Food Engineering

ENGINEERING R&D

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Lethal light

From radio signals to gamma waves, the electromagnetic spectrum offers considerable potential to prepare and preserve food products. Knowing precisely which wavelength in the spectrum to apply to a particular need is only the first step, however: scientists and engineers also need to fabricate systems that can withstand the rigors of an industrial environment. The application of UVC, short-wave ultraviolet in the C band range (200 to 280 nanometers) to inactivate mold, bacteria, fungus, viruses and other spoilage organisms illustrates the development challenge.

UV lamps to treat germicidal disease date to the 19th Century, when Nobel laureate Niels Ryberg Finsen used UV to treat skin infections in treatments that presaged today's chemotherapy. After the 1976 Legionnaire's Disease outbreak in a Philadelphia hotel, medical science linked Legionella bacteria to heating, ventilating and air conditioning (HVAC) systems that can spread bacteria and viruses thriving in warm, moist environments. Among the scientists who worked on a solution was Brad C. Hollander, who developed a UVC lamp to improve indoor air quality. Hollander was issued a patent in 1994 for an electric discharge device to sterilize HVAC air, and the following year Steril-Aire Inc. was established to commercialize the technology. The company now is based in Burbank, CA, and is headed by Robert S. Scheir, president and chairman.

In one of the 10 US patents assigned to Steril-Aire, Scheir cites a study involving a 20-year-old HVAC system in City of Industry, CA. Biocides, high-pressure sprayers and other treatments provided temporary removal of mold and bacteria from the cooling coils, but buildup resumed in as few as three days. The inventor configured germicidal lamps to permanently resolve microbial encrustation on the coils and boost heat transfer efficiency up to 30 percent, improving airflow and energy efficiency by a similar amount.

Scheir holds a PhD in medical microbiology from UCLA and performed graduate studies in immunochemistry at the School of Hygiene and Public Health at Johns Hopkins University. Before joining Steril-Aire, he was a senior scientist at McDonald-Douglas Corp., specializing in biological-warfare detection instrumentation

FE: How do your lamps differ from a bug zapper?
Scheir: Bug lights mounted on a wall emit UV waves that are close to 400 nanometers. The light attracts flying insects, which fly to the light source and are electrocuted.

Air conditioners and potato tumblers are being engineered to deliver a dose of short-wave ultraviolet light to control mold, viruses and bacteria that infect food.

Robert Scheir, president and chairman, Steril-Aire Inc., Burbank, CA

UVC from vaporized mercury lamps emit waves of 253.7 nanometers, which is close to 265, the wavelength that destroys DNA and provides maximum germicidal effectiveness. Altering the DNA prevents replication and causes cell death. Effectiveness of UVC is directly related to time and intensity. The intensity 2 inches from the lamp is almost three times greater than at 6 inches, and at 12 inches intensity is half the level at 6 inches. Total irradiation also is impacted by reflectance within the cavity. With aluminum and aluminized materials, you get about 85 percent bounce off the surface, potentially increasing the dosage received by organisms.

FE: What does your firm manufacture?
Scheir: We have developed system-engineered UVC emitters that, unlike conventional UVC lamps, work in cold environments. Standard UVC lamps lose output to the point they don't work below 40°F. Our emitters also overcome the short tube life issue. Of course, you don't want glass fixtures near food, which is why we've worked with a company that developed a shatter-resistant plastic sleeve.

FE: Refrigeration coils are notorious breeding grounds for bacteria. Have you applied the technology to those heat exchangers?

Scheir: Indoor air quality is our primary focus. In plants with air conditioning or refrigeration, we can place lamps at the heat-exchange coils, either inside the plant or around roof-mounted units.

FE: When did you move from HVAC to food-plant applications?
Scheir: About seven years ago, we visited a potato packing company and studied their process. I suggested applying UVC in the HVAC system, but they wanted to use it on the line. They were experiencing considerable loss related to mold in storage areas. We were able to significantly reduce mold with UVC. Since then, we've applied the technology to fresh-cut produce with limited shelf life. If low levels of pathogens are present, we can help a company achieve 2, 3, even 4 Log reductions.

It's not a be-all and end-all, but we're sitting here with a technology that can be beneficial and extend shelf life. Unfortunately, food processors are slow adopters of new technology. They have tight margins and some old-fashioned mentalities. We've had success controlling Pseudomonas on mushrooms before they're put into containers, destroying spoilage organisms and extending shelf life, but companies have told us, "We don't want a bigger yield because that would reduce the price."

An array of short-wave UV lamps provides a kill step against mold, viruses and bacteria in this tumbling drum bound for duty in a potato processing plant. Source: Steril-Aire Inc.

FE: How else has the technology been applied in food plants?
Scheir: In 2003, we started a partnership with Reyco Systems to incorporate UVC emitters in tumbling drums, conveyor and shaker systems and other food processing equipment. Two years ago, Reyco licensed patent-pending technology from C&S Equipment that includes watertight fittings to get the light as close to the food as possible. The shatterproof material that sleeves the lamp transmits the ultraviolet with very little heat. When emitters are used in a drum, the contact time with the food is 20-25 seconds. The blue light from the quartz-tube lamps is visible for years, but inert gases in the mercury deteriorate to 40%-60% of the initial output after a year. We recommend changing them at that point.

FE: What are UVC's limitations as a food safety remediation?
Scheir: We don't make any health claims, but if low levels of a pathogen are a concern, there's a good chance of destroying it with ultraviolet. Actual results depend on a number of factors beyond time of exposure.

We tested the technology on reducing salmonella on walnuts. We could only get a 2 or 3 Log reduction because of the irregular surface of the nut, and walnut processors wanted a 5 Log reduction. We've proposed and tested UV tunnels for treating sides of beef, with excellent results, but there just hasn't been any commercial interest. The amount of germicidal energy needed to destroy most mold spores is several times higher than what's required to destroy E. coli, Shigelis and many other bacteria, and we know UV is effective in destroying mold.

FE: Besides the Reyco units, are you able to provide an engineered solution to food processors?
Scheir: We've worked with a number of companies in setting up high-output UVC sterilization systems, calculating the distance, exposure time, number of emitters and positioning to achieve an objective. It's easy enough to put these in. You have to find space in the line for the lamps and shields so that there is no human exposure, of course. We've worked directly with ready-to-eat meat plants on packaging line installations. If the mil thickness of the film is thin enough, you get a reduction in bacteria such as Listeria and spoilage organisms.

FE: Have any scientific studies supported the efficacy of UVC in controlling food borne bacteria?
Scheir: USDA's Agricultural Research Service tested high-output UVC in reducing spoilage organisms in fresh-cut cantaloupe. Dr. Olusola Lamikanra concluded that cutting the fruit under a 24 in. long food-grade UVC emitter produced favorable enzymatic changes to extend shelf life several days.◆