

# SIEMENS



## How ionogen, a biotech pioneer, brought the world's oldest disinfectant to market on a massive scale to fight airborne viruses

ionogen®

**Customer:** ionogen, based in Knoxville, Tennessee.

**Challenge:** Develop a series of scalable, reliable, and cost-effective onsite HOCl generators.

**Solution:** Scalable options for on-site, ionogen disinfectant generation, powered by Siemens technology, expertise, and global service and support.

**Results:** Cut a year off time to market, poised for global success with scalable, flexible solutions, standardized controls, and proven deployments.

With a reliable method of scalable production and solid quality control, supported by Siemens technology, ionogen® is making hypochlorous acid, a non-toxic yet extremely powerful antimicrobial cleanser, an accessible tool to keep people safe from such airborne viruses as colds, flu, chicken pox, and even the deadly SARS-CoV-2 that causes COVID-19.

In early 2020, as news of the indeterminate disease-causing virus emerged across the globe, the immediate question was how to eradicate it. Growing evidence suggested the virus most readily spread through suspended aerosols, the nearly microscopic droplets expelled when coughing, sneezing, or even just breathing, talking or singing. As with many viruses, soap and hot water can kill the coronavirus. As with many viruses, soap and hot water can kill coronavirus, so hand washing and

cleaning of surfaces became important protocols. But those did little to eradicate the pathogen from the air where it presents the most danger, especially in closed, poorly ventilated environments. washing and cleaning of surfaces became important protocols. But those did little to eradicate the pathogen from the air where it presents the most danger, especially in closed, poorly ventilated environments.

Fortunately, a young Knoxville, Tennessee-based biotech firm called [ionogen](#) had a ready answer: fight airborne viruses of all kinds, including the SARS-CoV-2 virus, with an atomized aerosol of hypochlorous acid (HOCl). It's a powerful yet non-toxic disinfectant even in water dilutions as low as 200 parts per million (ppm). In fact, its disinfectant powers are 80-200 times greater than chlorine bleach and safer, too. Also known as electrolyzed water, HOCl is so gentle that it can be consumed internally, yet so strong it can sterilize surgical instruments and hospital surfaces. Created naturally in our bodies by our white blood cells, HOCl was used as a wound-care agent in both World Wars.

Even before the COVID-19 pandemic, ionogen's sister company had been selling a line of [ionopure™ HOCl-based disinfectant products](#) that are safe to use indoors around adults, children, pets, and food. The line includes a tabletop ionopure Purity™ System with patented technology that delivers a steady mist of ionopure solution into every corner of a room, disinfecting both the air and surfaces. The company sells a hand-held ionoMAX® power mister, too, for cleaning and disinfecting schools, clinics, and other facilities with enclosed spaces.

According to ionogen CEO and Co-founder John Shanahan, the efficacy of the company's HOCl disinfectant solutions has been validated by third-party, independent test labs. In fact, studies of dry-fogging vaporized HOCl have shown 99.99 percent reductions in viral quantities in surface viral testing. In the air, the aerosolized disinfectant's anti-viral action is even more dramatic. In one test which mimicked an office setting, the Purity unit killed 99.999% of an EPA-approved human coronavirus surrogate (known as OC43) on surfaces. Another test looked at the air conditions of a space occupied by a person infected with OC43, infusing the area with 33,000,000 times the concentration that would normally be present, and found that Purity reduced the viral presence in the air by 95.7%.

Given the growing demand for ionopure HOCl-based products, ionogen set its sights on developing a series of scalable, onsite HOCl disinfectant solution generators for use in hotels, schools, hospitals, churches, hotels, bars, restaurants, and other facilities with enclosed spaces where people gather. Shanahan cites agricultural and food production applications, too. "Anywhere that air quality can be made better and any time the air needs disinfecting from germs, viruses, microbes, allergens, mold, or other pathogens, our on-site generators can now produce the desired concentration of hypochlorous acid solution in volumes," he says. "This safe but effective disinfectant can eliminate the exposure of humans, pets, and foods to the toxins used in most of the top-selling brands of sanitizers and disinfectants. That's why we say you can use our solutions without fear of poisoning people, animals, or the planet."

#### **Challenge: Develop a series of scalable, reliable, and cost-effective onsite HOCl generators**

If hypochlorous acid is the perfect solution to a wide variety of sanitation issues, why isn't it readily available everywhere? Shanahan says the answer is simple: It is nearly impossible to make solutions of it shelf-stable and in high volumes. "As electrolyzed water, hypochlorous acid is created by running an electrical current through salt water," he explains. "The longer the current runs through the salt water, the stronger the solution

becomes. Unfortunately, this brilliantly simple compound begins to break down, back into salt water, soon after production. That's why we saw an opportunity to design, engineer, and build highly scalable, reliable, and cost-effective on-site generators. This way, the solutions can be created and immediately used when and where they are needed."

As ionogen moved from product concept to development, its engineers had six criteria to guide their work:

1. **Scalability.** ionogen wanted to provide customers with hypochlorous acid production options that would scale up from countertops to much greater quantities, making its disinfectant solutions available commercially to educational facilities as well as the healthcare, food production, agricultural, and hospitality industries, to name just a few.
2. **Safety and quality.** Though hypochlorous acid is generally regarded as safe, maintaining quality standards in commercial production is key. The ability to produce an ionogen disinfectant solution that is proportionate in strength to the task at hand is also crucial. For instance, the concentration to clean fruits and vegetables is not the same as what's needed to clean floors or for use in sanitizing the air.
3. **Data input and collection.** Data collection provides a way to monitor quality and provide accountability for operators. How many gallons of solution were made? Who was on shift at the time? What was the task at hand, and what concentration of solution was used? This data would provide visibility into each ionogen generator model's use and performance.
4. **Remote access.** With ionogen customers increasing worldwide, the company wanted to be able to communicate remotely with any of its large-scale hypochlorous acid generators to upgrade firmware, provide patches as needed, monitor performance, and conduct remote diagnostics. The company also envisioned eventually providing institutions the option of acquiring the ionogen generating capability as a service, so usage would have to be monitored.
5. **Ease of use.** The engineers assumed that ionogen system operators would be non-technical personnel, such as custodians, daycare providers, dental office workers, and others, so the human-machine interface (HMI) needed to be interactive, intuitive, user-friendly, and not intimidating.

Initially, the engineers experimented with using creative, home-grown circuit board designs as well as low-cost commodity programmable logic controllers (PLCs). After some trial-and-error dead-ends, a new head of engineering suggested the team contact Siemens. "Siemens is known for the quality and reliability of its SIMATIC PLCs and related components, such as its HMIs and TIA Portal software engineering framework," Shanahan says. "Also, with our plans to sell our ionogen reactors worldwide, we knew we could count on Siemens global service and support to backstop our own limited resources as a young company."

#### **Solution: Scalable options for on-site, ionogen disinfectant generation, powered by Siemens technology, expertise, and global service and support**

Today the company offers three sizes of ionogen HOCl generators that operate on 110/220-volt electric current (or, in Europe,

230-volt electric current) using water and an ionogen-provided chloride salt compound:

- **The Desktop On-Site Generator**, with a production capacity from 2–9 gallons.
- **The Industrial On-Site Generator**, which can also sit on a table or countertop and produce up to 300 gallons at a time for large facilities.
- **The Factory-in-a-Box Generator**, to meet even bigger requirements, such as those of school districts, hospitals or other large enterprises and institutions. It is built inside a mobile 40-foot shipping container delivered by truck.



Shanahan credits the Siemens application engineering team with helping the company achieve all its design goals for these ionogen HOCl-based disinfectant generating systems.

***“From the start, even though we’re a young company, Siemens provided us with engineering support that would rival what its largest customers get.”***

John Shanahan  
ionogen CEO and co-founder

“Our lead Siemens consulting engineer worked with our team to fully understand their design and engineering requirements, then offered an ideal combination of an advanced SIMATIC PLC, HMI, and other components, such as power supplies, to make our systems the best they could possibly be.”

Shanahan points out that from the very start of what’s become a strategic partnership with Siemens, it was clear the goal of the engagement was much more than to supply parts for the ionogen HOCl generation reactors. “Siemens clearly wants to see us succeed globally and is ready to put its worldwide resources behind us, including local service and support in just about every nation we could possibly sell our systems,” he says, noting that Purity systems are already operating in South Africa and Iceland for commercial and industrial applications. “Those are in addition to successful pilot projects we’ve deployed in the U.S. Those include two schools, an assisted living facility, an ambulatory surgical care center, and a youth community center for its after-school programs.”

Standardization on components from the Siemens Totally Integrated Automation (TIA) portfolio is a critical enabler of

scaling the ionogen system models from the countertop to the Factory-in-a-Box model. “By standardizing on Siemens TIA components, we greatly simplified and streamlined our parts procurement as well as our manufacturing inventories, assembly and commissioning,” Shanahan says. “And, once deployed, service and support will be much simpler, too. In many, if not most, cases, we’ll be able to conduct remote diagnostics and resolve issues without having to dispatch a technician.”

The Siemens components include the following:

- **SIMATIC S7-1214 PLC** with onboard I/O to automate and control the electrolytic HOCl-generating process. A built-in web server also provides the remote performance monitoring and diagnostics.
- **SIMATIC HMI MTP1000 Unified Comfort Panel**, a 10-inch color, touch-screen display with visualization of the generating process and controls provided by the SIMATIC WinCC Unified visualization software.
- **SCALANCE W761-1 industrial WiFi access point** with a 150 Mbit/s data rate and PROFINET-capable. Supports the 2.4 and 5 GHz frequency bands. To support global use, there are country-specific variants of these devices with corresponding radio signaling approvals.
- **SITOP PSU8600 intelligent power supply**, a compact and modular power supply system that’s highly efficient (up to 94 percent) to minimize heat loss, which is critical in small spaces. Integrated Ethernet/PROFINET facilitates communications with the other Siemens devices, and its onboard web-server can also provide performance monitoring and remote diagnostics.

All of the functional and SCADA software engineering was done in the SIMATIC TIA Portal, with an easy-to-use, point-and-click user interface and libraries of proven code for virtually every industry. “The TIA Portal was easy for our engineers to learn to use,” Shanahan says. “Once we engaged Siemens, we were able to move quickly on using the TIA Portal to program the controls and automation part of our ionogen on-site generators, developing our working prototype in less than a month.”

**Results: Cut a year off time to market, poised for global success with scalable, flexible solutions, standardized controls, and proven deployments**

Today the company is poised to start selling its ionogen on-site generators in high volumes, initially targeting schools and medical facilities. Eventually, too, the company plans to make its disinfectant-generating technology available free of charge to developing countries, where better sanitation is needed. “Without our partnership with Siemens to develop the controls and automation for our units, we would’ve needed another year before we could have released our first one,” says Shanahan. “That’s vastly accelerated both our time to market and, ultimately, our time to being cash-flow positive, which has also been enormously reassuring to our angel investors.”

Having feedback on the performance of each unit is a critical benefit of the Siemens controls, according to Shanahan. The proprietary reactors at the heart of ionogen’s HOCl generators are the most sensitive and expensive part of the system, which

is why it is so valuable that the PLC can monitor and track the behavior of the reactors throughout their service lives. “The Siemens controllers enable us to assure our customers that they’ll get the longest life possible from them – and we can tell when they’re wearing out”.



**Intuitive and easy to use.** The company’s engineers used the TIA Portal to program each unit’s Siemens HMI to be intuitive and easy to use, which minimizes training. “While the intricacies of programming logic and of interfacing with a machine may be interesting for an engineer, it’s not necessarily so for an end user like the custodian at a school, hospital, or local mall or a factory supervisor,” says Shanahan. “And since these are the people who ultimately use our generators, large or small, we made the controls and displays easy to understand and use — like an app on a smartphone. The more they look and function like something users already know, the more likely they will have an enjoyable experience, which is exactly what we want.”

Scalability goals have been met, too, with Siemens technology. Shanahan reports that the ionogen on-site generators can be programmed to produce multiple batches of the hypochlorous acid in concentrations from 200–2200 ppm, all of which the U.S. Environmental Protection Agency (EPA) considers safe for use around humans and animals. In the case of food, the EPA restricts food preparation uses to 200 ppm.

In addition to third-party laboratory assessments of the disinfectant powers of the ionogen on-site generators, their deployments have demonstrated it in practice. For example:

- A rural East Tennessee county school system implemented the ionogen Purity Air System at the beginning of the epidemic in 2020. The superintendent recently reported that the schools remained open throughout the pandemic with no reported COVID-19 infections in any of them.
- The director of the Renaissance Terrace elderly care facility in Knoxville, TN, similarly implemented the Purity System in the beginning of the pandemic enabling residents to mingle without masks. He reported no incidents of COVID-19 in the facility despite all his industry colleagues reporting they had been “brought to their knees” with case contagion, unfortunately including many deaths.
- The director of the Boys and Girls Clubs of East Knoxville thanked the ionogen CEO for providing the Purity system saying, the protection provided has so far “impacted 6,000 kids in the area during the pandemic” in the context of parents needing to work and the boys and girls needing a safe place to go during the day.

Looking ahead, Shanahan is confident that ionogen’s global partnership with Siemens will become a critical factor in both the company’s near- and long-term success. “In my 40-year industry career, I’ve rarely seen the levels of customer support, responsiveness, honesty, and candor in combination with a truly innovative product portfolio,” he says. “Combine all that with a global footprint of direct support and service, and ionogen will be able to truly make a difference in the post-COVID world.”

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