COST OPTIMIZING OF AUTOCLAVING IN EXCEL ENVIRONMENT

Z. Fabulya
University of Szeged, Faculty of Engineering

ABSTRACT

The heat treatment is the most significant regarding the energy demands of an enterprise. A heat treating cycle can be divided into three phases: heating up (with steam), holding (with steam), chilling (with water). When operating more autoclave simultaneously certain phases of the process can overlap thus the steam and water demand can develop with big fluctuation. Hence it is practical to coordinate the operation. To create the decision support system in Microsoft Excel environment, the database needed for the model has to be developed, a user friendly interface and the Visual Basic for Application software providing the timing and simulation has to be created.

1. INTRODUCTION

There are many food industry enterprises in Hungary requiring heat treating of cans, which will be subject to stiffer competition than at present due to joining the European Union. It is crucial for these enterprises to produce good quality products while optimizing the costs. One of the factors determining the quality of the cans and primarily the meat cans is the heat treatment; the process, which is the most significant, regarding the energy demands of an enterprise, so its economic aspects cannot be disregarded.

Enterprises using intermittent-duty autoclave groups for heat treating energy demand can develop with big fluctuations, which raise the costs and worsen the quality of the product. Hence, coordinating and timing the simultaneous operations is necessary.

Many publications have appeared on this subject studiing modelling of heat treating [1-6], but non of them have studied with autoclave groups.

Our purpose is to choose from the timings providing smooth water consumption where the steam demand results in lowest cost. To create the decision support system in Microsoft Excel environment, we have to develop the database needed for the model and we have to create a user-friendly interface and the Visual Basic for Application software providing the timing and the simulation.

2. MATERIALS AND METHODS

Energy modelling

We need the data to write down the two opposite sides, the demand and the capacity for the modelling. First we examine our system from the viewpoint of energy demand.

Energy demand data of the heat treatment

A heat treating cycle can be divided into three phases: heating up, holding, chilling. Steam is used typically to achieve the necessary temperature and water is used for chilling. Fig.1 shows the momentary run of steam and chilling water requirements as a function of time when heat treating a product.

Demand of resources develop in the beginning of the heat up and in the chilling phases with maximum intensity while there is virtually no steam consumption during the heat holding since only the heat loss has to be compensated.

There are different regulations on temperatures and time of heat holding for each product so the duration of the heat treatment depends on the product. Still the character of the energy demands in function of time is the same as can be seen on fig.2. This sameness does not only exist in case of different products but also in the case of steam and water utilization.

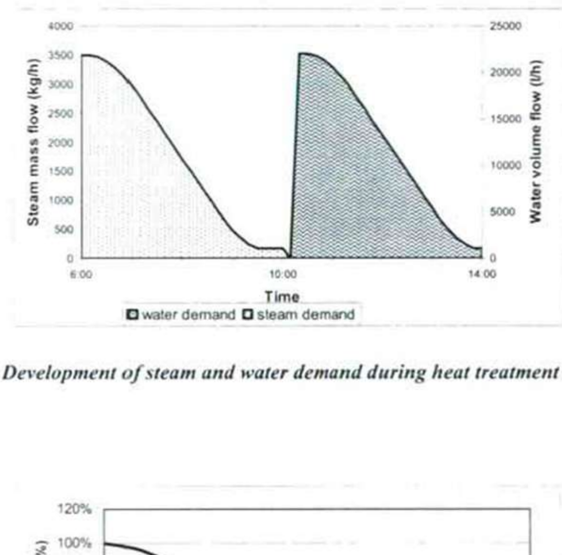

Figure 1 - Development of steam and water demand during heat treatment of a product

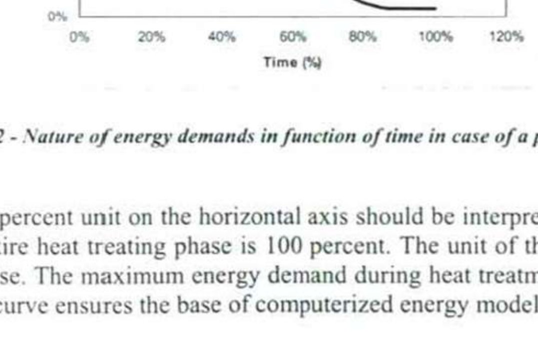

Figure 2 - Nature of energy demands in function of time in case of a product

The time in percent unit on the horizontal axis should be interpreted as the run time of the heat. The entire heat treating phase is 100 percent. The unit of the vertical axis can be explained likewise. The maximum energy demand during heat treatment is 100 percent. This characteristic curve ensures the base of computerized energy modelling of the heat treatment with autoclave groups. If we know the duration of the heating and the heat holding, and we also know the initial i.e. the maximum energy demands in the case of every product, then by transposing the characteristic curve we have the supply side data to model the heat treating of the products.

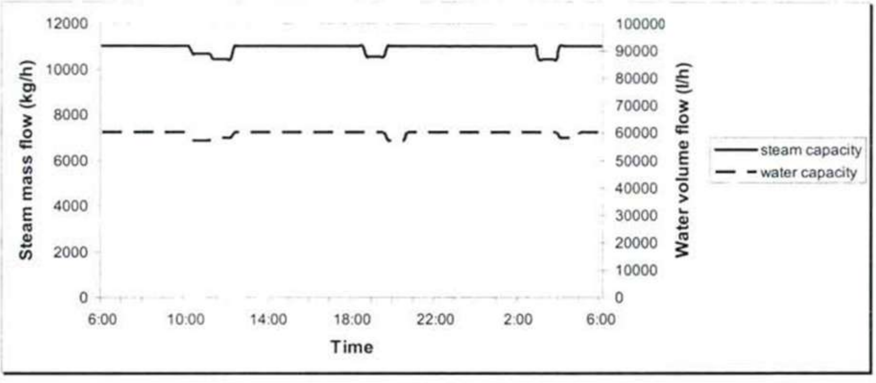

Figure 3 - Development of steam and water capacity

Modelling heating steam and chilling water capacity

The data of the capacity that can be provided for the heat treating plant of the company can be acquired by measurements. A universal characteristic curve suitable for all enterprises cannot be defined. These data cannot be accounted constant in time because of many reasons. On the one hand there can be divergence depending on the season in an enterprise too. On the other hand there can be periodical capacity variations in a day. Therefore it is practical to collect data for several days in different seasons and then recognise the regularities in the interest of modelling. For example we can get similar curves (as can be seen in fig.3) about capacity data that can be presented to the heat treating plant.

Excel and Visual Basic for Application

Excel spreadsheet provides an excellent customizable possibility to store the data of the model in a structured form. A user friendly interface can be created with custom menus and forms to manage the data. The pages containing the partial results of the calculations can be hidden from the user and the effect of the change of the model parameters modified by controls on the forms can be shown on diagrams. Menu and toolbar controlled functions and methods can be created.

3. RESULTS

Realization of timing

We made a spreadsheet to model the heat treatment energy and the timing. The spreadsheet stores:

- the data of the energy demand characteristic curve,
- the data of the product for the timing:
    - *product identifier*
    - name
    - heating time
    - heat holding time
    - chilling time
    - maximum steam mass flow demand
    - maximum water volume flow demand
    - maximum waiting time
- the data of the products to be heat treated on the current day (tomorrow)
    - *number*
    - product identifier
    - earliest time to begin heat treatment
    - wait time of the beginning of heat treatment
    - yet can be scheduled (yes/no)
- a calculating table to define the development of the sum of the steam and water demand of the products to be heat treated on the current day and respectively to sum the capacity exceeded by these
- Visual Basic methods for timing
- a diagram of steam and water consumption (fig.4)
- a customized menu to control the execution of the methods
- forms for servicing data (fig.5), for manual and automatic timing

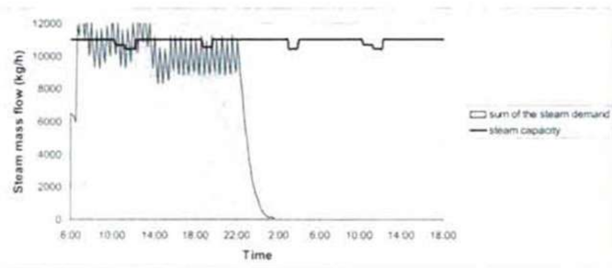

Figure 4 - Development of daily steam consumption

The menu supporting the timing tasks appear instead of the conventional Excel menu when the spreadsheet is opened. The spreadsheet contains the steam and water consumption diagram (fig.4) and the data stored in the spreadsheet the day before.

The event control programming technique of Visual Basic for Application ensures that when an event (opening a sheet, clicking a menu or command button) occurs a programme item or method is executed.

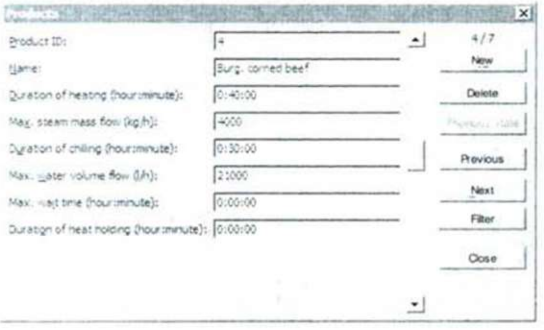

Figure 5 - Form of product data servicing

The menu structure of the programme

- File
  - New timing
  - Open
  - Save
  - Save as
  - Print preview
  - Print
  - Exit
- Data
  - Product general data
  - Products to be heat treated
- Timing
  - Manual
  - Automatic
- Help
  - How to use
  - About

When executing the "New timing" command, the programme deletes the stored product list and brings over the energy demands stretching over to the next day to give the base of the new daily data.

So the programme does not only calculate and stores the data in the period of 6:00 to 6:00 in 10 minutes detail but from 6:00 to 18:00. Thus it ensures the possibility of run in three shifts (as can be seen on fig.4).

Printing prints the product list in the order of timing.

The wait time of a product on the product list to be treated can be paced with an arrow with 10 minute steps on a form when manual setting is used. The impact of the pacing on the development of the steam and water consumption can be followed graphically on the diagrams.

The record pacer ensures the movement in the product list and the effects of pacing refreshes the index number of water and steam consumption for timing comparison.

The principles of automatic timing

When modelling the energy data, the summary of momentary energy demands of an all-day (usually the next day) is available in 10 minutes resolution. It is not worthy to work with higher resolution because the arrival of the produced cans to the heat treating plant can be counted with this inaccuracy. The limit of the timing resulting from the food safety is the maximum waiting time to begin the heat treatment. All timing – not exceeding the maximum waiting time – is optimal where the energy demand does not exceed the limit resulting from the steam and water capacity during the day, if there is a timing at all. There are two index numbers calculated in every case which can be used to compare the timings. These can be defined by the simple addition of the steam and water capacity overrun. Thus the two timings can be compared. Comparing a newer timing to an earlier one is questionable when the value of one of the indexes has decreased while the other one have increased. To give an answer in such cases the two indexes with different units should be formed to one data. This would be possible if the surplus demand of resources over the capacities could be expressed in monetary value so they could be totalled. In the case of steam utilisation this can be done if the enterprise can supply its shortage from an external steam provider but this is not viable in the case of water utilisation. If the water demand is over the capacity, the adequate speed of chilling cannot be guarantied, thus the product is exposed to more heat strain which worsens the quality of the product. So the optimum criterion of the product's quality is the smooth water consumption.

Our purpose is to choose from the timings providing smooth water consumption where the steam demand results in lowest cost so the best available product quality can be guarantied.

For the sake of completeness it should be noted that this is the simplest manageable model and as such there are several factors that are not taken into account. Our model does not calculate on the effects which come forward when the demands over the capacities cannot be covered even in case of the best timing. In this case the duration of the heat treating phases increase which is disregarded by our simple model.

The software technology based on generic dual layer network model developed to map process models on computers provides the adequate background to plan this economic process based on simulation and to realize the timing.

4. DISCUSSIONS AND CONCLUSIONS

When operating more autoclave simultaneously certain phases of the process can overlap thus the steam and water demand can develop with big fluctuation. The availability of these resources is limited or they are accessible by extra costs. Hence it is practical to coordinate the operation of the different autoclaves in the interest of thrift.

We have developed a decision support system in Microsoft Excel environment and the database needed for the model. We have also created a user friendly interface and the Visual Basic for Application software providing the timing and simulation.

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