A device for locating measuring sensors in temperature probes used for precise determination of SHZ in cans

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Keywords: the slowest heating zone, temperature probe, multi-channel temperature probe, temperature sensor

ABSTRACT:

The article describes a measuring instrument used for precise location of temperature sensors in temperature probe housings. The description concerns the construction of the device and the measurement method.

Urządzenie do lokalizacji sensorów pomiarowych w sondach temperatury wykorzystywane do precyzyjnego wyznaczania SND w konserwie

Słowa kluczowe: strefa najmniejszego dogrzania, sonda temperatury, wielokanałowa sonda temperatury, czujnik temperatury

STRESZCZENIE:

Artykuł opisuje przyrząd pomiarowy służący do precyzyjnego lokalizowania czujników temperatury w obudowach sond temperatury. Opis dotyczy budowy urządzenia oraz metody pomiarowej.

1. INTRODUCTION

The sterilisation process extends the life of the food. It is important to note, however, that excessive heating time adversely affects the quality of the food, its nutritional value, vitamin content and organoleptic characteristics [1]. It also increases the production costs of the plant. For optimum processing time, it is necessary to define the slowest heating zone (SHZ) in the product [2]. As a general rule, if the designated zone is sterilised, this means that the entire product has obtained the required commercial sterility [3]. Precise determination of the slowest heating zone (SHZ) in the can should be supplemented by precise determination of the location of the measuring sensor of the temperature probe.

As stated by Rao and Anantheswaran [4], due to convection currents, the slowest heating zone is located below the geometrical centre of the can. It is necessary to determine experimentally said zone before any thermal process begins. On the other hand, Vatankhah et al. [5] heat treated *Haleem*, a type of stew popular in the Middle East, estimating that the slowest heating zone is placed at the geometric centre. The model based on the design fluid mechanics confirmed that the slowest heating zone was located in the geometrical centre of the container. Model tests, however, showed less compatibility with the validation tests during cooling than during heating. The authors note that this may be related to the composition of the product (starch) and expansion inside the container acting on the value of internal pressure in the can. By listing the parameters to be taken into account during the production of the cans, Kołodziej [6] pays particular attention to the fat content due to its bad heat conduction and the formation of anhydrous capsules around the bacteria which reduce the heat efficiency of the process.

In the measurement practice, due to the increasingly irregular shapes of can packages (attractive to the customer, problematic for the manufacturer), the theoretical determination of the SHZ has been increasingly flawed due to difficulties or inability to perform appropriate calculations. Therefore, the importance of empirical verification of the location of the SHZ in the packaging space increases. This verification typically involves measuring the temperature at various points in the packaging space during heat treatment processes (pasteurisation or sterilisation). In order to simplify the entire process and increase the measurement accuracy, it is worth using multi-channel temperature probes. Each of them is equipped with a larger number of sensors (e.g. 6) distributed at constant intervals over the entire length of the probe operating section. In this case, it is very important from the measurement perspective to know the exact position of the sensors in the probe shell. Additionally, the process of production of measuring probes (regardless of the number of sensors installed in probe housings) even at the leading manufacturers includes manual stages which may be the source of potential obstacles with the location of measuring sensors. It is therefore necessary to verify the location of the sensors in the probe housing. This applies both to multi-channel probes which are innovative on the Polish market and to traditional probes with a single measuring point. A patented method for testing the probes and the measuring instrument that performs it is presented in the following section of the article.

2. DESCRIPTION OF THE EQUIPMENT AND MEASURING METHOD

The method of locating the sensors in the probe housing is to heat the probe housing locally and to read the temperature measured by the individual sensors (Fig. 2). This process involves applying a heated head heating element (Fig. 2-10) with controlled temperature (e.g. 90°C) to the probe shell and moving the probe (Fig. 2-2) in relation to the head. As the temperature probe housings are made of non-ferrous metals with very low heat transfer rates, the error caused by warming up the probe shell does not have a significant impact on the measurement result. The readings from the temperature sensors are recorded by means of a computer and an appropriate application. The data are presented in the form of a legible graph (Fig. 1) of temperature as a function of distance from the end of the probe housing, separately for each sensor. The application automatically locates the points where individual sensors measured the highest temperature. These points are considered as locations of the sensors.

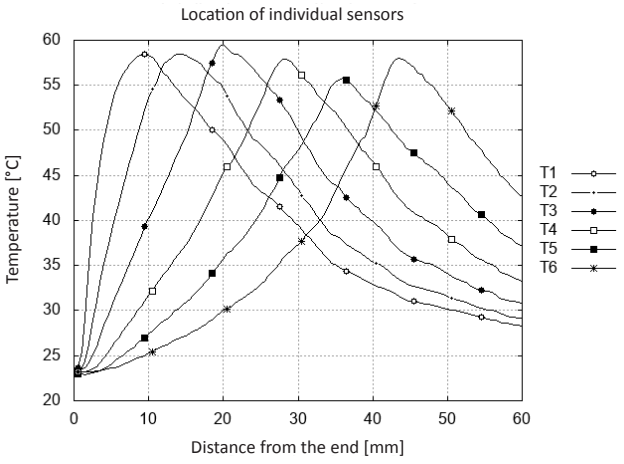

Figure 1 Diagram of the temperature measured by the sensors located in the probe housing as a function of the distance from the end of the probe housing

A sketch of the sensor location device in the temperature probe housings is shown in Figure 2. The probe (1) containing sensors (2) is installed in the mobile holder of the measuring instrument (4). The free end of the probe (3) is placed on the support (8) of the device. The tip of the head (10) with a heater with a precisely defined temperature (9) is applied to the tip of the probe. After the lapse of a fixed time, the measuring unit (11) reads the temperature measured by the sensor. Then, the mechanical system (5) equipped with a motor (7) with an embedded encoder moves the mobile handle (4) holding the probe by a user-specified distance, e.g. 1 mm, by means of a feed screw (6) before the process is repeated. Using the appropriate application (Fig. 3), the user may adjust the values of such parameters as:

- head temperature;
- probe heating time;
- number of measuring points;
- distance between individual measuring points.

There are also two variants of the measurement procedure — with waiting for the probe housing to cool down after each measurement and with bypassing this step. The first variant is more reliable and is used for measurements requiring greater accuracy. Its only disadvantage is a relatively long measurement time. After each reading of the temperature value, the head is moved away from the probe housing and the application reads the indications of the temperature sensors. Only when the indications of all the sensors exceed the user-defined temperature threshold (and the probe cools down), a subsequent step of the measuring procedure is performed.

The second, simplified variant of the measurement procedure does not take into account the cooling process, which greatly reduces the measurement time. In most cases, the results obtained by both methods coincide with high accuracy, so there is no need to use the first option in daily laboratory practice.

The method of determining the location of measuring sensors in multi-point or single-point temperature probes and the measuring instrument for this method is described in a patent application No P.423655 [7].

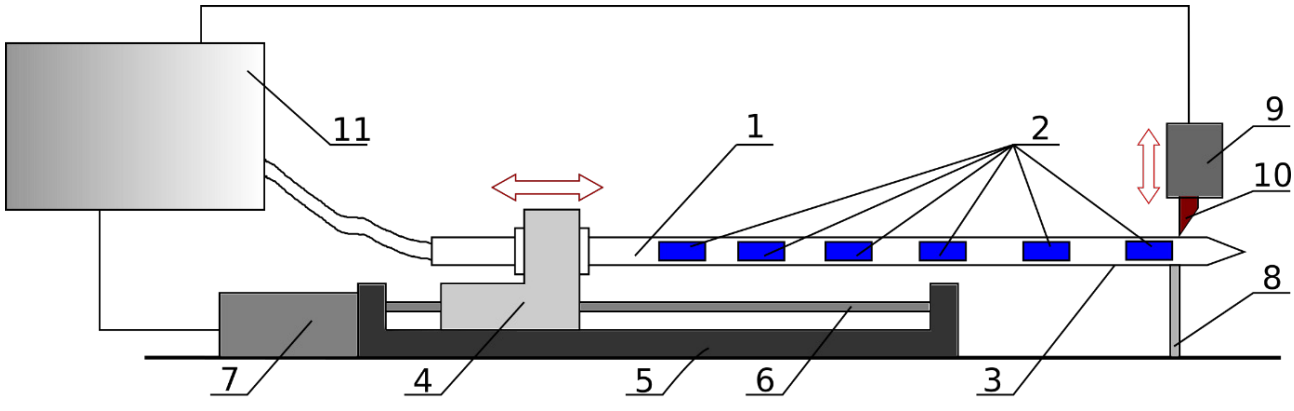

Figure 2 A sketch of the sensor location device in the temperature probe housings

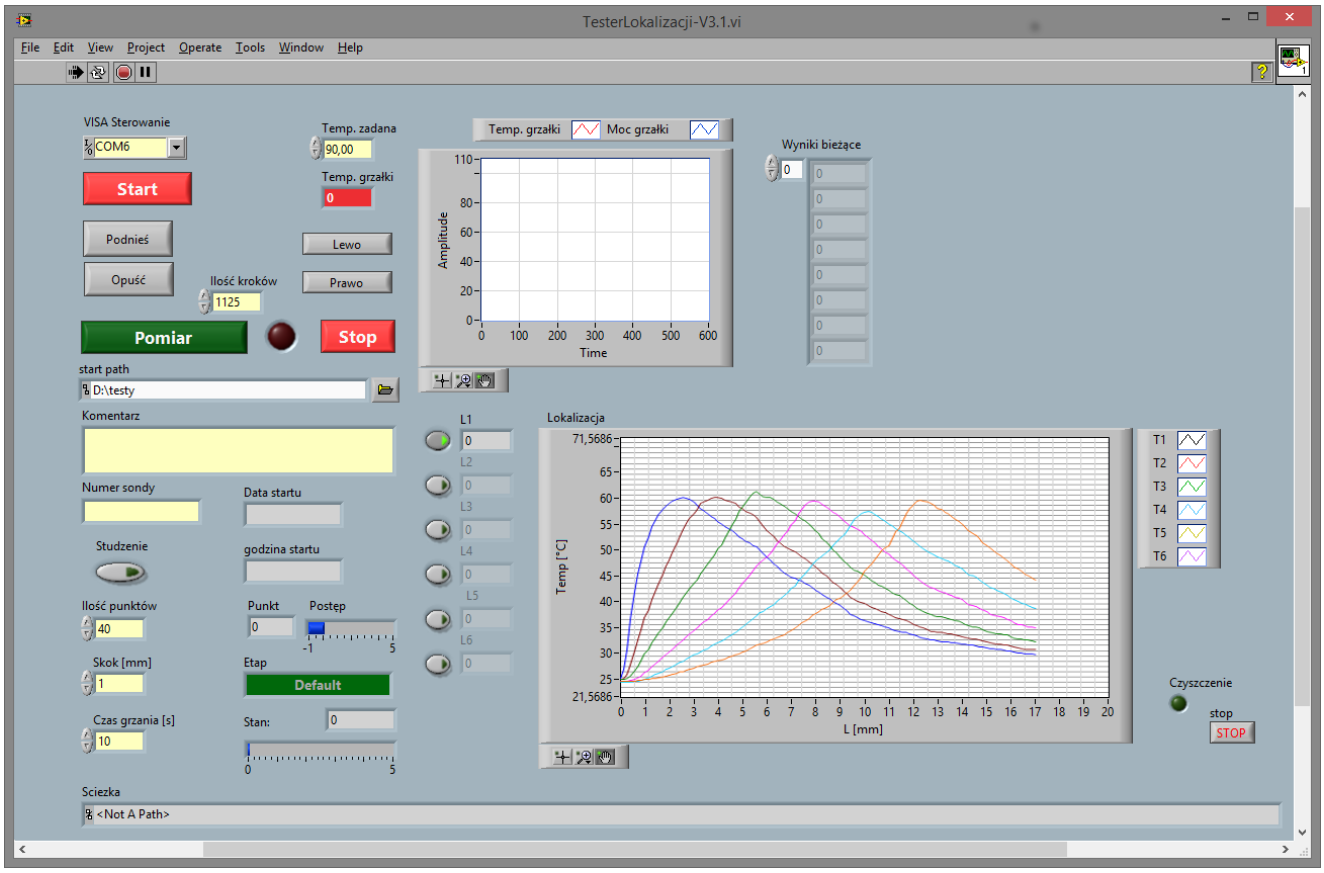

Figure 3 User interface of the instrument control application to locate sensors in temperature probe housings

3. SUMMARY

The device was designed to control the quality of temperature probes used in thermal food preservation process monitoring equipment located in numerous food industry plants. Multi-point temperature measurements are used in different food industries and relate to many stages of production processes, both during heating and cooling, and during storage or transport.

All probes offered by Central Research and Development Centre of Testing and Didactic Equipment COBRABiDsp.zo.o.arecheckedusingthedescribed device. When the measurement is completed, a certificate is generated containing a table with measurement results, a diagram and parameters at which the measurement was performed.

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