection compared to viruses. Although coronaviruses have not been tested, peracetic acid has been found to have some efficacy against some non-enveloped viruses (e.g., Norovirus) that are known to be more resistant than enveloped viruses.

Chlorine is extensively used for wastewater disinfection due to its effectiveness, low cost, and ease of application. It typically reacts with ammonia present in wastewater to form combined chlorine (chloramines), which behaves differently than free chlorine during disinfection. Thus, it is important for each facility to understand the chlorine species that are present and their relative abundance within the disinfection process. Additional research could provide reassurance on the effectiveness of wastewater disinfection processes, specifically against coronaviruses and at lower doses and contact times.