

## **DETERMINATION OF THE AVERAGE PRESCRIBED VALUES OF THE PARAMETERS FOR MAINTAINING A CONSTANT AUTOCLAVING TEMPERATURE OF THE AAC**

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**Abstract:** A designing methodology is presented for a system that tracks the temperature chart of the ACC's autoclaving process. The computer management of the control and monitoring process offers a solution to the qualitative requirements that need to be fulfilled by building materials in the context of the current competition in the building materials market. The main purpose of a computer management system is to allow the active control over the ACC production medium, thus increasing the efficiency and profitability of the enterprise. Reaching this purpose is based both on the architecture of the production management system and on its vision of the administrative medium of the enterprise in terms of saving significant energetic resources and of increasing the performance and quality of products.

**Key words:** building material; temperature; autoclave; pressure; database

### **1. GENERAL PRESENTATION**

The Autoclaved Aerated Concrete (AAC) is a light prefabricated material, good thermal and phonic insulator and also resistant to fire and mold. Used in constructions, the AAC is produced in blocks and wall panels, both for interior and exterior use, being lightweight and easy to polish and cut and having a reduced impact on the environment. This concrete is obtained from a mixture of sand, cement, gypsum, water and an expansion agent, which offers it a porous structure. After the first stage of fabrication, the AAC is subjected to a thermal treatment in an autoclave, at high pressure and temperature.

### **2. DESCRIPTION OF THE WORKING PROCESS THAT HAPPENS INSIDE THE AUTOCLAVE**

The autoclave, which has a big volume, must have constant temperature and

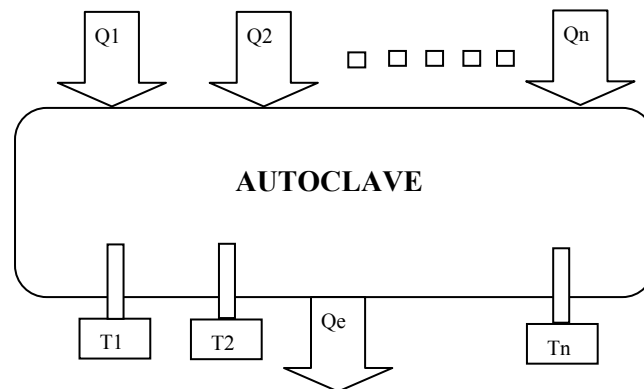
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pressure inside it in order to have an autoclaving process that evolves in good conditions. For this to happen, a series of pipes through which the pressurized steam circulates are placed inside. Moreover, temperature transducers are placed inside the autoclave, in different locations, and they transmit information to an acquisition board that is attached to a computer. This information is processed and saved in the tables of an Oracle database. The decisions that are made after comparing the values that were read from the installation with those that were read from the database are transformed into decisions of increasing or decreasing the temperature in various points of the autoclave and these decisions are saved in the database. Figure 1 shows the scheme of this technological process.

Inside the autoclave, the processes that harden the ACC happen at a temperature that is in accord with the technological process and also at a pressure that corresponds to this temperature. The power valves are placed in the superior part of the autoclave, whereas the evacuation ones are placed in the inferior part, as shown in figure 1.



**Fig. 1.** The scheme of the technological process

### 3. THE LOGICAL OPERATING SCHEME OF THE AUTOCLAVE

In order to ensure the right development of the autoclaving process, which allows following a uniform regime, the command of the steam supply is done through the steam distribution installation. The steam distribution installation has temperature transducers which transmit the parameters that the process needs to comply with, basically the steam flow and pressure which enter the autoclave. Figure 2 presents the logical operating scheme of the autoclave.

Many industrial processes are characterized by having multiple inputs that generate multiple outputs, with strong connections between variables, this being the case of the ACC autoclaving too. The process inputs are the fluids' flows  $Q_1, \dots, Q_n$ , which generate different temperatures  $T_1, \dots, T_n$ . Inside the autoclave, the interactions between the different temperatures of the ACC blocks and the steam's temperature create differences. Thus, the difference between the real temperature that is found

inside the autoclave and the temperature that should exist according to the temperature chart (ideal temperature), is denoted  $\varepsilon$  and has to be as low as possible, close to zero. These temperatures are measured by temperature transducers and are transmitted to the process computer, which will analyze the values and execute the commands in order to maintain the autoclaving temperature. The managing program of the technological process has a module that establishes the connection with the database and helps writing the temperatures in the database in the table temperature and the pressures in the table pressure.

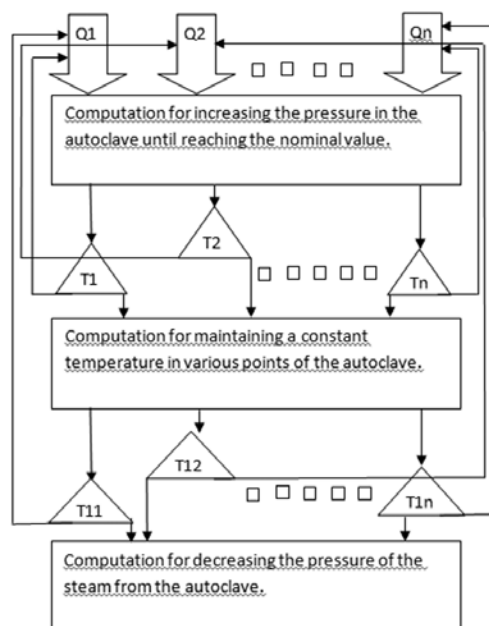


Fig. 2. The logical operating scheme of the autoclave.

Depending on the result of the comparison between the values that were read from the installation and the values from the table *temperatura\_presiune*, commands of increasing or decreasing the pressure of the access steam and of modifying the position of the evacuation valves of the steam are sent at various intervals to the steam valve from the installation. These values are written in the database, in the table named *corectie*.

#### 4. THE PRESSURE-TIME OPERATING DIAGRAM OF THE AUTOCLAVE

The aerated concrete autoclaving stage is one of the most important operations of the technological process. For hardening the mass of aerated concrete, which presents itself as a fragile porous structure after expansion, the following operations will be performed: the gradual heating of the mass until the temperature that is

stipulated by the technological process's parameters is reached, the autoclaving of the mass at a constant pressure and also at a constant temperature, the gradual evacuation of the steam from the autoclave. The AAC mass that is introduced in the autoclave is sensitive to the sudden changes in temperature and pressure and therefore the autoclaving diagram must be followed. The autoclaving process consists in the following stages: heating the AAC mass with steam, maintaining a constant pressure, decreasing the pressure and evacuating the steam from the autoclave according to the chart from figure 3. During the production process, deviations appear in the autoclaving chart because of disturbing factors. These deviations need to be corrected through the process of tracking and correcting the steam's pressure, like it is shown in figure 3.

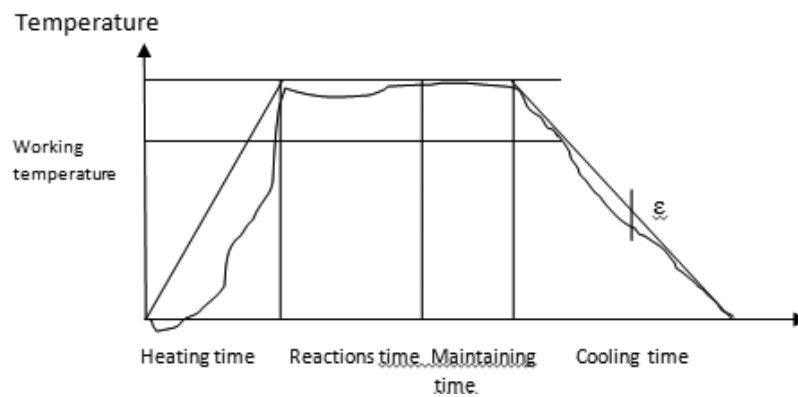


Fig. 3. The pressure-time diagram of the autoclave

## 5. THE STRUCTURE OF THE DATABASE

The database's structure is presented in figure 4 and is composed of the following tables:

1. **Temperatura** - with the fields: *temperatura\_id*, *data*, *ora*, *valoare*, *tructor* and *sarja*. These values are read from the installation and are written in the database.
2. **Presiune** - with the fields: *presiunea\_id* and *data*, *ora*, *valoare*, *tructor* and *sarja*. These values are read from the installation and are written in the database.
3. **Corectie** – with the fields: *corectie\_id*, *presiune*, *data*, *ora*, *valoare*, *sarja*, which are compared with the values from the tables *temperatura* and *presiune*.
4. **Sarja** – in this table with the fields *sarja\_id*, *data* and *ora* the *number*, *date* and *hour* of an autoclaving charge are written.
5. **Temperatura\_presiune** – with the fields: *timp*, *temperature*, *presiune*, *epsilon* – these are values of the steam's pressure, which will modify the values of the temperature according to the epsilon error.

6. **Debit** – with the fields: *debit\_id*, *timp*, *valoare*, *data*, *sarja* – are values that are kept in the database as a chart of the autoclaving process’s functioning.

The evolution of the technological process is done according to the diagram that is presented in figure 3. Thus, after a time interval, the temperature and pressure from the autoclave are read, the temperature and pressure values from the *temperatura\_presiune* table are compared with the two variables and depending on the resulting values the Epsilon value is applied, from the *temperatura\_presiune* table, to each valve, like it is shown in figure 5. The values of each temperature and pressure transducer and also the corrected values are written in tables that are dedicated to each regulating loop.

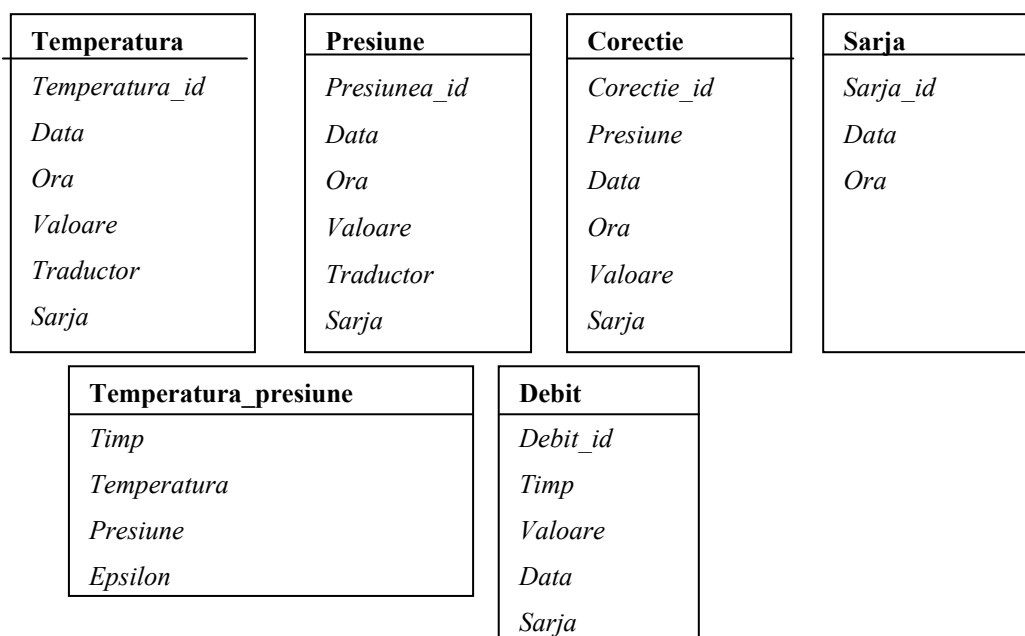


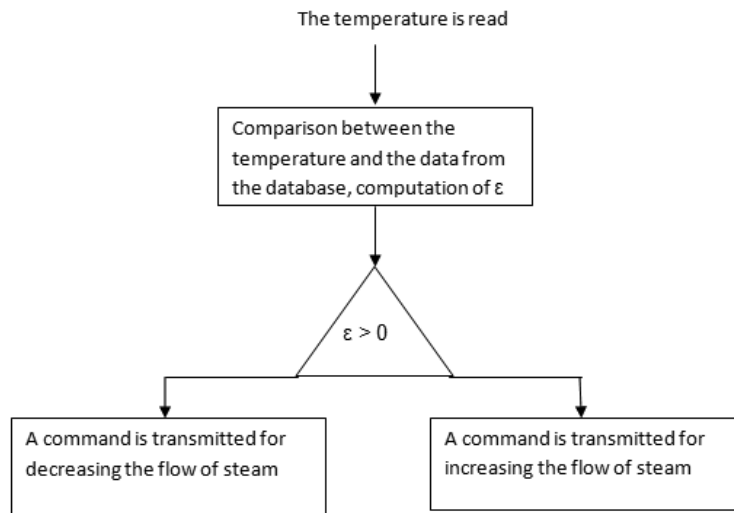
Fig. 4. The database’s structure

The connection with the database is established at the beginning of the technological process and remains stable throughout the entire process, conveying data that is used in making decisions regarding the parameters that need to be followed.

### 6. TEMPERATURE ADJUSTMENT

At first, the value temperature/pressure is read from the database, from the table *temperatura\_presiune*. This pair of values is then compared with the temperature and pressure that were read by the installation’s transducers. If the value of the difference between the temperature that was read from the installation *\$temperatura\_instalatie* and the temperature that was read from the table

*temperatura\_presiune* is  $\varepsilon > 0$  ( $\text{temperatura\_presiune} - \text{Stemperatura\_instalatie} = \varepsilon$ ), a signal that is proportional with the difference  $\varepsilon$  is transmitted to the admission valve for overheated steam, with the intention of increasing the flow of steam and thus the pressure. The value of the flow, transmitted to the execution element, is written in the database in the table named *debit*. Afterwards, at the time interval *timp\_intermediar*, which is proportional with the size of the autoclave, the value of the temperature is read again and the cycle is restarted, in this way obtaining temperature values that are close to those from the table *temperatura\_presiune*, values that follow the temperature chart from figure 3. If the values are the same, the value of the temperature is read for the next time interval and so on. The logical scheme is presented in figure 5.



**Fig.5.** The logical scheme of adjusting the temperature

The chart of temperature variation in the autoclave according to time:  $\text{Temperature} = f(t)$ , which has the form of ascending, constant and descending segments. During the time interval *Heating time*, the valves are open according to time and the error is read from the installation and during the interval *Reactions time* the valves need to be adjusted, making sure that the value that corresponds to the temperature of reactions' evolution is constant. In the time interval *Maintaining time*, the valves are maintained in the same position and after that the time interval *Cooling time* follows, when the valves are closed. Because of the thermal inertia, a temperature increase is observed after closing the valves and a temperature decrease after opening them.

## 7. THE ACCESS TO THE DATABASE AND THE DIALOGUE WITH THE DATABASE

The functions that are needed for the connection with the database mysql (or

Oracle, as it is similar) are declared using the instructions from the programming language Visual Basic, which are presented below. The connection remains open throughout the execution of the program. The connection is made with the username *root* and the password *root*.

```
Public ConexiuneaDB As ADODB.Connection
Public Function ConectareLaBazaDeDate() As Boolean
ConectareLaBazaDeDate = False
On Error GoTo EroareInitDataBase
Set ConexiuneaDB = New ADODB.Connection
ConexiuneaDB.CursorLocation = adUseClient
ConexiuneaDB.ConnectionString = _
"DRIVER={MySQL ODBC 3.51 Driver}; " & _
"SERVER=" & CFG.IPserverDB & "; " & _
"DATABASE=mysql; " & _
"UID=root; " & _
"PASSWORD=root; "
In case some errors appear, they are reported in the following way:
On Error GoTo EroareConectareLaBazaDeDate
'MsgBox ConexiuneaDB.ConnectionString
ConexiuneaDB.Open
s = _
"Server=" & CFG.IPserverDB & "" & vbCrLf & _
"UserName=" & CFG.UserName & "" & vbCrLf & _
"Conectare reusita. "
Call AppendFisierLOG(s)
ConectareLaBazaDeDate = True
Exit Function
EroareConectareLaBazaDeDate:
EroareInitDataBase:
End Function
The connection with the address of the database is done with the instruction:
If CFG.IPserverDB <> "localhost" And CFG.IPserverDB <> "127.0.0.1" Then Exit
Sub
'Creating the database AAC with the instructions:
Call ExecutaComandaSQL("CREATE DATABASE IF NOT EXISTS  BCA ;")
' Creating the table debit in the database AAC
s = "CREATE TABLE IF NOT EXISTS  bca.debit (" & _
" TIMP          VARCHAR(" & LG_TIMP & ") NULL, " & _
" DATA          VARCHAR(" & LG_DATA & ") NOT NULL, " & _
" SARJA          VARCHAR(" & LG_SARJA & ") NULL, " & _
" VALOARE          VARCHAR(" & LG_VALOARE & ") NULL, " & _
s = s & "); "
```

'MsgBox s  
Call ExecutaComandaSQL(s)

All these commands are written in the language of managing the autoclaving technological process. The next step is to configure the ODBC. The access to the database can be done through a web browser too.

## 8. CONCLUSIONS

The strategy of managing the autoclaving process needs to be established in order to ensure some objectives transposed by values of the technological parameters. Thus, the computer management must ensure the proposed objectives at the production management level. The program that is designed in Visual Basic using the Oracle database executes and processes the commands that are received from the execution elements through the acquisition boards.

The operation of the automatic managing system in case of the industrial process is dictated by a series of algorithms for processing the initial information with the intention of reducing the deviation from the real values of the process's parameters from the values that they are expected to have under some time, costs and other types of restrictions. These restrictions are imposed by the supervising system or by the medium requirements imposed during operation. The presence in this structure of the inverse reaction received from the process transducers ensures that the managing system is informed of the deviations in operation, deviations that are caused by perturbations that act randomly or by not following some commands, caused by an incorrect functioning of some elements or process equipment.

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