Sustainable beverage filling

cold, dry electron beam sterilisation

David Icke introduces an alternative technology for aseptic filling.

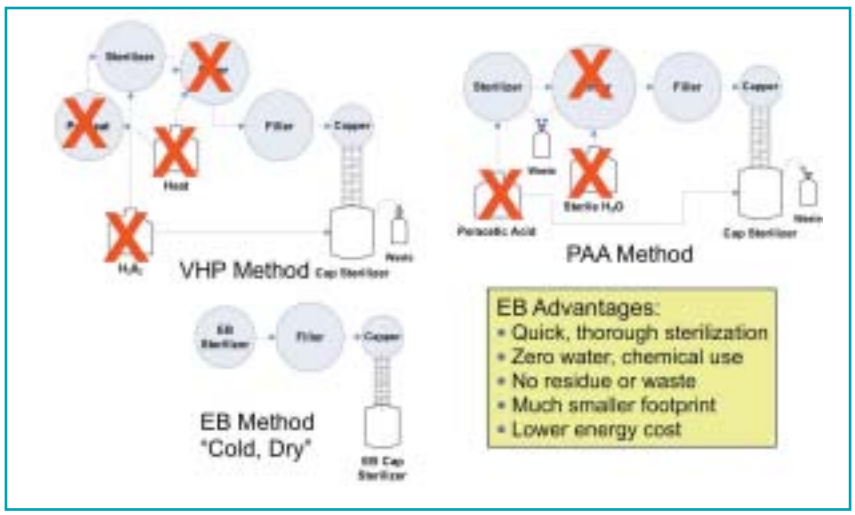
Beverage companies face tough challenges finding profitable growth in today's economy. One area of growth, driven by consumer trends towards wellness, is the demand for healthier, non-carbonated beverages. Aseptic processing has been rapidly adopted for this segment in order to deliver maximum product quality, while allowing lighter weight packaging and more flexible distribution, without refrigeration. At the same time, rising energy costs and global concerns about water availability are making sustainability a core business issue for manufacturers using aseptic processing methods.

Sterilisation or disinfection systems used for conventional aseptic (and extended shelf life or ESL) processing use a combination of chemicals, heat and sterile water, which creates complexity and dominates the cost of a beverage filler. Existing hydrogen peroxide and paracetic acid processes for PET bottle sterilisation consume significant amounts of energy and water, have a narrow process window, can be difficult to validate, and can leave residual chemicals in the bottle or package. In recent technical conferences, suppliers and brand owners continue to call for drier, more sustainable processes.

Cold, dry sterilisation

Compact electron beam technology enables a breakthrough in sustainability and cost for sterilisation within aseptic processes. Electron beams offer highly effective bioburden reduction (6 log) at high speed and at ambient temperature. No rinse water or chemicals are consumed and residuals are eliminated. Since the bottle doesn't need to resist heat or chemical contact, a wider range of lighter weight packaging is now possible. System footprint and operating cost are significantly reduced, offering compelling economics for the beverage manufacturer.

The emitter produces a cloud of energy, which a fast an effective method for surface sterilisation.



Electon beam sterilisation allows fillers to simplify their processes

How it works

Electron beams are a form of ionizing radiation, applying energy to the surface of products in order to break apart chemical bonds in DNA and achieve high microbial kill rates. It is a highly effective and efficient method for sterilisation and sanitisation; as a result, the pharmaceutical and medical device industries have widely adopted electron beam technology for aseptic packaging applications. Efficacy in reducing bioburden, measured as D0 values against the most resistant challenge organisms (typically the bacterial spore *bacillus pumilus*), has been well documented in published literature.

There is broad acceptance of electron beam sterilisation among regulatory agencies worldwide. A key reason is that electron beams provide an extremely efficient solution with very few parameters to control. Microbial kill rates are directly proportional to current, voltage, and line speeds – making an electron beam sterilisation line straightforward to validate and operate.

Evolution of electron beam technology?

Large system electron beam technology has been available for more than 30 years. However, adoption of e-beam-enabled industrial processing has historically been slow due to: the complicated maintenance and operation of electron beam sources; the prohibitive expense and size of production equipment; and the lack of practical and affordable R&D/pilot equipment.

The availability of compact, electron technology has opened up new possibilities for direct integra-

tion into aseptic process equipment. Through the use of field-replaceable modules, emitters can be easily exchanged as needed, which means minimal downtime and no need for on-site technicians or costly maintenance visits.

Many industries are now adopting industrial electron beam processing as an economically viable approach to making their operations more sustainable. There is universal demand for cost-effective, energy efficient, clean process technologies to combat rising energy costs, depleting water resources, new government regulation, and increased consumer demand for green products.

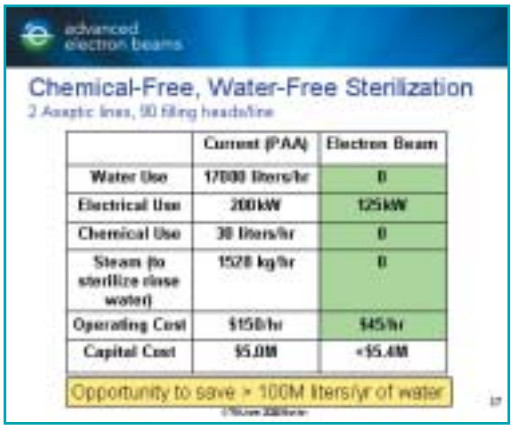
Electron beam applications for the beverage industry

Compact electron beam is being adopted for a wide variety of applications in the beverage industry, including:

- Bottle sterilisation
- Cap sterilisation
- Pouch, Pak, Form/Fill/Seal packaging sterilisation
- Printing and converting

Bottle sterilisation

Using a uniquely designed nozzle shaped emitter that can be inserted into a bottle finish, the interior or PET bottles are sterilised. This technique allows for sterilisation with no chemicals, no rinse water consumption, and no heat. As shown below, this can save up to 100 million litres of water per year for a typical plant with two aseptic lines. By enabling cold-filling of aseptic beverages, the resin weight of bottles can also be reduced. Many leading suppliers of aseptic beverage equipment are working to provide electron beam sterilisation solutions for aseptic filling lines.



Cold, dry sterilisation of PET bottles enable significant cost and sustainability benefits over current methods.

The emitters are easy to operate and service.

Caps and closures

In addition to sterilising bottles entering an aseptic filler, electron beam technology is integrated directly into cap steriliser systems, allowing manufacturers to rapidly disinfect caps and closures in-line. This technique provides a sterilising-grade dose to all surfaces of the cap within a fraction of a second, without chemical residues or deleterious effects on the material or lubricant. This electron beam method is particularly useful with difficult cap designs, which currently may be gamma-sterilised off line.

AEB Cap sterilisation system.

Pouch, Pak, Form/Fill/Seal

Low voltage electron beams are an enabling technology for aseptic pouch and pak filling applications. With no heat, chemicals, or rinse water, electron beam sterilisation is a cold, dry alternative to conventional hot fill, retort and chemical-based sterilisation techniques. Whether sterilising a web of material prior to forming the package, or treating a fully formed pouch with a spout, compact electron beams bring sterilising energy to the process, allowing significantly faster line speeds with high efficacy.

A similar approach is being used for thermoformed containers, where the current methods of steam, hydrogen peroxide and UV approaches offer limited process speeds and kill rates. With electron beams, both the containers and lidstock can be quickly and thoroughly sanitised at production speeds, while shrinking the size of the system.

Printing and converting

In addition to sterilisation, the adoption of electron beam for curing and polymer treatment applications is growing.

- Electron beam curing of inks, coatings, and adhesives is an energy-efficient, VOC-free alternative to traditional solvent based curing methods. This method has application for direct printing on the package, as well as for curing barrier layers used to block ingress of oxygen and UV and egress of carbon dioxide.
- Electron beam crosslinking of polymers can improve the strength and heat resistance of many packaging materials - leading to higher performance and lower resin weight packaging concepts.

Summary

Beverage makers face significant challenges with existing sterilisation and decontamination methods used in the growing area of aseptic processing. Compact electron beam technology is being integrated into beverage applications today, offering substantial cost savings along with significant sustainability benefits: zero water and chemical use, less energy required, no chemical residues or waste disposal. Beverage companies, equipment OEMs, and electron beam technology providers like AEB are working together to make a sustainable solution possible and profitable today. ■

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