



Extension FactSheet

Food Science and Technology, 2015 Fyffe Road, Columbus, OH 43210-1007

Pulsed Electric Field Processing Fact Sheet for Food Processors

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1. What is pulsed electric field processing?

Pulsed electric field (PEF) processing is a non-thermal method of food preservation that uses short bursts of electricity for microbial inactivation and causes minimal or no detrimental effect on food quality attributes. PEF can be used for processing liquid and semi-liquid food products.

2. How does this technology benefit consumers?

PEF processing offers high quality fresh-like liquid foods with excellent flavor, nutritional value, and shelf-life. Since it preserves foods without using heat, foods treated this way retain their fresh aroma, taste, and appearance.

3. How does PEF work?

PEF processing involves treating foods placed between electrodes by high voltage pulses in the order of 20–80 kV (usually for a couple of microseconds). The applied high voltage results in an electric field that causes microbial inactivation. The electric field may be applied in the form of exponentially decaying, square wave, bipolar, or

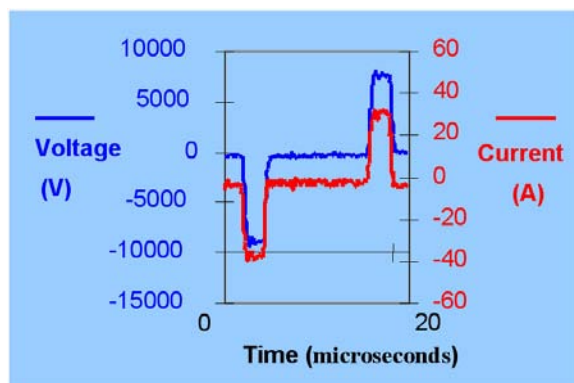
oscillatory pulses and at ambient, sub-ambient, or slightly above-ambient temperature. After the treatment, the food is packaged aseptically and stored under refrigeration.

4. How does PEF inactivate microorganisms?

PEF treatment has lethal effects on various vegetative bacteria, mold, and yeast. Efficacy of spore inactivation by PEF in combination with heat or other hurdles is a subject of current research. A series of short, high-voltage pulses breaks the cell membranes of vegetative microorganisms in liquid media by expanding existing pores (electroporation) or creating new ones. Pore formation is reversible or irreversible depending on factors such as the electric field intensity, the pulse duration, and number of pulses. The membranes of PEF-treated cells become permeable to small molecules; permeation causes swelling and eventual rupture of the cell membrane.

5. What types of foods benefit from PEF treatment?

Application of PEF technology has been successfully demonstrated for the pasteurization of foods such as juices, milk, yogurt, soups, and liquid eggs. Application of PEF processing is restricted to food products with no air bubbles and with low electrical conductivity. The maximum particle size in the liquid must be smaller than the gap of the treatment region in the chamber in order to ensure proper treatment. PEF is a continuous processing method, which is not suitable for solid food products that are not pumpable. PEF is also applied to enhance extraction of sugars and other cellular content from plant cells, such as sugar beets. PEF also found application in reducing the solid volume (sludge) of wastewater.



6. What is the shelf-life of a PEF processed product?

In general, the shelf-life of PEF-treated and thermally pasteurized foods is comparable. PEF pasteurization kills microorganisms and inactivates some enzymes and, unless the product is acidic, it requires refrigerated storage. For heat-sensitive liquid foods where thermal pasteurization is not an option (due to flavor, texture, or color changes), PEF treatment would be advantageous.



7. How are PEF processed foods stored?

PEF pasteurized products currently are stored refrigerated. In some cases (for example, milk), this is necessary for safety (to prevent the growth of spores in low-acid foods). For acid foods, refrigeration is not necessary for microbial stability, but is used to preserve flavor quality for extended periods of time.

8. Is commercial scale equipment available?

Yes. In the United States, the first commercial scale continuous PEF system is installed at The Ohio State University's Department of Food Science and Technology. This PEF system is part of a new food treatment system assembled by a DoD sponsored, University directed industry consortium. Diversified Technologies Inc., Bedford, MA, builds commercial PEF systems of processing volumes ranging from 500 to 2,000 liters per hour, with The Ohio State University supplying the PEF treatment chambers.

9. Is PEF equipment safe for the environment?

Yes. This process uses ordinary electricity. The facility meets electrical safety standards and no harmful environmental by-products are produced.

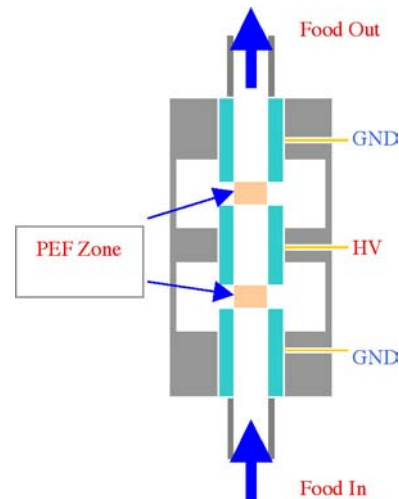
10. What is an integrated continuous PEF Processing System?

An integrated PEF system consists of a fluid handling unit, high voltage pulse generator, PEF treatment chambers,

and packaging machine. The fluid handling unit delivers stable, uniform flow with sterilize-in-place (SIP) and clean-in-place (CIP) functions. The pulse generator supplies high voltage pulses into foods flowing through PEF treatment chambers. Treated foods are packaged continuously.

11. What is a PEF treatment chamber?

A PEF treatment chamber consists of at least two electrodes and insulation that forms a volume, i.e., PEF treatment zone, where the foods receive pulses. The electrodes are made of inert materials, such as titanium.



12. How economical is PEF processing?

PEF is an energy efficient process compared to thermal pasteurization. The PEF processing would add only \$0.03–\$0.07/L to final food costs. A commercial-scale PEF system can process between 1,000 and 5,000 liters of liquid foods per hour and this equipment is scalable. Generation of high voltage pulses having sufficient peak power (typically megawatts) is the limitation in processing



large quantities of fluid economically. The emergence of solid-state pulsed power systems, which can be arbitrarily sized by combining switch modules in series and parallel, removes this limitation.

13. What regulatory approval is required for commercializing a PEF processed product?

Currently, regulatory requirements are evolving, but will likely involve the development of Hazard Analysis Critical Control Point (HACCP) plan for most juices and beverages. A current USDA project will address these very points.

14. Are facilities available for product development before venturing into PEF processing?

An industrial scale-up PEF pilot plant facility is available at The Ohio State University in the Department of Food Science and Technology. Food processors are invited to take advantage of the expertise of OSU faculty and staff, and facilities to conduct confidential product evaluations for food safety, quality, and shelf-life, and to obtain guidance on product development. A portable pilot scale PEF processing system is also available for customer-site evaluation. The resources at OSU can be accessed for a nominal fee.



For additional information, contact:

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Visit the OSU PEF technology web page at: <http://fst.osu.edu/pef>

Reference to commercial product or trade names is made with the understanding that no endorsement or discrimination by The Ohio State University is implied. Support of USDA-CSREES National Integrated Food Safety Grant No. 2003-51110-02093 is gratefully acknowledged.

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