Microbiological Stability...

...cost efficiently ensured

Current increases in energy and raw material costs and associated inflation are presenting beverage producers with ever-growing challenges. Manufacturers around the world are therefore gearing up accordingly to be able to adapt to the new market conditions.

Rarely, macroeconomic changes have had such a profound effect on consumer behavior and also on beverage manufacturers as in recent three years. During the pandemic, beverage out-of-home consumption shifted heavily to the private sector. In parallel, supply chains were strained to such an extent that it led to reduced availability in raw materials and packaging. In contrast to past crises, the effects are not only regional, but they are clearly felt globally. Flexible and energy-saving methods for microbiological stabilization of beverages are becoming increasingly important for many producers in this context. For that purpose, Lanxess offers its established cold sterilization technology Velcorin®. Particularly in times of volatile prices and probably limited availability of fossil energy sources, Velcorin® represents an alternative or an addition to classic thermal preservation.

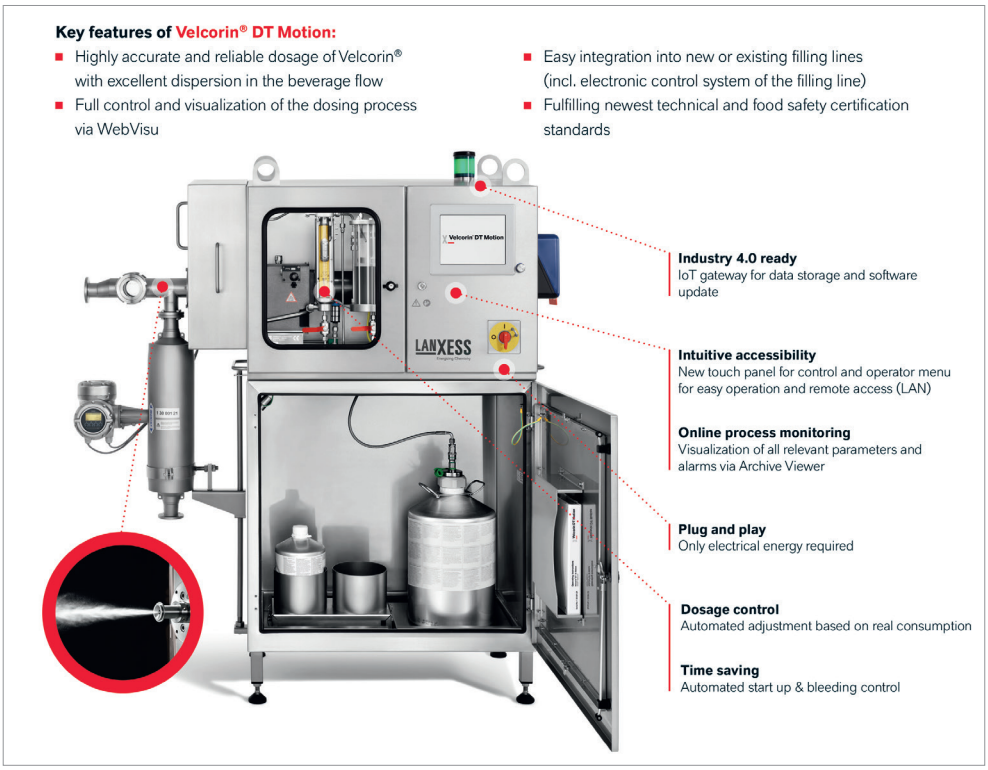
Different beverage filling technologies

Most commercially marketed beverages require microbiological stabilization to ensure their shelf life. However, the type of required treatment depends on the beverage recipe, quality of the raw materials and the hygienic conditions of in the production and filling areas. Carbonated beverages are fundamentally better protected against spoilage due to the inherent absence or at least greatly reduced oxygen content. In addition, no molds and very few bacteria can grow under these anaerobic conditions. Nevertheless, in this beverage category, yeasts that are strong in fermentation or capable of fermentation can play a major role as possible contaminants. In contrast, yeasts, mold and bacteria can grow in still beverages. Hence, they are classified as more sensitive to spoilage, since a key microbiological hurdle is missing due to the lack of carbonation.

Essentially, four different methods can be used for bottling and preservation of beverages.

Hot filling has been used for a long time and is well established. Heated beverage, usually at a temperature ≥ 85°C, is filled into the packaging and thereby eliminating potential thermosensitive germs. However, limitations are that temperature-stable packaging must be used and that only non-carbonated beverages can be filled, as CO_2 would escape immediately due to the filling temperature. In addition, the long heat retention time and slow cooling phase in the packaging may have a negative impact on sensitive flavors and other ingredients.

Tunnel pasteurization is another method of preservation. Here, the beverage and the packaging are simultaneously microbiologically stabilized by spraying hot-water. Thermostable packaging is essential in this case, too. Furthermore, the level of carbonation is limited as the heating process results in a considerable increase in pressure within the closed package, which can lead to the package bursting during heat treatment. As with the



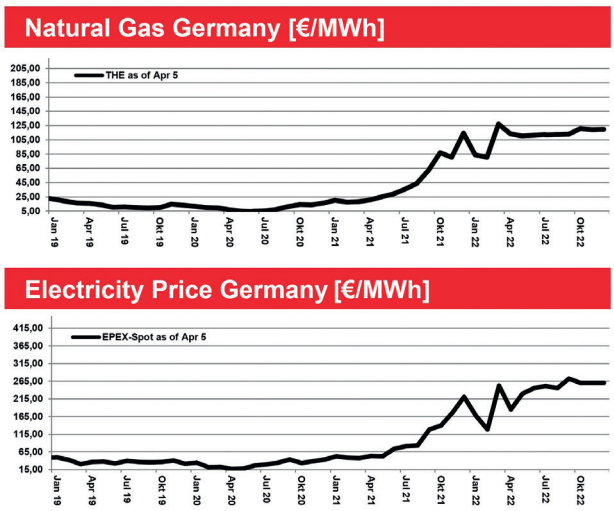


Fig. 1 German gas and electricity price development and outlook; source: THE (German gas market index), EEX.

hot filling method, the thermal impact can also have a negative influence on the sensorial profile of the product. Along with the effects on the taste of the final beverage, the required footprint and the maintenance are often seen as disadvantages. The latter is seen not only as a cost factor but also as safety issue, since special precautions must be taken when entering confined spaces.

In addition, aseptic filling should be mentioned, in which the packaging (e.g. bottle and closure) is sterilized separately from the product and both are then brought together and hermetically sealed in a sterile environment. Here, batch size, number of product change-overs and intensively trained and qualified personnel are crucial to the economical efficient and safe operation of the system. Manual intervention often leads to a loss of sterility, which must be restored before filling can be resumed.

In conclusion, it can be stated that all the three methods above require a relatively high level of technical equipment in combination with a high input of energy and resources in order to protect the product from secondary contamination. In times of historically high inflation with galloping prices for raw materials and supplies, more and more producers are looking for alternatives. The development of gas and electricity prices in Germany serve as an example of one of the drivers (cf. Figure 1)

Gentle cold filling with Velcorin® as a technological alternative

The fourth method, conventional cold filling, is a low-energy alternative to the processes described above. Its great popularity stems from its ease of use, although it is necessary to look out for possible secondary contamination in the filler area. This poses a challenge even in the case of hygienically well-designed systems with an appropriate cleaning and disinfection concept.

In order to protect the beverage against contaminants, depending on the product category and its intrinsic self-protection, Velcorin® technology provides beverage man-

ufacturers with a highly efficient and widely established method of microbiological stabilization. On one hand, even when used in small quantities, Velcorin® is highly effective against typical spoilage microorganisms such as yeasts, bacteria, and mold. On the other hand, this method of eliminating microbes has no effect on color and taste, meaning that the sensory profile of the finished beverage remains unchanged.

Velcorin® in liquid form is added to the beverage just before filling. It penetrates the cells of the microorganisms, deactivating the enzymes responsible for metabolism and thus induces cell death. At the same time, Velcorin® hydrolyzes and is consequently no longer present in the final product.

Along with Velcorin®, Nagardo® complements the product portfolio of Lanxess for microbiological protection of beverages. Recently approved by the European Union (mid-2022), Nagardo® represents now an additional option of a natural preservative based on glycolipids obtained by fermentation from an edible fungus, Dacryopinax spathularia . It comes as a powder and is usually pre-dissolved in water before adding it to the beverage formulation during product blending. Nagardo® remains in the beverage and thus protects it even after opening in a natural way. Its broad spectrum of efficacy, even at low concentrations, shows excellent activity against heat-resistant spore formers such as Alicyclobacillus species or representatives of the genera Byssochlamys, Neosartorya and Talaromyces. The expanded portfolio enables Lanxess to open up new possibilities for preservation by combining these two products. This not only widens the efficacy profile, but also, depending on the application, they complement each other synergistically so that further microbiological hurdles, such as energy-intensive chilled chain distribution, can be eliminated.

Criteria for selecting the right technology

With the multitude of possibilities and combinations for preserving and safely filling beverages, the question naturally arises as to which criteria should be considered to select the most suitable technology. In addition to sensory aspects, the chemical and physical stability of the product over its entire shelf life is of significant importance. Oxygen entry itself, and possibly migration via the packing material, exposure to heat and light – in other words the overall storage conditions are key factors here, in addition to raw material quality and the treatment conditions in the manufacturing process. Packaging and raw materials can be directly evaluated in terms of cost, while product stability has an influence on logistics and the production cycle.

Packaging and raw materials in particular have a considerable influence on equipment output (also OEE Overall Equipment Effectiveness) and must be taken into account when selecting the technology platform in line with the range of products. For instance, with a highly segmented product portfolio, which automatically requires smaller batches and more frequent product changes, it makes little sense to rely on technologies that require more frequent cleaning and sterilization cycles or that are associated with long start-up and, in particular, heating times. In this case, the planned production time is reduced while the risk of low output rises, resulting in less time to produce a marketable beverage (cf. Figure 2).

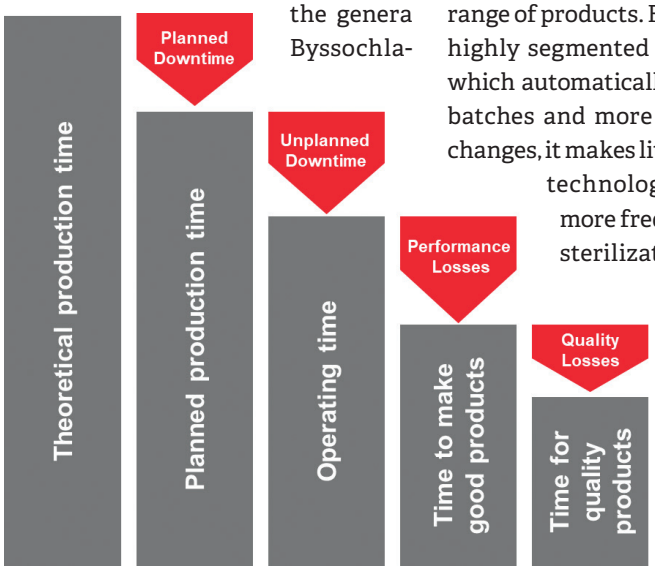


Fig. 2 Influencing factors on overall equipment effectiveness

In addition to the output efficiency, a holistic cost analysis is a key selection criterion for the right production platform for the producer. All costs incurred, i.e. one-off costs and running costs, must be taken into account. Figure 3 shows an example of the individual elements.

For new investments, this consideration is essential and is usually carried out as a matter of routine. However, it makes sense to evaluate production costs not only on the basis of current market conditions but also systematically during regular production operations. In this way, cost drivers can be identified, such as higher cost of heavier PET bottles for the hot fill process, rising energy prices, or higher spare parts costs with limited availability in the individual segments.

If certain cost elements rise, efficiencies decrease or product innovations cannot be served with existing technologies, a fast switch to a better fitting platform is highly unlikely possible. This is particularly true since new investment projects are often time and cost intensive and can only be implemented with a long lead time and corresponding parts availability. In times of rapidly changing customer requirements and shorter product life cycles, a fast time-to-market is crucial for the success of a beverage in the market.

The great advantage of both, Nagardo® and Velcorin® technology is that they can easily be used in new manufacturing setup, but more importantly, also in combination with existing filling lines. This makes it easy to ensure microbiological protection even on equipment that was not originally intended for filling sensitive beverages, such as fillers for water or carbonated soft drinks.

All filling systems, from glass/PET/HDPE bottles to carton packaging, cans, KEGs, and bag-in-box, can be handled with the same technology.

Easy Implementation

To use Velcorin® technology, a dosing unit is integrated into a new or existing filling line. The latest generation, the Velcorin® DT Motion, is characterized by its clear and intuitive menu navigation. To meet the requirements of Industry 4.0, the dosing system is equipped with an IoT gateway. Furthermore, communication with the filler is possible by means of a simple signal exchange.

Apart from implementing the dosing unit on site, Lanxess as the manufacturer of Nagardo® and Velcorin® also offers plant assessments in order to optimally integrate both products into the manufacturing process and to suggest potential improvement measures from a hygienic and process engineering perspective.

Additionally to a team of technical and regulatory experts, two in-house laboratories are available for this purpose, in which the most modern microbiological, molecular-biological and chemical-technical analysis methods can be carried out. The customer can be supported with specific laboratory tests on a product-related basis. A trial period can be arranged, if required with a loan dosing unit on site.

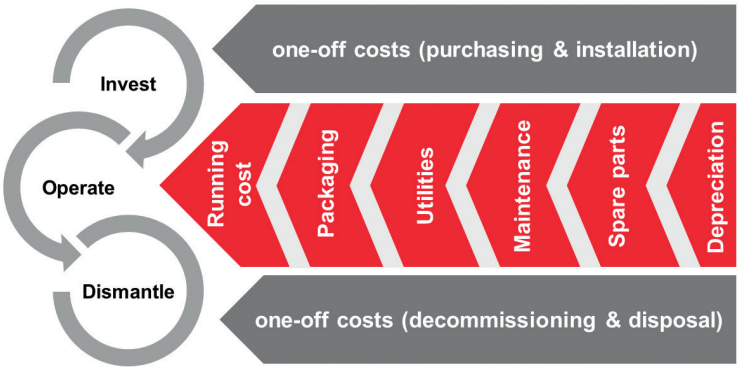


Fig. 3
Elements of total cost of ownership

Conclusion

In order to fill beverages microbiologically safe while at the same time allowing to offer them cost-efficiently, flexibly and innovatively on the market, Lanxess developed an optimal solution with Velcorin® and Nagardo® - either individually or in combination. Both products clearly follow the premise of enabling the filling of sensitive products in an economical way at lowest possible investment in manufacturing equipment as well as reduced energy and maintenance costs.

Swiftly changing circumstances can be responded to with the utmost flexibility and competitive advantages can be achieved by launching new products quickly. ←

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