NTNU

Sustainable Energy in Food Production

MSTU

Technology of sterilized cans. Ways to increase energy efficiency

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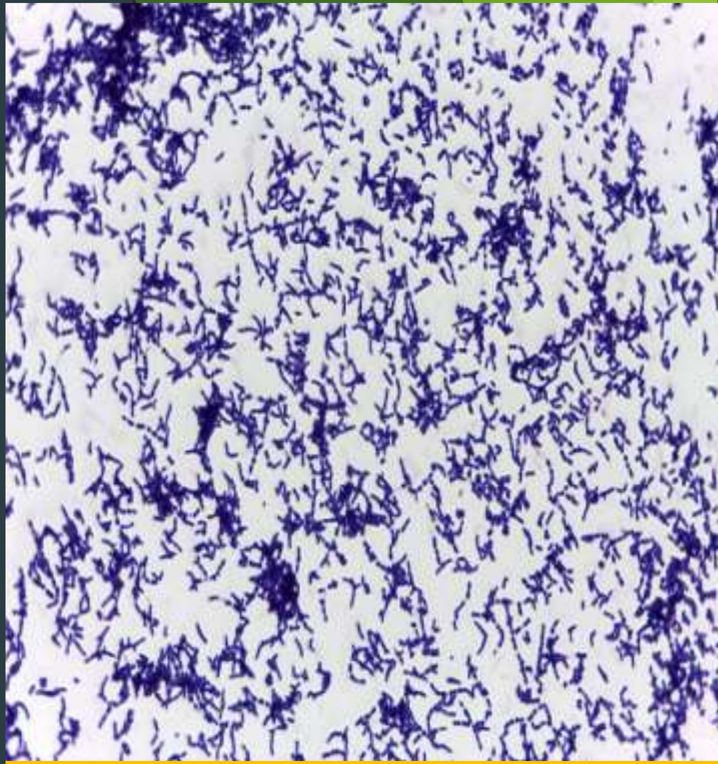
Principles of food canning

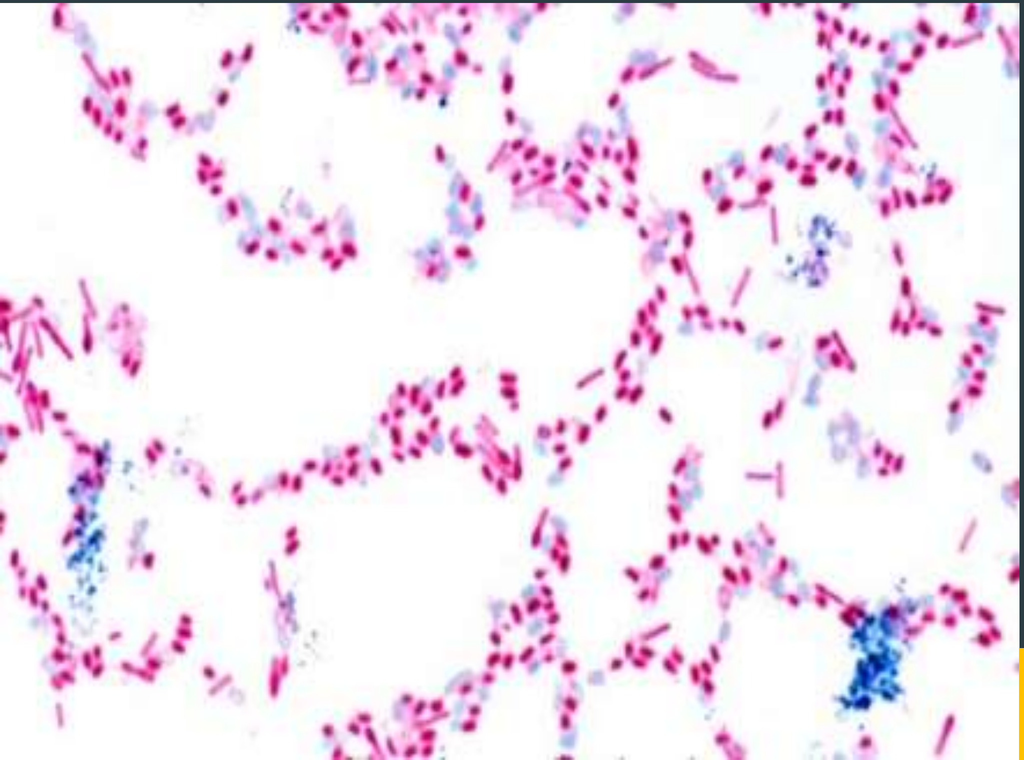
Unlike pasteurized “cooked” products where the survival of heat resistant microorganisms is accepted, the aim of sterilization of products is the destruction of all contaminating bacteria including their spores.

Amongst the two groups of spore producing microorganisms, Clostridium is more heat resistant than Bacillus. Temperatures of 110°C will kill most Bacillus spores within a short time. In the case of Clostridium temperatures of up to 121°C are needed to kill the spores within a relatively short time.

The above sterilization temperatures are needed for short-term inactivation (within a few seconds) of spores of Bacillus or Clostridium. These spores can also be killed at slightly lower temperatures, but longer heat treatment periods must be applied in such cases to arrive at the same summary effect of heat treatment.



Bacillus

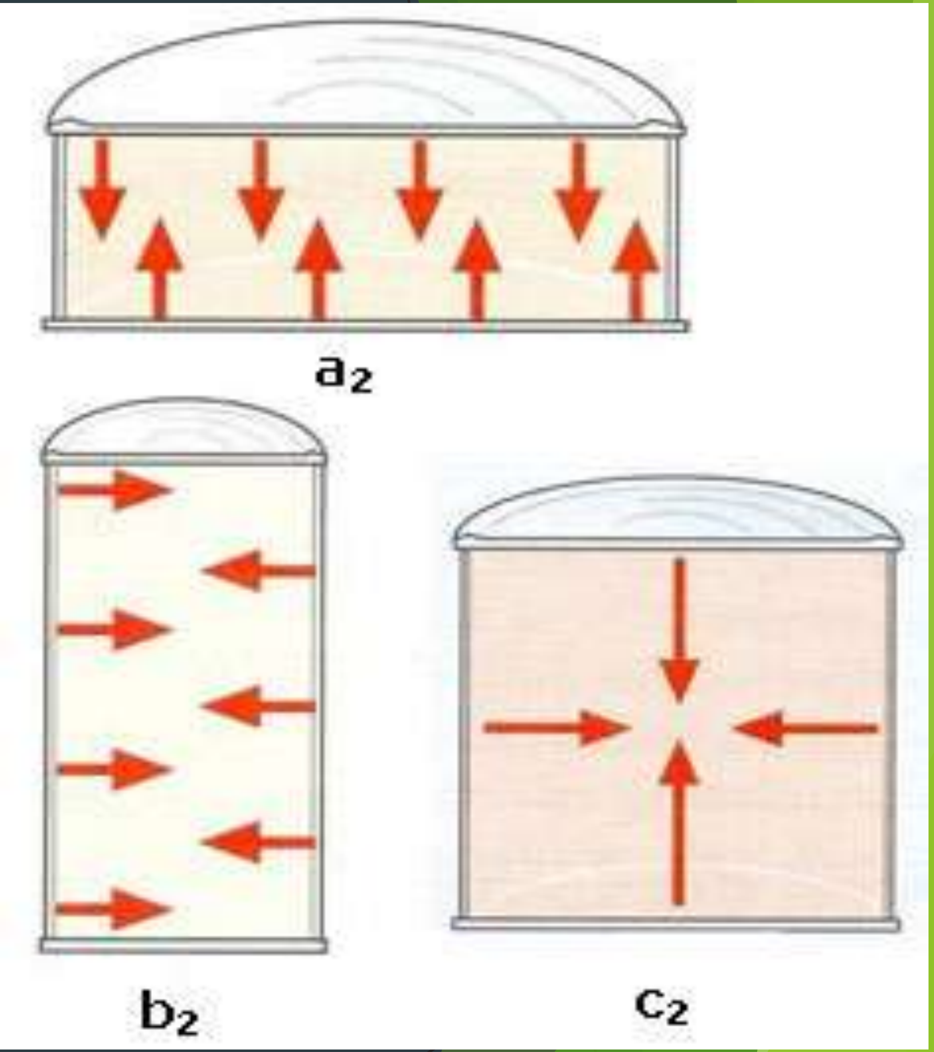


Clostridium

From the microbial point of view, it would be ideal to employ very intensive heat treatment which would eliminate the risk of any surviving microorganisms. However, most canned meat products cannot be submitted to such intensive heat stress without suffering

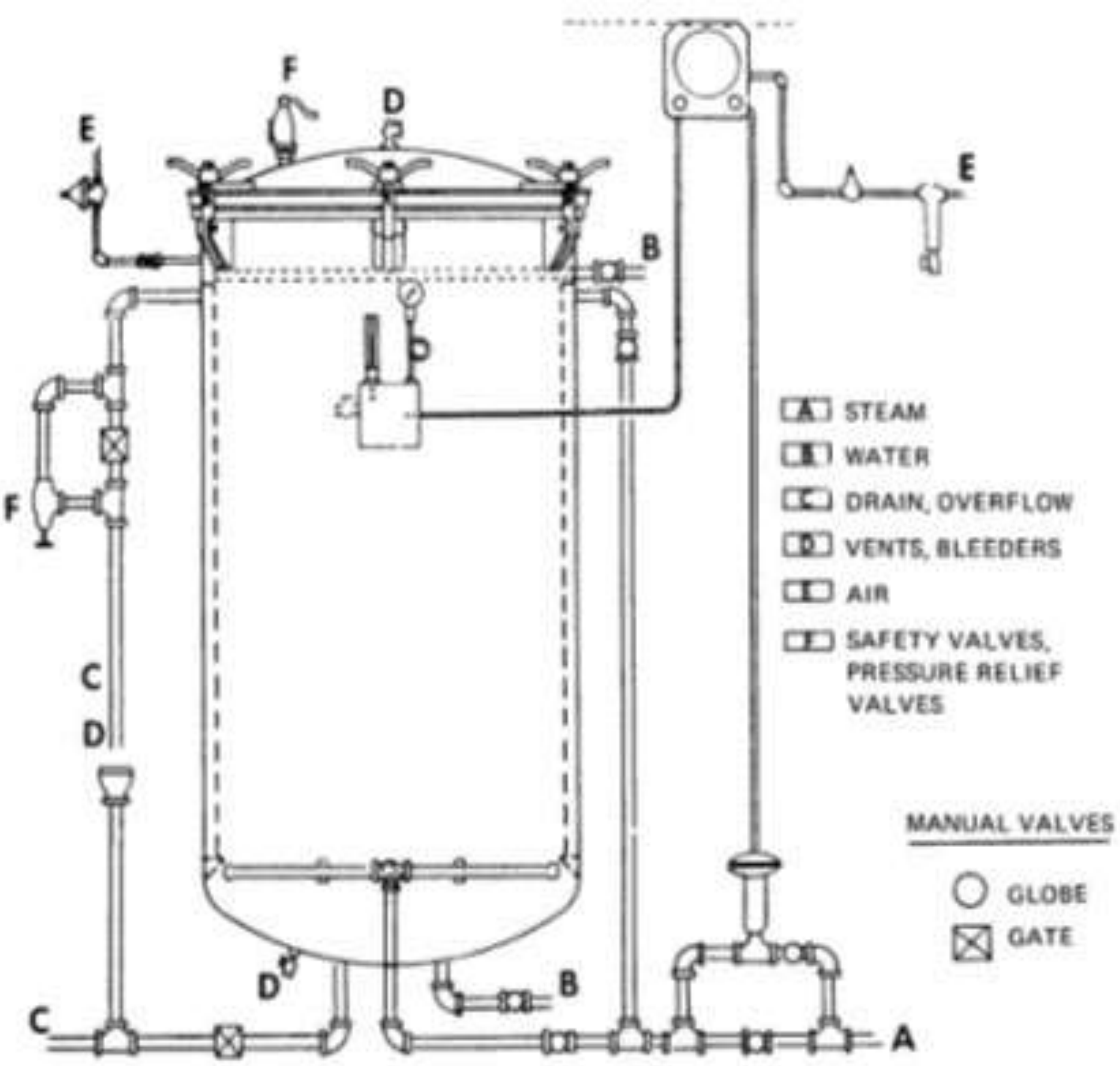
- **degradation of their sensory quality** such as very soft texture, jelly and fat separation, discoloration, undesirable heat treatment taste and
- **loss of nutritional value** (destruction of vitamins and protein components).

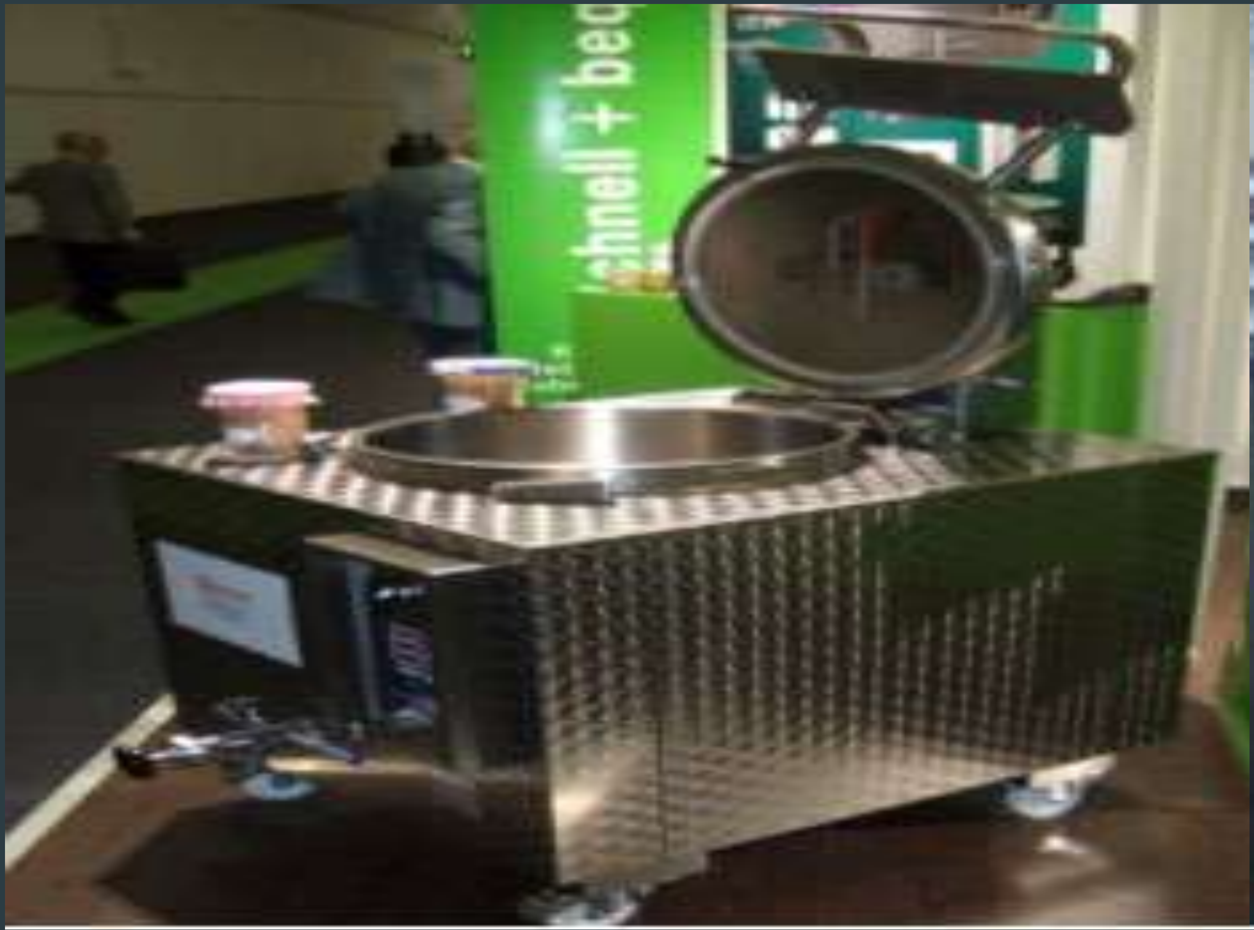
In order to comply with above aspects, a compromise has to be reached in order to keep the heat sterilization intensive enough for the microbiological safety of the products and as moderate as possible for product quality reasons.



Ways of heat penetration into horizontal (a2) and vertical (b2) flat cans and square (c2) cans with solid (not liquid) content.

In order to **reach temperatures above 100°C ("sterilization")**, the thermal treatment has to be performed under pressure in **pressure cookers**, also called **autoclaves** or **retorts**.

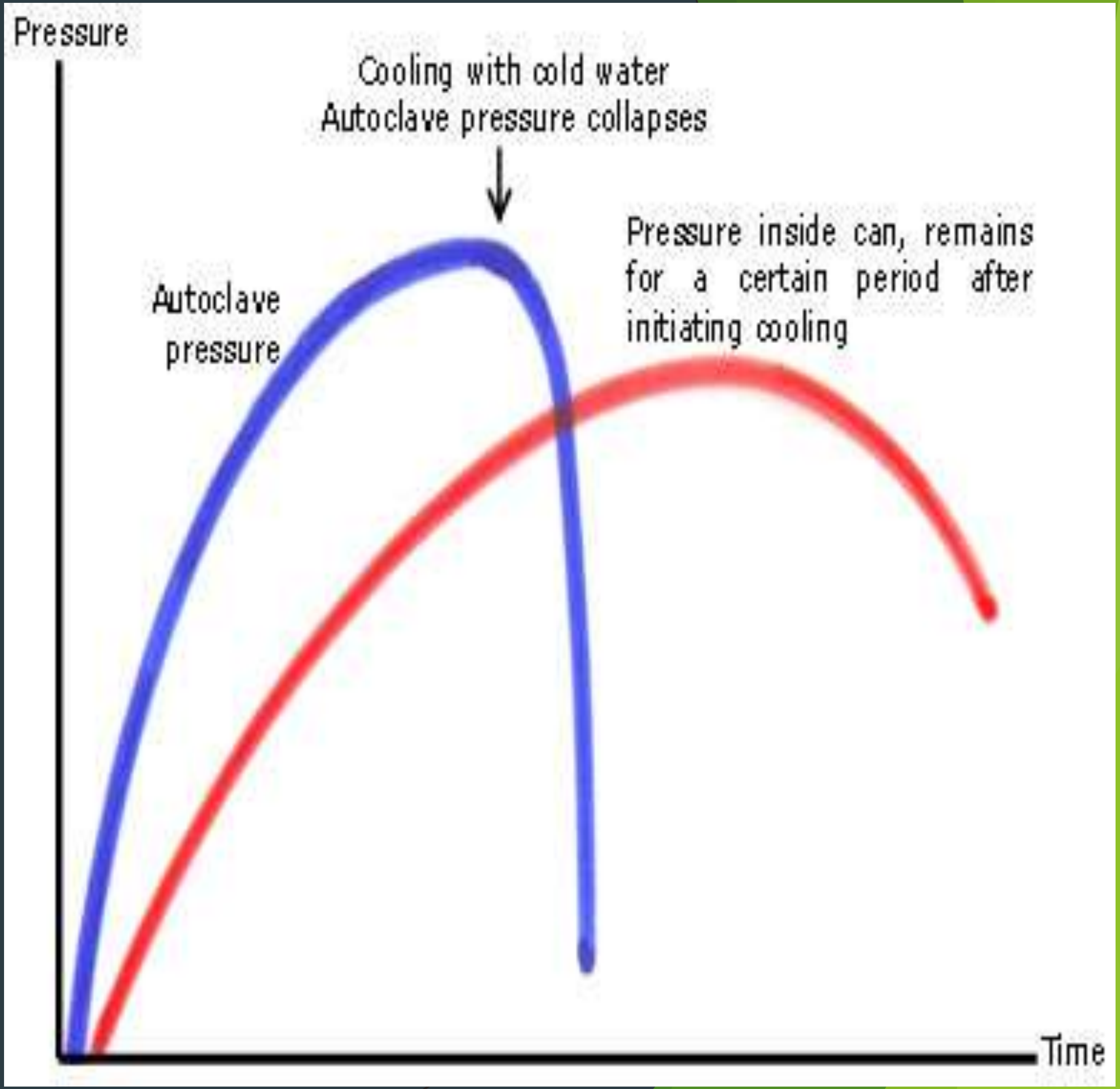




Simple small autoclave

Large horizontal autoclave

The sterilization process in the canned product can be subdivided into three phases. The product temperature is increased from ambient to the required sterilization temperature (phase 1 = heating phase). This temperature is maintained for a time (phase 2 = holding phasing). In (phase 3 = cooling phase) the temperature in the can is decreased by introduction of cold water into the autoclave.



Main parameters of sterilization process

Normative sterilization effect

$$F_N = D_T \cdot (\lg B + a)$$

where

- B – initial quantity of spores
- a - order of spores destruction (the probability of spore survived in a single can is 10^{-a})
- x – coefficient for non-logarithmic effects
- D_T - thermal stability constant (duration of decreasing microorganism quantity 10 times) at temperature T.

Practical lethality

$$LT_Z = \frac{U}{10^{\frac{T_B - T_C}{z}}}$$

where

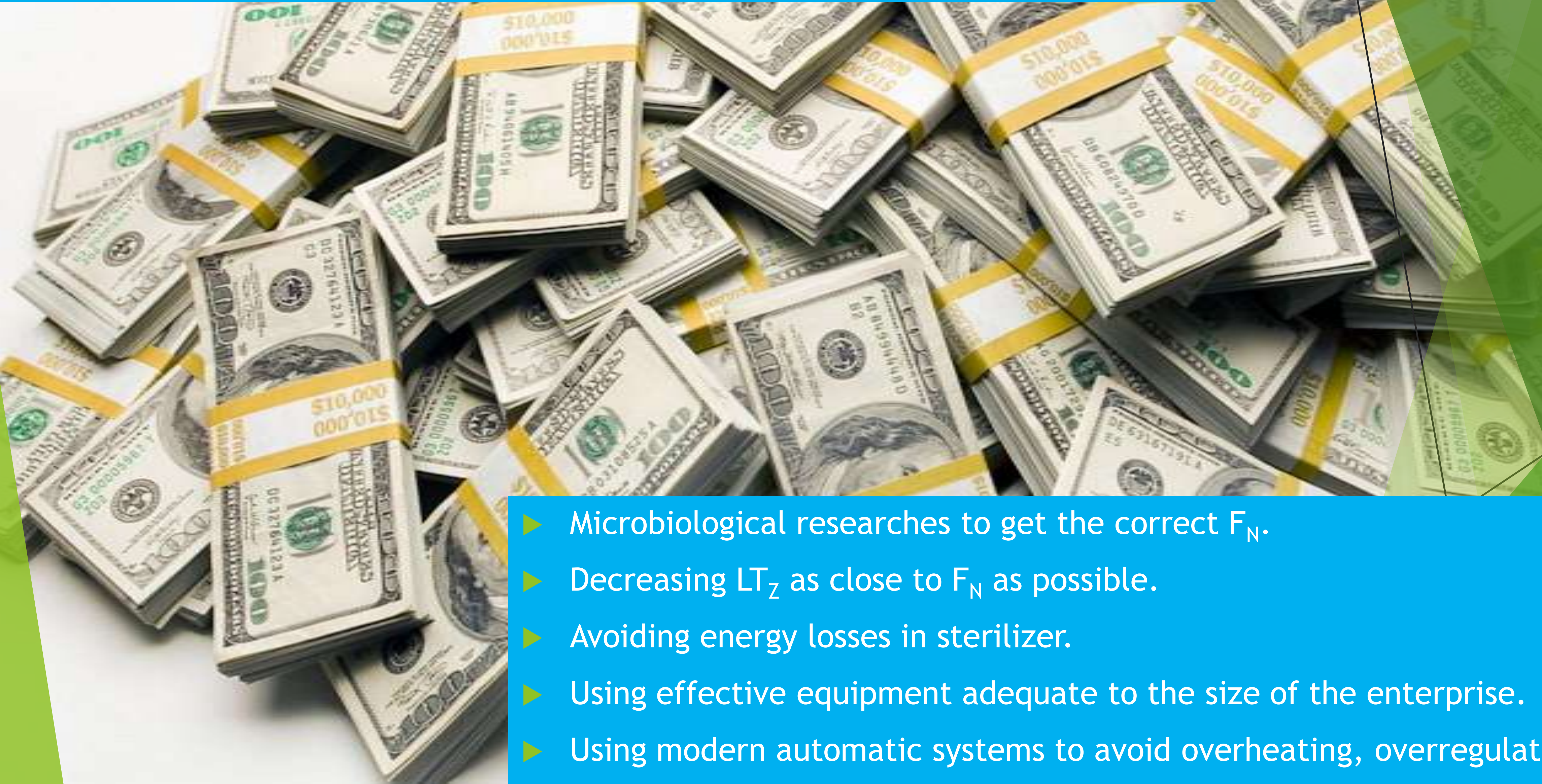
- LT_Z – practical lethality of the process (rel.min)
- U – time of the real process at T_C.
- T_C - current temperature
- T_B – base temperature
- z - thermal stability constant (how degrees to increase the temperature to decrease duration of the process 10 times).

Sterilization formula

- $$\frac{a - A - B - C}{T}; P$$

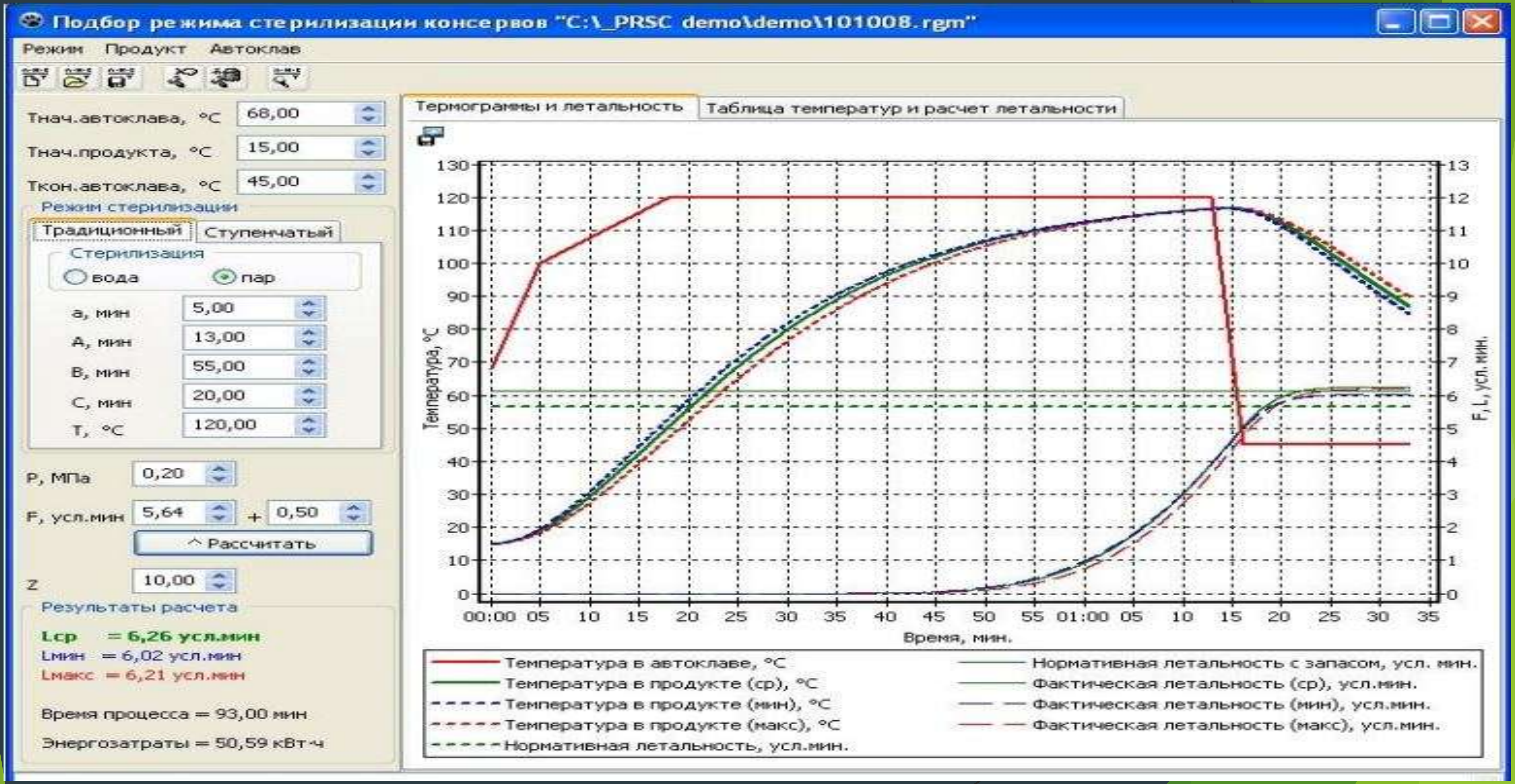
- *a* – blowing up time (for steam sterilization only)
- *A* – heating time (from somewhat less 100 °C up to T)
- *B* – sterilization time (at T)
- C – chilling time
- *T* – temperature of sterilization
- *P* – backpressure (bar or MPa)

How to save your money, if you want to be a canning baron?

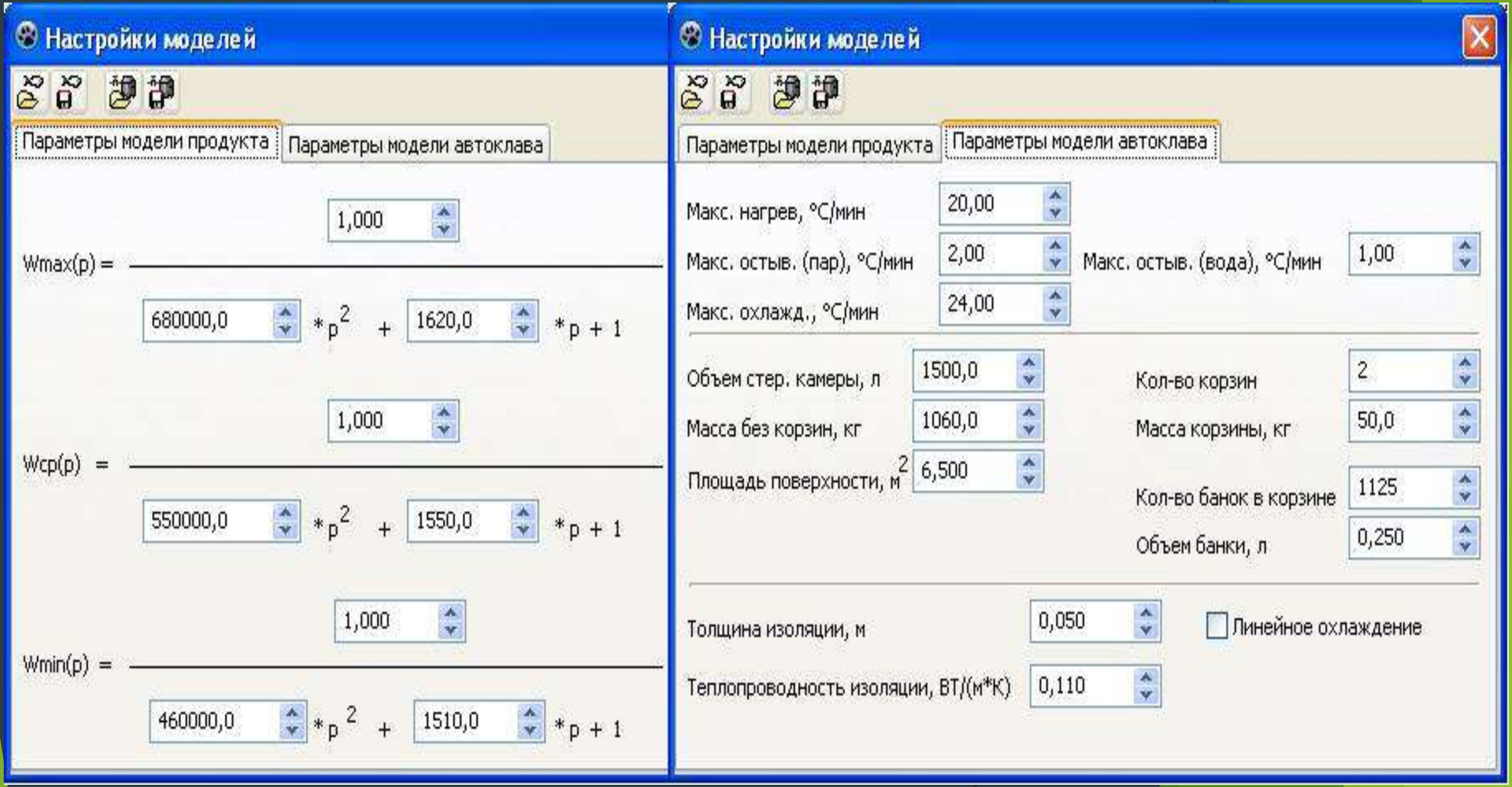


- Microbiological researches to get the correct F_N.
- Decreasing LT_Z as close to F_N as possible.
- Avoiding energy losses in sterilizer.
- Using effective equipment adequate to the size of the enterprise.
- Using modern automatic systems to avoid overheating, overregulation etc.

Elegant solve of a problem.



Elegant solve of a problem.



Thanks for attention!