

## **PRODUCTION PROGRAMMING IN THE CANNING**

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### **ABSTRACT – Production programming in the canning**

Our examinations aimed at the positive role of software production programming on costs. In addition to the fact that reduction of expenses can be reached with rearrangement of production between shifts, we pointed out that with this simulation technique the following problems can be avoided: product bump on the production belt due to careless planning, product piling in the heat-treatment unit and thus, product deterioration due to the heat-treatment which was not started in time.

To put the experiences in practice we developed a software system based on factory data. In development we used Microsoft Excel and Access programs as software environments and we made the necessary program codes in the built-in Visual Basic for Applications, as a programming language. We elaborated a user-friendly operation mode to reach functions with a special menu. We applied form-technique to upload and to modify data. Production programming and scheduling software modules can be used easily with dialogue boxes. Queries can be applied to check product bump on the production belt and sufficiency of heat-treatment capacity.

**Keywords:** modelling, optimization, autoclaving.

## **INTRODUCTION**

To increase quality is the primary aspect in food industrial researches. It is the most important aim to lessen the degree of conservation in food processing otherwise the food cannot preserve its original qualities, consuming and nutritional values. Furthermore, consumers claim the possibility to prepare their food more quickly, the safe and hygienic application, longer shelf-life, the constant and checked quality, the usability on wider scale and the solution of unexpected situations. All of them could be utilized by preserved food-makers but for this they have to employ modern work organization which follows the expectations of our time. (BIACS 1998, GOLDBERG 1994, KISS 2000, FARKAS 2001, BÍRÓ and BÍRÓ 2000)

Heat-treatment is used to prevent the microbiological danger thus it makes longer conservation-time possible. However, in case of an over-guaranteed heat-treatment there is a deterioration of quality, since sensory features, substance, taste, smell of the food can suffer a serious loss (discolouration on the surface in case of liver pastes, liquid exudation and jelly precipitation in case of meat, transformation into puree etc.)

It is worth involving engineering calculations, modelling, computer simulation in the research of this field, for the sake of the quality of products and expense-efficient production. A work organization should be formed which guarantees manufacture of products which are safe from microbiologic aspect; which keeps the regulations more precisely in the interest of higher quality and lower expenses. To do this there should be an informatics background which can provide the necessary assistance, on the basis of research results, to elaborate the suitable work organization. For this aim it provides the

user-friendly operation surfaces, which fulfill the claims of our time, the simulating and optimizing technique, the predicting and problem solving services and the flexible enlargement possibilities.

## **MATERIAL AND METHOD**

What basically determined the research and appeared in almost each element of the work was computer modelling. For this reason primarily we utilized the applied methods and techniques of this field from observation and data collection through details of modelling, programming, which often needed considerable creativity, up to the statistic methods of verification and validation of the model and finally, to the statistic processing of results coming from the experiments (simulation) carried out on the model.

For modelling and optimization with simulation we employed the microsoft Excel and Access 2003 programs both for development of the mentioned program with the built-in Visual Basic for Applications (VBA) service and for function insertion and statistic operations with Solver and Data Analysis functions available as the Excel complements.

## **RESULTS**

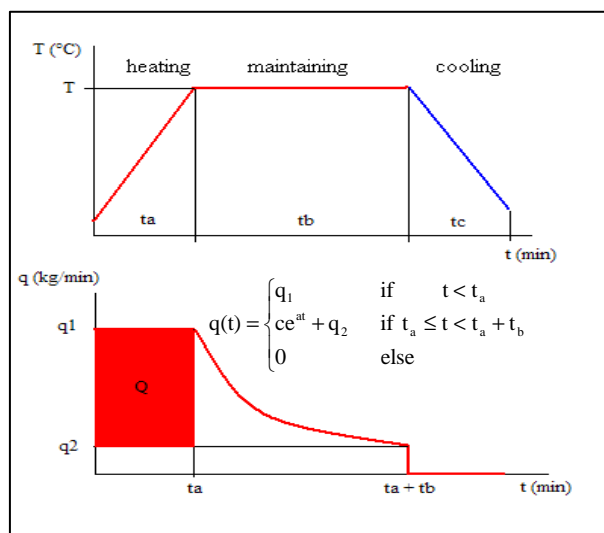
### **REDUCTION OF COSTS WITH SCHEDULING THE PRODUCTION**

Companies make a production plan for the forthcoming period in a certain frequency. At the company we carried out my researches at the production plan for the following week is elaborated on a weekly basis the most important element of which is to decide which products should be made in each shift. They have more production belts and it is product-dependent which product which belt can be made on. More products can be manufactured on the same belt, if the size of the can makes it possible, but only one of them can be made in one shift because of the loss of time due to refitting the belt. The weekly plan does not contain which product should be made on which belt because the product clearly determines the belt. However, the plan can have a mistake here since product bump can be experienced on the belts, in spite of the fact that different products are set in a shift. At present, the plan and the data from it are not checked with a computer, thus a problem of this latter kind can happen easily due to the human inadvertence.

The planning mistake that cannot be predicted easily is when products are made in parallel on different belts whose heat-treatment claim great capacity even separately and thus altogether they exceed the limit arising from the number of autoclaves. What is more, this mistake becomes clear only when the products arrive at the heat-treatment unit from the production belt and they form a waiting line which continuously grows. However, a strict regulation prescribes how long the maximum waiting time may be before heat-treatment. If it cannot be kept, a temporary cooling storage should be guaranteed, otherwise the germ number can considerably increase. For security reasons these conditions are calculated in the sterile formula but a germ activity over the level can imply explosion of conserves. It would not happen in the waiting line of some hours but after heat-treatment during the compulsory quarantine storage which lasts for a week or two, or in worse case, in the customers home, because the sterile formula was not determined according to the initial germ number which increased. The financial loss is significant because in this case the whole portion for heat-treatment (about 1 ton) or might as well, the total amount produced in the shift is endangered, so after a laboratory test it needs either further heat-treatment or it is destroyed.

## MODELLING THE GAS DEMAND OF A HEAT-TREATMENT PROCESS

On the upper part of *Figure 1*, the prescribed temperature (provided by the sterile formula of the given product) can be seen, while on the lower part the changes of the necessary steam mass flow in time (unknown, to be determined) are given.



**Figure 1. The prescribed temperature and changes of the necessary steam mass flow in time**

Product-dependent data known from the regulations on heat-treatment:

- $T$  – temperature to be reached (°C)
- $t_a$  – time of heating up (minute)
- $t_b$  – time to keep on temperature (minute)
- $t_c$  – time of cooling (minute)

Parameters of the  $q(t)$  steam mass flow (kg/min) are to be determined.

- $Q$  – steam demand (kg) of heating up, value dependent on the product mass
- $q_2$  – loss of the steam mass flow (kg/min), constant non-dependent on the product
- $c, a$  – parameters of curvature of the  $q(t)$  function, one of them is unrelated to the product and it determines the other.

With knowledge of the model, we can calculate the changes of steam demand of certain equipments in time which is related to the product to be treated (thus to the regulations on heat-treatment) and the starting points in time. Making use of the simulator created in Excel we constituted the daily data series of the total gas demand broken down in hours on the basis of the total heat-treatment in a day. The data of the gas demand should be calculated from these 24 data, but it has to be taken into consideration that a part of the steam produced is turned to the loss. It is unknown, too, and it is indicated as a new parameter ( $G$ ) of the model, like the gas amount which covers the loss in  $m^3/h$  unit of measure. It can be regarded constant in time. It was indicated in the technical description of the boiler that about  $80 m^3$  of gas is necessary to produce 1 t of steam. Thus, the total gas consumption per hour based on the model can be calculated both by realizing the steam demand of heat-treatments and from the loss. Then, it can be cross-checked with the measured gas consumption per hour.

We got the values of the model parameters (q2, k, a, G) with the Solver complement of Excel making use of the smallest squares method. However, the modelling of each day gave different results for the parameters. So the average of the parameters of five days (working days of a chosen week) provided by Solver was regarded as the final result which then we had to check (model verification) if with these parameters the gas consumption of the modelled day can be statistically considered as equal to the measured data. Checking it with the combined t-proof in case of all five days we found it adequate, there was no significant deviation ( $p < 0,05$ ). As a next step we examined if the model is adequate in case of days of the week which did not imply determination of the model (model validation). We had a positive answer again by means of a similar method. Consequently, the model and the simulator can be applied in software system, too.

## SOFTWARE ENVIRONMENT

A database manageable with an Excel spreadsheet would serve the user's interest the most. Thus, data processing and tabulation, graph making, which fit to the different demands and cannot be planned in advance, could be done easily. Application of spreadsheet guarantees a simple opportunity to provide program functions for calculations and graph making, besides it can be used as a development environment with the service Visual Basics for Applications (VBA) to elaborate the program. In addition, the database manager program should be used because firstly, it is easier to realize data storage, secondly, the program could have more functions, thirdly, the user-friendly way of data entry can be guaranteed by the technique of forms. Fortunately, both the spreadsheet and database manager can be applied since Excel sheets can be used as attached tables with the database manager program. It means that physically the data storage is realized on Excel sheets, while Access manages these data as if they were stored in its own tables. Thus, data correction done in Access will be stored on Excel sheets.

## USER INTERFACES, MAIN FUNCTIONS

After starting the program the first thing to appear is the main menu (*Figure 2.*) which shows three submenus, besides log out.

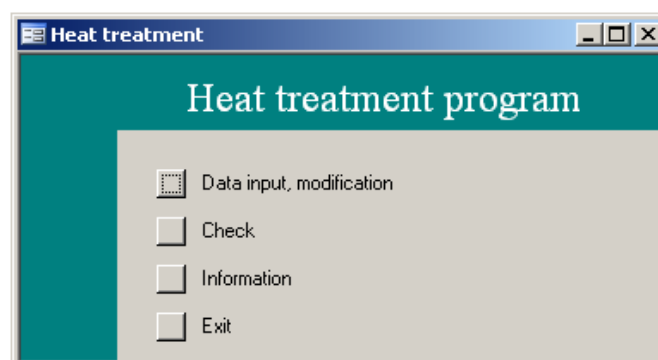


Figure 2. The main menu of Access

First of all, we can fix the data of tables „Product” and „Sterile formula” which can be modified only when a new product is to be manufactured or the regulations on the heat-treatment (sterile formula) of a given product should be modified because of the bigger

security or the earlier over-guaranteed regulations. The user will rarely need these functions, the program provides forms of data input to realize them. Indication of the data of the weekly production plan is used in a weekly frequency in the program which can be done by means of a form.

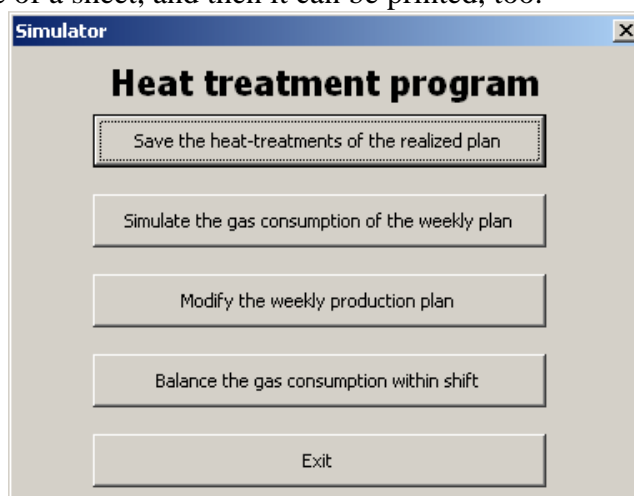
Due to the applied technique of attachment, data manipulations done in Access forms are stored on Excel sheets, so they can be used directly in Excel.

Data of the plan should be checked. The submenu „Check” guarantees these functions. The first one examines if the plan contains a mistake in case of which more products would arrive at one production belt at the same time (in the same shift). The list of products bumping on the production belts are provided by a query available on the Access surface which is shown by the program as the view print preview by means of a report. Since the table stores, among the product data, which production belt it can be made on, this result can be obtained without simulation.

The other checking function examines if the heat-treatments can be done in time. We can get the printable report without simulation, since the number of the necessary autoclaves can be calculated from the time spans of heat-treatment stored in tables. If the demand of any shifts exceeded the capacity, the plan should be modified. For this, the list shows when the capacity is unemployed in the suitable measure and then we can move the product here with the form which modifies the plan.

Having the checked plan the Excel spreadsheet takes over the work from the Access database manager to do the other tasks. It is the main menu shown in *Figure 3*. which helps us reach the functions that should be performed in the order of appearance with weekly frequency.

First, we can save heat-treatments of the realized weekly plan, then we can simulate gas consumption of the plan for the following week. Then, the program generates heat-treatment data necessary for the input of the simulator, and makes the calculated data for gas consumption broken down in shifts appear on a diagram. Data generation is done with a VBA (Visual Basic for Applications) operation, while the program switch on the adequate sheet to make the diagram appear. The task of this function is to point out if it is necessary to modify the plan, provided gas consumption of each shift shows a big deviation. The manual data modification can be accomplished with a form made for data input, but plan modification can be done automatically, too, in case of which a VBA operation rearranges the products of the plan within shifts. Modification can be followed by the user in a table of a sheet, and then it can be printed, too.



**Figure 3. The main menu of Excel**

The last function of the program guarantees that gas consumption within the given shift will be even, evolving the appropriate schedule by delaying the heat-treatment of the products. It is done by a VBA algorithm, together with the simulator, which in every shift of the production week tries to find the value variation of delay of heat-treatments which causes the gas consumption of the lowest standard deviation thus securing the even boiler-load and avoidance of high gas consumption peaks. In this function the maximum waiting time appears as a restriction since it cannot be exceeded to avoid spoilage of canned food. As a final result we can get the optimal value variation of the waiting time for the heat-treatment which then gives the recommended time to start heat-treatments.

Apart from the initial setting functions, the program should be used in a weekly frequency and by storing the data of the accomplished heat-treatments, it makes their registration possible. This registration is compulsory for the company but the stored data can provide an excellent basis for an informational system, too. In our database statements can be made with queries from different points of view, and our data can be displayed even in diagrams. We can easily observe changes, tendencies and seasonalities in the production profile. These functions can be formed in „Information” submenu. Thus, for example, we can have a statement on the weekly summary of production, a diagram of the changes in the produced amount of a certain product per week, production of a selected week per product etc.

## CONCLUSIONS

For the software developed for simulation, optimization and scheduling the Excel can be applied, in a user-friendly way, to store, process the data and to represent them in diagrams, to fulfill programming tasks, while the Access to feed data into the computer with forms and to form queries and reports. The developed computer system guarantees an easy possibility for data input and modification, to check product piling on the production belt, to avoid the long waiting lines for the heat-treatment by checking the autoclave capacity, to balance the gas consumption of the shifts and to prevent the gas consumption peaks.

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