CONSTRUCTION SOLUTIONS IN MODERN FOOD STERILIZERS

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Commonly prevailing trend in the food industry is a decrease of technological processes costs with simultaneous increase of demands in terms of quality and food articles safety [11]. This forces a continuous search of a new food processing methods and constitutes a driving factor for novel food processing methods forming, including those connected with food pasteurization and sterilization, among others.

Sterilization is one of the basic thermal treatment process employed in foodstuff processing. Mainly, it is based on a very intense heating treatment of a product. The process temperature ranges vary from +115 to +121°C or +130 to +145°C. The aim of the sterilization process is an eradication of all microorganisms and its endospores forms [15].

Food products in a solid or semiliquid state are subjected to sterilization or pasteurization in a tunnel- (fig. 1) or tank-construction devices (fig. 2) [10].

Fig. 1. Tunnel sterilizer from Hermis Source: [6]

Fig. 2. Tank sterilizer from Allpax Products LLC Source: [5]

Development of new technologies, respecting pasteurization and sterilization, is targeted at acceleration of food processing technology together with decreased energetic input. The most significant progress, in this respect, has been made in terms of technical solutions of tank sterilizers. Study of different constructional and technological variants in the range of tank sterilizers solutions is performed in four main areas (fig. 3).
A tank sterilizer is a hermetically closed container used for thermal treatment of food. Thanks to its structure, it is possible to reach a significant pressure values in the working chamber (usually 2 – 4 bar), thus enabling the decrease of operating temperature. By increasing the values of physical parameters of a running process, a significant reduce of time may be achieved [1, 3].

The second important area is the selection of an appropriate heating medium. In tank-type sterilizers hot water or water vapor spraying is widely used. Use of the water vapor as a heating medium may be a very beneficial solution. Saturated steam has higher specific enthalpy by an order of magnitude comparing to water for the same physical parameters. For comparison, at pressure 2,5 bar and temperature app. 125°C the specific enthalpy for water reaches 525 kJ•kg⁻¹, whereas for vapor being under saturation, for the same pressure is equal to 2733 kJ•kg⁻¹ (computed according to [9]). Nevertheless the usage of vapor as a heating medium brings some restrictions as well. The main limit is connected with costs and exploitation of a vapor transporting infrastructure and connection armature.

Another important area is a selection of adequate thermal insulation. In the vast majority of sterilizers insulation, a special wool, placed on the operating chamber casing and covered by sheet metal is used as an insulation. Though spraying with ceramic materials onto surfaces is being increasingly used. Selection of a suitable insulation material, layer thickness and arrangement is of primary importance for heat loss to the surroundings [1, 2, 3].

The last area of selection is the relative motion of a batch. Leading European sterilizers manufacturers have in their offer at least two solutions of the internal system. The former is a stationary system in which a basket, containing a batch, located on a trolley is pushed onto an operating chamber chain conveyor (in a shorter versions of sterilizers roller conveyor is extensively used). Then, through chain drive launch, basket is transported to the chamber interior in a manner which allow to transport remaining baskets (fig. 4). Unloading action is performed analogously.

The sterilization process is based on spraying a heating medium (water or water vapor) onto baskets which are arranged on conveyor. Spraying can be performed gravitationally or can be forced. In the former one, a collector is located close to the upper surface of the tank. Water flows onto a so called head shower which has many holes thanks to which water is evenly distributed onto a batch. System with forced flux consists of group of pipelines with nozzles, altogether attached to the working chamber casing. Heating medium flows through pipes under high pressure, and is distributed onto baskets from different directions [1, 3]. In both situations, any movement of a batch relative to tank occurs, what in case of sterilization of liquid or semi-liquid products is a serious technological limitation.

The movement within a product during sterilization brings a number of advantages, the most important of them involves [1, 3]:
- increase of values of heat transfer coefficient (forced convection),
- mixing and homogenization of products (particularly desirable in semi-liquid products),
- decrease of processing time,
- decrease in heat and electric energy consumption.

With a view to above-mentioned benefits, a number of producers have developed systems enabled to move a loading relatively to the sterilizer working chamber. Among the design solutions of an internal swaying systems, two basic types can be distinguished: rotational (oscillatory motion) and reciprocating.

The rotational system consists of a special construction frame, being an assembly of rings connected together with profiles which are fixed radially with respect to tank horizontal axis. Loading and unloading process of baskets is performed through chain or roller conveyor. In the Steriflow SAS (Barriguand) solution, the outer layer of a first ring works as a track for roller units, which are fixed to the sterilizer tank. Drive is transferred from a gearmotor through shaft which enters the working chamber from tank end side (fig. 5).
During operation the construction is moved with adequate angle performing an oscillatory movement with velocity ranging from 2 to 20 rev/minute. Application of an additional, multipoint heating medium injection ensures very good conditions for heat exchange [8, 12].

Similar solution is employed by Gea Levati Food Tech S.r.l. Baskets are also fixed in a special construction frame being an assembly of rings connected together by profiles. However, here, unlike to sterilizer from Steriflow SAS, an annular gear is used fixed to the outer layer of frame ring and works with gear wheels driven by motorgear (fig. 6).

The system from Gea Levati Food Tech is enabled to perform a full rotation of a batch about the tank horizontal axis. The use of annular gear working together with gear wheels facilitates precision control [14].

The main disadvantage of described solutions is the frame, which significantly reduces the working space of a sterilizer.

With this in mind a Spain company Surdry S.L. has developed their own oscillatory construction based on chain conveyor which is placed on a special construction bed. Driving unit sets in motion the conveyor together with baskets (fig. 7).
The main advantages of the oscillatory system employed by Surdry S.L. are: large volume of the working chamber, simple construction and a wide range of working parameters. Due to the system working condition it is addressed to products placed on trays (fishes and meat in airtight packages) and in unit packages like doypack, which in sum is a major limitation [4].

Second type of sterilization-aided systems are reciprocating motion systems. The simplest one is system called “DALI” developed by Steriflow SAS company. Operation of the system is based on conveyor chain control, on which baskets are fixed. The reciprocating motion amplitude is relatively large because it can reach even several hundred millimeters. Whereas its frequency is small due to the electric motor limitations related with cyclic changes of rotation direction [8].

The system is characterized by simplicity. One major advantage is that the sterilizer has large working chamber. However, low frequency do not intensifies heat exchange as good as the competitive systems.

The most technically advanced system with reciprocating motion is “SHAKA” developed by Steriflow SAS. Similarly with “DALI” system, baskets perform reciprocating motion but the driving motorgear is connected with a crank mechanism. This mechanism is fixed to the baskets fixing construction which lies on slideways. The system motion is characterized by relatively large amplitude (about 150 mm) and rotation velocity reaching 100 – 200 rev./min (fig. 9). High mixing parameters as well as heat transfer coefficients allow to decrease sterilization time [8, 13].
Despite a number of advantages of the „SHAKA” system, there exist some disadvantages related to its use. The main drawback of the system is its lack of universality, i.e. it is dedicated to a sterilization of narrow range of liquid products or semi-liquid products in precisely selected unit packages (fig. 10).

Wide range of rotation velocity values of the system forces a use of baskets having appropriate construction, closely fitted to sizes and amount of unit packages with product. Any change in packages parameters is associated with the need to rebuild current baskets or their total replacement. Hence above solution is beneficial for those food producers who produce large series of the same product.

**Summary**

Sterilization process of food products plays a significant role in the food industry. Continuous pursuit of food manufacturers to reduce the costs of food production with simultaneous increase in its safety and quality makes that sterilizer producers develop technologies that meet the expectations of food sector producers. The essence of these technologies is intensification of heat exchange processes which aim is decrease of processing time and thereby decrease of costs. Technical solutions are focused on four main areas, namely: change of a process physical parameters, choose of an adequate heating medium and insulation material, and finally on relative motion of a batch.

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**Literature**


