THE ESTIMATED POSSIBILITIES OF THERMODYNAMIC SENSORS IN FOOD INDUSTRY

Adámková A.[1], Tančinová D.[1], Adámek M.[2]

[1]Department of Microbiology, Faculty of Biotechnology and Food Sciences, Slovak University of Agriculture in Nitra, Tr. A. Hlinku 2, 949 76 Nitra, Slovak Republic

[2]Department of microelectronics, Faculty of Electrical Engineering and Communication, Brno University of Technology, Technická 3058/10, 616 00 Brno, Czech Republic

E-mail: xadamkovaa@is.uniag.sk

ABSTRACT

This paper describes the predicted possibility of using thermodynamic sensors in food industry. The paper is mainly focused on fermentation and renneting processes in the production of dairy products. Final stages of renneting and fermentation processes are often determined on the basis of sensory evaluation. The fast and simple non-analytical instrumentation method for the process of final determination does not exist in this time. Tests of fermentation process, renneting process and yoghurt process by thermodynamic sensors were measured. First results of simple experiments show that the thermodynamic sensors might be used for determination of time behavior of these processes.

Key words: thermodynamic sensor, fermentation process, yeast

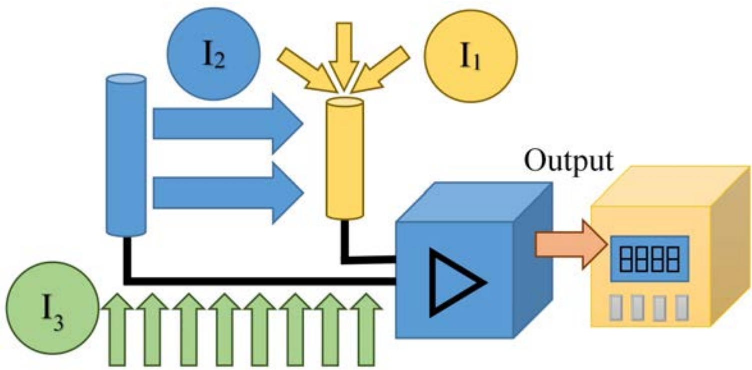
Acknowledgments: Thermodynamic sensors that were borrowed from HIT, s.r.o., were used for the measurement of experiments in the area of monitoring food production that are presented in this paper.

INTRODUCTION

The thermodynamic sensors (TDS) can be used for monitoring and characterization of thermal processes in thermodynamic systems. The basic idea, basic model and theory of ideal thermodynamic sensor integration as an ideal element in large models of thermodynamic system were presented in patent (Anonym, 2001). The original theory of ideal thermodynamic sensor as a process and media energy activity monitoring device was presented in (Reznicek M., Szendiuch I., 2005, Reznicek Z., et al., 2005, Reznicek Z., et al. 2006). The principle of thermodynamic sensors is based on measurement of energy, which is supplied to circuit to temperature setting and equilibration of temperature element with ambient. The sensor element is very often integrated with an amplifier and a converter to defined electrical signal (U, I, f), which is very easily connected to other measuring systems. High speed and sensitivity are the main advantages of thermodynamic sensors over other temperature sensors' types, for example thermocouples.

The basic idea of thermodynamic sensor is possible to use in various applications. Some groups of influences have effect on TDS, fig.1. First group of influences is presented by influences I1, which only have effect on a temperature of sense element T2. Various physical quantities (temperature, radiant heat, humidity, flow of liquid), which are possibly transformed to temperature energy, are theoretically measured in this group. Second group of influences is presented by influences I2, which change the temperature properties between the sense elements T1 and T2. In this group, the physical quantities as volume, density, flow of liquid, pressure, … are theoretically measured. Last group of influences is presented by influences I3, which have effect on a temperature of both sense elements T1 and T2. This group does not have effect on output signal of thermodynamic sensor.

Fig. 1 The group of influences, which have effect on TDS.



Because the TDS are very sensitive and fast, it is possible to measure very small temperature changes that may be produced for example by yeast. It is therefore possible to use TDS in the food industry in

- dairy products - fermentation processes, yogurt processes, renneting processes,
- breweries - fermentation processes,
- distilleries - fermentation processes,
- bakeries - controls vitability of yeast,
- control unwanted development of yeast and other microflora (sterilization, canning)
- pickled cabbage - fermentation processes, etc.

One of the application areas, where the thermodynamic sensors can find their new area of usage, is a production of milk products - cheeses, yogurts, kefirs, etc. Milk and products from milk are one of important ingredients of diet in people´s lives, especially for children. Milk and dairy products are sources of vitamins, proteins, fat, minerals, lactose, etc. (Tamine A. Y., 2009), which are not fungible in people´s sustenance. The production of dairy products is a complicated and sophisticated process, which is exacting to precision, temperature stability and hygiene (Griegr C., Holec., 1990). This is a reason for close quality checking. The production of dairy products is often realized by fermenting or renneting processes (Robinson R. K., 2005). The fast and simple non-analytical instrumentation method for determination of final process does not exist in this time. Final stages of fermenting or renneting processes are often determined on the base of sensory evaluation. One of the possible ways solving this problem is measuring of the final process by thermodynamic sensors.

The aim of this article is to suggest the use of TDS in food using simple examples.

MATERIAL AND METHODS

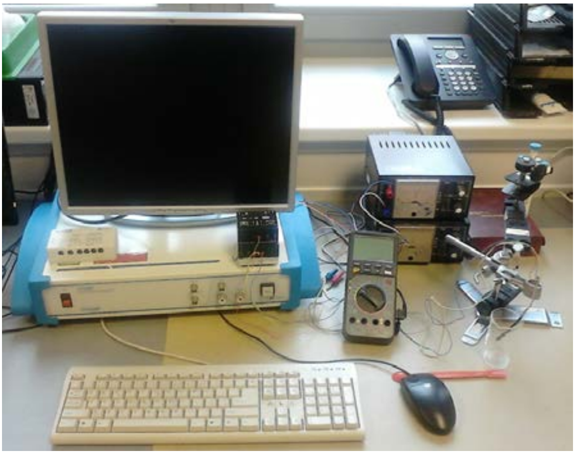
Chemicals

First experiments were made with distilled water, caster sugar "Cukr bílý krystal", Cukrovary a lihovary TTD, a.s., Dobrovice, CZ, and active dried yeast "INSTANTNÍ DROŽDÍ", S.I.Lesaffre, France. The basic material used for measurement of milk products was fresh milk "Mléko čerstvé Selské 3,5%", OLMA, a.s., Olomouc, CZ. The yoghurt "White country yoghurt with probiotic BiFi culture", Hollandia Karlovy Vary a.s., Touzim, CZ, was used as start culture for production of yoghurt.

Experiment

All the measurements were done using the TDS sensors, a simple measuring circuit, power source and multimeter Metex 3270 D as voltmeter, which was controlled by computer. Experiment was made on the workplace, which is shown on fig. 2. Temperature was 22 °C in case of first experiments with water and 35 °C in temperature-controlled box in case of second experiments with milk products. The sensor for experiments was manufactured in HIT, s.r.o., Nedachlebice.

Fig. 2 The workplace for experiments.



RESULT AND DISCUSSION

Measurement of activity yeasts was tested in first series of experiments. Experiments were made with water in room temperature (22 °C). Volume of water was 100 ml. First experiment (fig. 3) was focused on fermenting process, where the yeasts weight was changed (0,2g; 0,5g; 1g). Weight of sugar was 15 g. Results show a dependence of yeasts activity on yeasts weight in first fermentation phase and stabilization of yeasts activity on constant value in second phase of process. The weight of sugar was changed (5 g; 10 g; 15 g) in next experiment (fig. 4). Weight of yeasts was 1 g. The yeasts activity is increased with weight of sugar in first fermentation phase and is stabilized on constant value in second phase of process again.

Fig. 3 The fermenting process of yeasts in water - a change of yeasts weight.

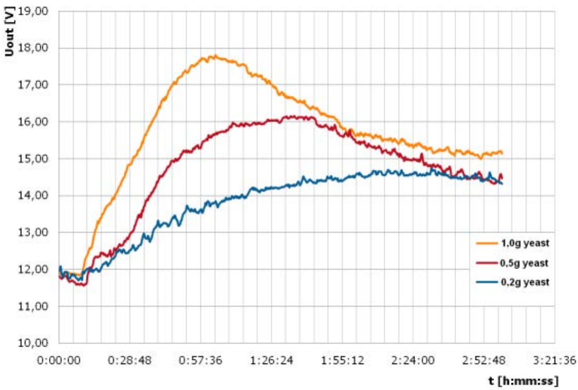
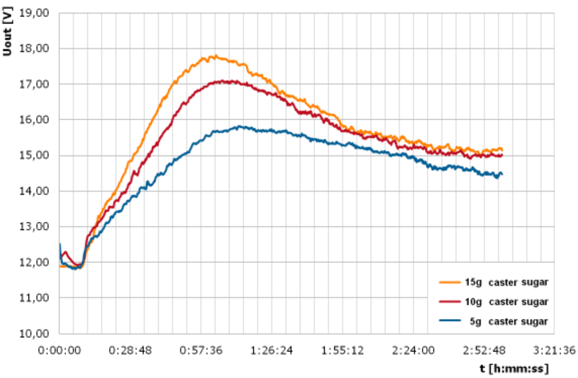


Fig. 4 The fermenting process of yeasts in water - a change of sugar weight.



Measurement of processes in milk production was tested in second series of experiments. Experiments were made with fresh milk in temperature-controlled box (35 °C). Two examples of yogurt and rennet processes are shown on fig. 5 and fig. 6. Both pictures show final stage of the processes. The simple yogurt process and rennet process were tested minimally three times with similar results. Therefore, it is possible that the thermodynamic sensors might be used for determination of these processes.

Fig. 5 The yogurt process.

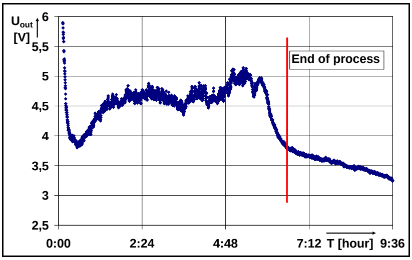


Fig. 6 The rennet process.

CONCLUSIONS

The thermodynamic sensor was tested in basic operations in milk production. Tests of rennet process, yogurt process and fermentation process were characterized and measured with thermodynamic sensor, which was borrowed from HIT, s.r.o. First results of simple experiments show that the thermodynamic sensors might be used for time behavior and end determination of these processes.

REFERENCES

ANONYM, 2001: *Technique of referential temperature and temperature difference measurement, asymetric temperature sensor and asymetric referential unit to technique application*. Patent pending Nr. CZ-297066, Bulletin Nr. 3/2001.

GRIEGR C., HOLEC., 1990: *Hygiena mlieka a mliečných výrobkov*, Bratislava: Príroda, 1990, pp. 39-49, ISBN 80- 07- 00253- 7

REZNICEK M., SZENDIUCH I., 2005: *Process energy balance monitoring*, In Proceedings of the11th conference Student EEICT. Brno. ISBN-80214-2888-0. No. 1, pp. 33-44.

REZNICEK Z., TVAROZEK Y., REZNICEK M., SZENDIUCH I., 2005: *Temperature balanced process media energy activity monitoring*. In Proceedings of International Conference EDS-IMAPS CS 2005 Brno, September 15-16 2005, Brno, Czech Republic.

REZNICEK Z., TVAROZEK Y., REZNICEK M., SZENDIUCH I., 2006: *Hybrid Constant Temperature Regulator*. In International Conference EuroSimE It 2006 COMO, Italy, April 15-16 2006.

ROBINSON R. K., 2005: *Dairy Microbiology Handbook: The Microbiology of Milk and Milk Products*, New York: John Wiley & Sons, 2005. ISBN 0471227560, 9780471227564

TAMIME A. Y., 2009: *Milk Processing and Quality Management, Society of Dairy Technology series*, New York: John Wiley & Sons, 2009. ISBN 1444301659, 9781444301656