

# Viral Infections and the Development of Disinfection: 100 Years of Progress at *I&ECR*



Cite This: *Ind. Eng. Chem. Res.* 2020, 59, 6345–6346



Read Online

ACCESS |



Metrics & More



Article Recommendations

Headlines worldwide these last several months have been filled with references to COVID-19, the illness resulting from infection with a new strain of coronavirus. Efforts by health officials to control the spread of the virus have led to quarantines and cancellations of large gatherings including sporting events in locations where infections are known to have occurred. Scientific life also is affected with the American Physical Society, World Petrochemical Conference, ACS, and AIChE among those canceling or postponing their recent annual spring conferences.<sup>1</sup> Some local meetings and the recently concluded Pittsburgh Analytical Conference (Pittcon) were held, but with fewer attendees than expected due to travel restrictions and personal and organizational decisions to avoid large gatherings.<sup>2</sup>

We remember that about 100 years ago, at the end of the first world war, a virulent strain of influenza virus raced around the world, causing the death of an estimated 30 million people—more than were killed in the war itself. At that time, life was different because the war had significantly decreased economic productivity, disinfectants were largely unknown or underutilized, and the only known pain medication was aspirin.

By 1920, scientific reports began to appear in journals including *I&ECR* about significantly lower influenza sickness rates near chlorine facilities. Initial reports from the Edgewood Arsenal in Maryland—where the United States had been producing Cl<sub>2</sub> as a chemical weapon for use in the war—were quickly confirmed at other locations where chlorine was used, such as in textile and paper manufacture.<sup>3,4</sup> In one case, at a plant where 15% of the workforce was infected, no cases occurred in workers in the chlorine or bleach (sodium hypochlorite, NaOCl) portion of the factory. In another factory where 75% of the workforce was infected, only one death occurred, and few serious cases were observed. While these observations should raise significant questions about chemical hygiene and fugitive emissions at the plants, this was a time when scientists often carried out experiments on themselves or people they knew and some level of exposure to chemicals was tolerated.<sup>5,6</sup>

When combined with prior discoveries,<sup>7</sup> these observations from industry helped propel the case for chlorine-based disinfection and led to widespread implementation of water chlorination processes with significant reductions in mortality rates.<sup>8,9</sup> Additional rapid research and technological discoveries led to new preparation methods for NaOCl,<sup>10</sup> and the commercial production of chlorine containing solutions as disinfectants.<sup>11</sup> Subsequent improvements included advanced electrolytic cells for chlorine production,<sup>12</sup> and production of

disinfectant and bactericide N-chloramines with fewer drawbacks than Cl<sub>2</sub>.<sup>13,14</sup> Throughout, process safety has continually increased with time.<sup>15,16</sup>

Research in the field continues today, but with highly sophisticated tools, such that studies of the interaction of Cl<sub>2</sub> with viruses can detail penetration through lipid membranes and reaction with protein cores.<sup>17</sup> We also understand how to synthesize materials incorporating N-chloroamines into polymers to prepare materials with multiple beneficial properties.<sup>18,19</sup>

While we do not yet know what discoveries will come from the many ongoing investigations related to SARS-CoV-2,<sup>20</sup> one constant has remained fixed during a century of progress. *I&ECR* is the top journal for reports of industrial and chemical engineering observations and research relevant to the world.

The observations, conclusions and opinions in this editorial are the Author's and not necessarily those of Honeywell International Inc. or UOP LLC.

Christopher P. Nicholas [orcid.org/0000-0003-1461-3791](https://orcid.org/0000-0003-1461-3791)

## AUTHOR INFORMATION

Complete contact information is available at:  
<https://pubs.acs.org/10.1021/acs.iecr.0c01294>

## Notes

Views expressed in this editorial are those of the author and not necessarily the views of the ACS.

## REFERENCES

- (1) Coronavirus Cancels Chemical Events. *Chem. Eng. News* 2020, March 2/9, 18.
- (2) Pittcon Goes Ahead Despite Coronavirus. *Chem. Eng. News* 2020, March 2/9, 18.
- (3) Baskerville, C. Chlorine and Influenza. *J. Ind. Eng. Chem.* 1920, 12, 293–294.
- (4) *The National in the World War: April 6, 1917–November 11, 1918*; National Lamp Works, General Electric Company: Cleveland, OH, 1920.
- (5) Jones, S. The first world war scientists who gave their lives to defeat poison gas. *The Guardian*; 2015, <https://www.theguardian.com>.

Published: March 27, 2020



com/science/blog/2015/apr/22/the-first-world-war-scientists-who-gave-their-lives-to-defeat-poison-gas.

(6) Hale, H. Chlorine as a Preventative of Influenza. *J. Ind. Eng. Chem.* **1920**, *12*, 806.

(7) Labarraque, A. G. *On the Disinfecting Properties of Labarraque's Preparations of Chlorine: Particularly in Preventing Putrefaction... Also in Medical and Surgical Practice, and in the Diseases of Horses*, translated by Scott, J S.; Highley:London, 1828.

(8) Wolman, A.; Enslow, L. H. Chlorine Absorption and the Chlorination of Water. *J. Ind. Eng. Chem.* **1919**, *11*, 209–213.

(9) Penfield, W.; Cushing, R. E. Bathing The Green Goddess - Purification of Chlorine. *Ind. Eng. Chem.* **1939**, *31*, 377–381.

(10) Zoller, H. F. Sodium Hypochlorite. *Ind. Eng. Chem.* **1923**, *15*, 845–847.

(11) Industrial Notes. *J. Ind. Eng. Chem.* **1917**, *9*, 817.

(12) Hardy, W. L.; Snell, F. D. Chlorine Manufacture. *Ind. Eng. Chem.* **1957**, *49*, 55A–56A.

(13) Ingols, R. S.; Wyckoff, H. A.; Kethley, T. W.; Hodgden, H. W.; Fincher, E. L.; Hildebrand, J. C.; Mandel, J. E. Bactericidal Studies of Chlorine. *Ind. Eng. Chem.* **1953**, *45*, 996–1000.

(14) Worley, S. D.; Wheatley, W. B.; Kohl, H. H.; Burkett, H. D.; Van Hoose, J. A.; Bodar, N. A new water disinfectant; a comparative study. *Ind. Eng. Chem. Prod. Res. Dev.* **1983**, *22*, 716–718.

(15) Shearon, W. H.; Chrencik, F.; Dickinson, C. L. Modern Production of Chlorine and Caustic Soda. *Ind. Eng. Chem.* **1948**, *40*, 2002–2010.

(16) Saroha, A. K. Safe Handling of Chlorine. *J. Chem. Health Saf.* **2006**, *13*, 5–11.

(17) Ye, Y.; Chang, P. H.; Hartert, J.; Wigginton, K. R. Reactivity of Enveloped Virus Genome, Proteins, and Lipids with Free Chlorine and UV254. *Environ. Sci. Technol.* **2018**, *52*, 7698–7708.

(18) Luo, J.; Sun, Y. Acyclic N-Halamine Coated Kevlar Fabric Materials: Preparation and Biocidal Functions. *Ind. Eng. Chem. Res.* **2008**, *47*, 5291–5297.

(19) Chen, Y.; Yu, P.; Ren, G.; Zhang, Q.; Han, Q.; Teng, H. Interpenetration of Polyethylene Terephthalate with Biocidal Quaternary Ammonium/N-Chloramine Polysiloxane in Supercritical CO<sub>2</sub>. *Ind. Eng. Chem. Res.* **2017**, *56*, 9560–9568.

(20) Chemistry in Coronavirus Research: A Free to Read Collection from the American Chemical Society. Feb 2020, [https://pubs.acs.org/page/vi/chemistry\\_coronavirus\\_research](https://pubs.acs.org/page/vi/chemistry_coronavirus_research) (accessed 2020/03/21).