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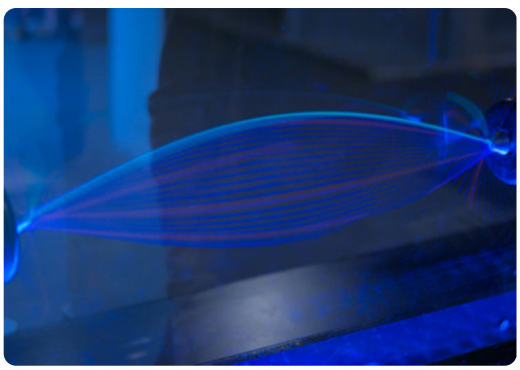
PROCESSING TECHNOLOGY

New pulsed light technology for sanitation of footwear in food processing facilities



By Tatiana Koutchma, Ph.D. on 10/14/2019

Food recalls are happening in the U.S. at the rate of approximately 10 per week and their frequency is growing as the demand for fresh, healthy, minimally processed food increases. The estimated average recall cost is around $10 million and there are reports of single recalls that exceeded $100 million. In addition to the direct costs, there is indirect damage to the brand and significant product liability borne by the processor. Fewer deaths, fewer hospitalizations, and less illness due to food poisoning is of obvious value to food industry, as well as increased confidence of the consumers in the safety of consumed products.

The scientific reviews of existing sanitation practices in food processing facilities have shown that shoe soles are potential vectors for pathogen transmission and cross-contamination in all settings reviewed, including healthcare/hospital facilities and animal and food processing facilities (Rashid et al, 2016).

Existing solutions (shoe covers, disposable booties and sanitizing shoes in chemical footbaths are often wet and use toxic chemicals that are environmentally unfriendly, unsafe for users, costly to maintain and may increase the risk of microorganisms spreading further into food processing areas. Chemical baths can take up to a minute to be maximally effective and workers may be walking an average of 100 feet during this time, thus extending the living environment for bacterial growth.

In addition, not all current decontamination procedures have sufficient antibacterial efficiency and employees often avoid of using them altogether. In private conversations with sanitation staff at food processing plants, it was mentioned to the author that shoe covers and booties generate a significant amount of waste requiring disposal. Most food processing facilities are extremely interested in eliminating water and chemicals from food production environment and have been calling for a dry solution to footwear sanitization.

Disinfection by light

A new method, based on the application of pulsed light (PL) has been developed and has shown to be highly effective in killing food pathogenic bacteria including Listeria monocytogenes on the surface of the shoes. PL is a dry sanitation method that uses unique properties of pulsed light technology. Pulsed light has a broader range of the wavelengths of 170 -1100 nm and often combines visible and UV photons at energies of 0.01-50 J/cm². Pulsed light is generated using a capacitor and delivered in several flashes of light per second, allowing fast throughput of product and low energy usage.

The intensity of the pulse is about 20,000 times the intensity of continuous ultraviolet (UV) light. Xenon lamps are commercial sources of PL that require air or water cooling for the operation. The short pulse width and high doses of the PL source provide some practical advantages over UV light sources, especially in situations where rapid disinfection is required. Other advantages of PL treatment are the lack of residual compounds and the absence of applying chemicals that can cause ecological problems and/or are potentially harmful to humans.

Xenon flash lamps have an emission spectrum ranging from UV to infrared light that are also more environmentally friendly than continuous UV sources because they do not use mercury. The germicidal UVC part of the spectrum from 200 to 400 nm is the most effective for microbial inactivation because it coincides with maximum absorption of microbial DNA.

Sample heating is perhaps the most important limiting factor of PL for practical applications. Heat can originate from the absorption of infrared part of PL spectrum.

First applications of PL included water purification and virus inactivation systems for biopharmaceutical manufacturers. The conducted tests of footwear disinfection showed that PL is more effective technology than other wet chemical solutions in use with much shorter exposure time that is typically from 1 to 3 seconds, better safety of treatment, non-toxic natural light, fewer slips and falls on the floors and less required maintenance.

Code 21 *CFR* 179.41, issued by the U.S. Food and Drug Administration (FDA) in 1996, approved the use of pulsed light in the production, processing and handling of food. PL may be safely used for the treatment of foods under the following conditions:

a) The radiation sources consist of xenon flash lamps designed to emit broadband radiation consisting of wavelengths covering the range of 200 to 1,000 nm and operated so that the pulse duration is no longer than 2 ms;

b) The treatment is used for surface microorganism control;

c) Foods treated with pulsed light shall receive the minimum treatment reasonably required to accomplish the intended technical effect; and

d) The total cumulative treatment shall not exceed 12.0 (J/cm2).

Proof of concept

One commercial PL footwear solution uses a scanning process that allows the light to enter any tread regardless of pattern on any footwear someone might wear into a plant. This process effectively eliminates any shadowing that might take place from a static light source. The unit is equipped with an RFID card reader, which allows operators to monitor traffic into food processing areas. In order to mitigate any risk of direct light exposure of the workers, brushes and flaps close over the ankles to prevent light from coming directly up to a person's eyes. Also, photoelectric sensors ensure that a person is in the right position (both feet on the glass, brushes and flaps down) before the lights are activated. These sensors will turn off the lights if a person moves out of position while the unit is activated.

To measure the efficacy of the shoe disinfection system against food pathogens, a proof of concept study was conducted by treating listeria-inoculated Teflon coupons. The consistent reduction of listeria at the level from 5 to 6 logs was demonstrated at three testing conditions of PL scanning rates and dose levels not exceeding the FDA requirements, thus demonstrating the suitability of the treatment for shoe disinfection. There was no noticeable impact on boot material. Also, despite high intensity of PL, there was no change in ambient temperature so the heat didn't affect the boot.

The comparison of continuous UV devices for shoe sanitation has shown a 2- to 3-log reduction in bacterial count but required at least 8 seconds of exposure time versus a 6-log reduction with 3 seconds of exposure using PL technology. Because the lifetime of PL lamps is about a year, the lamps have to be replaced annually. The results of this study were in an agreement with earlier reports where the effectiveness of PL was tested for meat applications to improve the microbial quality and safety of ready-to-eat (RTE) vacuum-packaged ham and bologna slices inoculated with L. monocytogenes. Also, it has been proven that PL is effective against other food pathogens such as E. coli and salmonella.

In addition to eliminating the need for wet and chemical-based procedures, a light-based disinfection system has several advantages, including reducing risk for employee injuries inherent with wet footwear sanitization, quicker movement of employees onto the production floor, and decreasing daily maintenance since there is no need to refresh mats or chemicals. The physical nature of light can accomplish production sustainability goals by eliminating the need for regular disposal of sanitizers.

*— By **Tatiana Koutchma, PhD**, research scientist, novel food processing, Agriculture and Agri-Food Canada*

Reference

1. Rashid, T., H. Vonville, I. Hasan and K. Garey. (2016). Shoe soles as a potential vector for pathogen transmission: A systematic review. *Journal of Applied Microbiology, 121*(5), 1223-1231. doi:10.1111/jam.13250.

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