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# CONTROL OF THE DISTRIBUTING ELEMENTS PROVIDED ELECTRIC HEATING SYSTEM

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*Abstract* – **The system is used for many years for heating a margarina warehouse having a capacity of 1500 m$^3$, DUNA 2000 subsystems are used, having very small overall size (10x12x12 cm$^3$), in order to provide a temperature of 6 - 9$^0$C.**

***Keywords***: *control, heating system.*

## 1. INTRODUCTION

Electric heating has several important advantages against other heating solutions for warehouses, high capacity industrial areas; one of them may be a flexible control and monitoring of the energy consumption and of the operating condition.

## 2. PREPARATION OF PAPERS

The system (fig.1) consists of many subsystems distributed in the capacity that must be heated [5]. Each subsystem (fig.2) consists of one heating element with positive temperature coefficient, a fan driven by an electric motor, an alternative voltage variator and a temperature transducer.

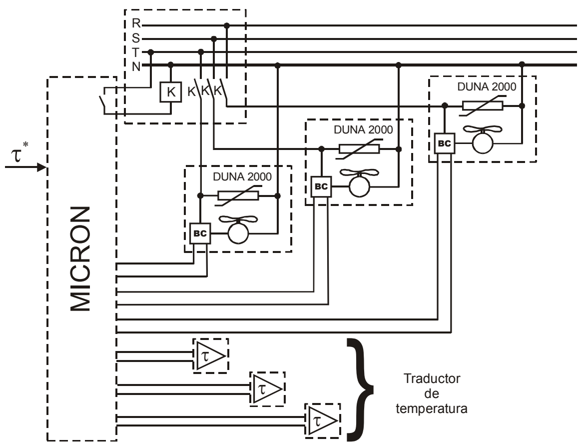


Figure 1: Heating system structure

K- contactor for coupling to the electric network;
BC – control block for the fan motor speed;
MICRON – programmable device ;
$\tau^*$ -settled temperature for the heated capacity;
$\tau$- temperature in the controlled area.

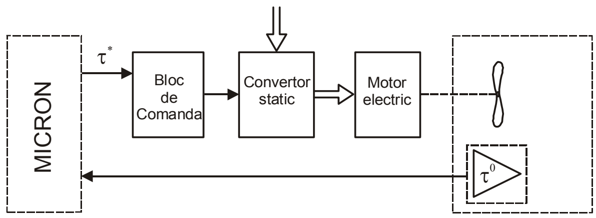


Figure 2: Heating subsystem structure

The heating element electric power can be adjusted between 800 - 2000 W by changing of the air flow, moved by the fan at values of 20 - 150 m$^3$/h (fig.3).

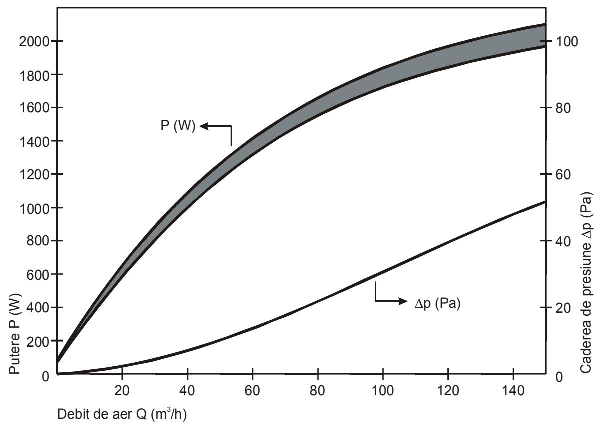


Figure 3: Heating element static characteristic

This change is carried out by adjusting the motor rotative speed of the fan motor, by means of the static converter, in fact an alternative voltage variator [2], [7] that changes the middle value of the motor supply voltage. Therefore, the high value electrci heating powere (2 kW) can be directly adjusted by the control of the 50 W motor, which actuates the fan [3].
The control of the motor rotative speed is provided in a centralised manner (fig.1) through a microcontroller architecture MICRON [1], [4] depending on the measured temperature in the area where the heating element is located. MICRON device (fig 4) provides also other functions such as electrical connecting /disconnecting of the heating elements, monitoring of the operating time and of each DUNA 2000 subsystem condition.

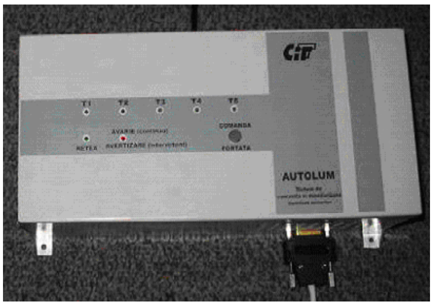


Figure 4: MICRON device in AUTOLUM application

## 3.THE CONTROL ALGHORITME

### 3.1. Actuating system control alghoritm (fig.5).

The MICRON programmable device mesures the temperature in each zone and compares it with the imposed temperature. Depending on the result, increase or decrease of the fan speed, namely increase or decrease of the dissipated of each heating element.

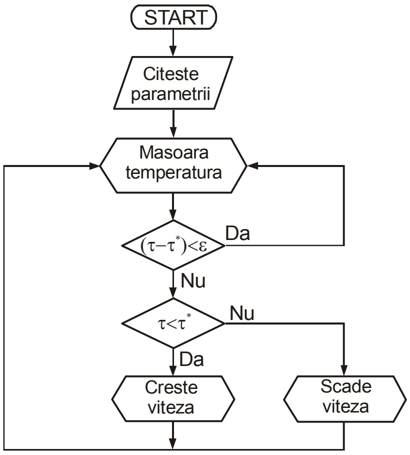


Figure 5: Logical diagram of the fan control.

### 3.2. Control alghoritm of the alternative voltage.

Adjustment of the motor supply voltage is carried out through an original diagram [3] (fig.6).

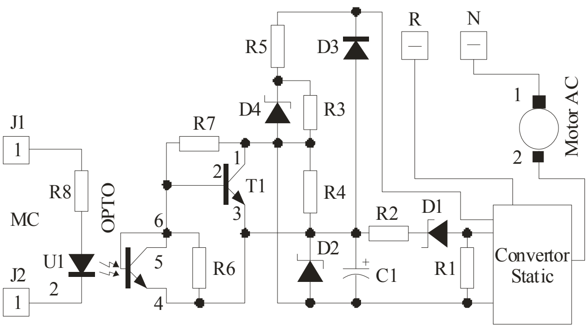


Figure 6: Electric diagram of the operation system

The programmable device MICRON provides a train of pulses with a variable filling factor, depending on the desired temperature (fig. 7).

$$FU\% = \frac{t_1}{t_1 + t_2}.100$$

where :

- $t_1$ - the time when the control signal has the value “1”;
- $t_2$ - the period when the control signal has the value “0”;

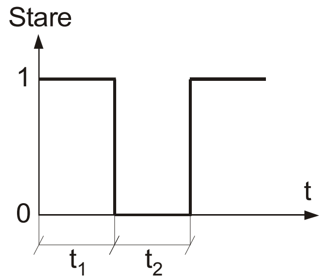


Figure 7: Control signal shape.

OPTO (Optic-fibercoupling element) provides the galvanic separation between the programmable device MICRON and the system power side and the group R3, R5, R6, R8 şi T1 transforms the pulses train in the current for charging of the capacitor C2. So, the capacitor charging time, respectively the delay angle of the alternative voltage variator control depends on the pulses train filling factor α.

The control programul de comandă has two parts: one for the fan control elaboration depending on the imposed de temperature and another one that provides the properly control of the fan. Taking into account the necessity of providing the control in real time and the time constancy of the processand for have a low price of the product, a microcontroller is used [6] with 24 MHz frequency that generates 8 signals at a frequency of 3,3 kHz and a variable filling factor (fig. 8) in 10 steps.

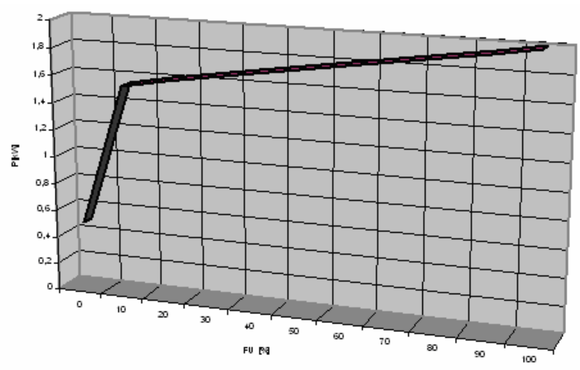

Figure 8: Dependence between the dissipated power and the control signal filling factor

## 4. RESULTS

The system is used for many years for heating a margarina warehouse having a capacity of 1500 $m^{3,}$ DUNA 2000 subsystems are used, having very small overall size (10x12x12 $cm^3$) (fig.9), in order to provide a temperature of 6 - $9^0C$ if the external temperature decrease until - $15^0C$; the operating temperature must be provided in 2 hours starting from $-15^0C$. It can be see that (fig.10) in the first operating cycle (lasting 2 hours) all heating sources stay connected, releasing the maximum power, then, it happens decreasing or increasing of the released power at shorter periods, depending on the real temperature inside the warehouse.

Figure 9: DUNA 2000 subsystem overview

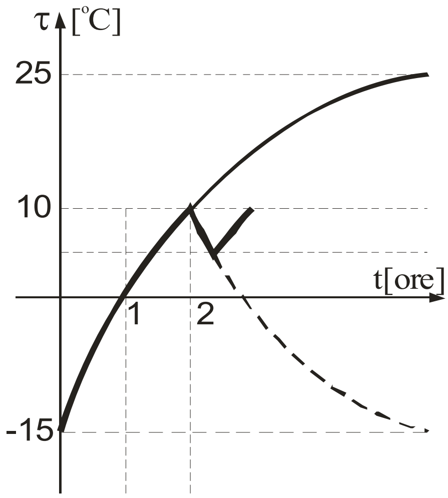


Figure 10: Temperature increasing in the first operation cycle.

It can be seen (fig.11) that the signals at the device output have a rectangular shape, almost identical with the theoretical shape shown in fig.7, the signal frequency is kept (3 div x300μs, namely 3,3 kHz), and the signal factor changes in the range 0,07..0,5..0,9.

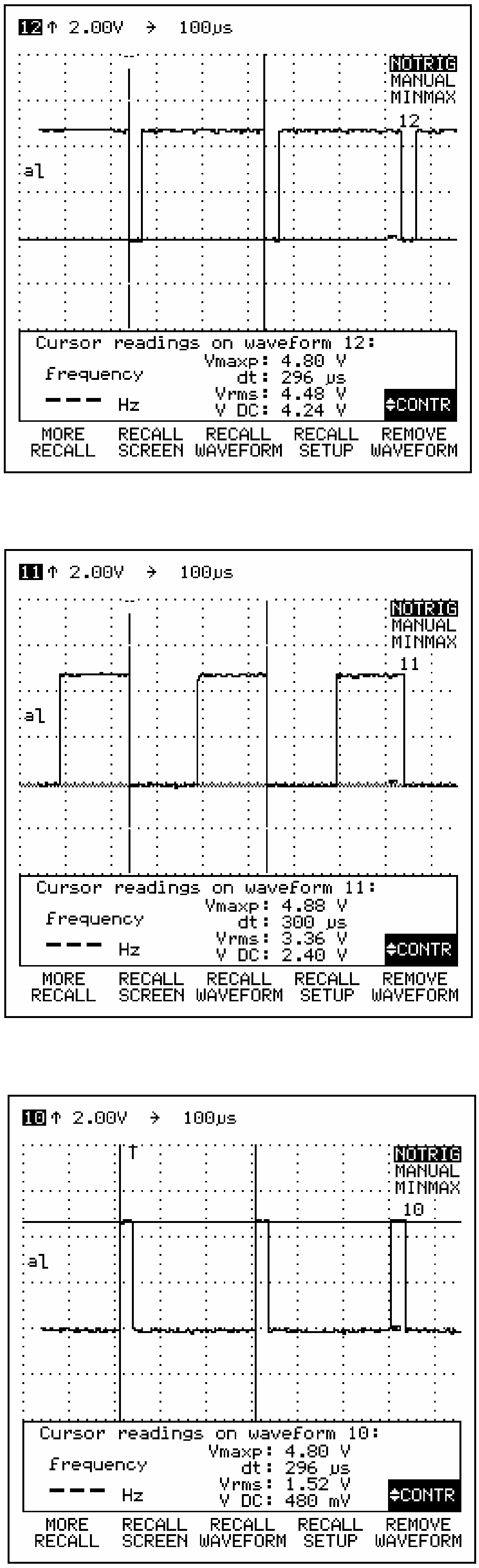


Figure 11: Shape of the control signals at the device output

In figure 12 it also observes, that the middle value of the motor voltage is 96 V, 168V and 200 V as we can see on the text written automatically on the apparatus which made the oscilographies.

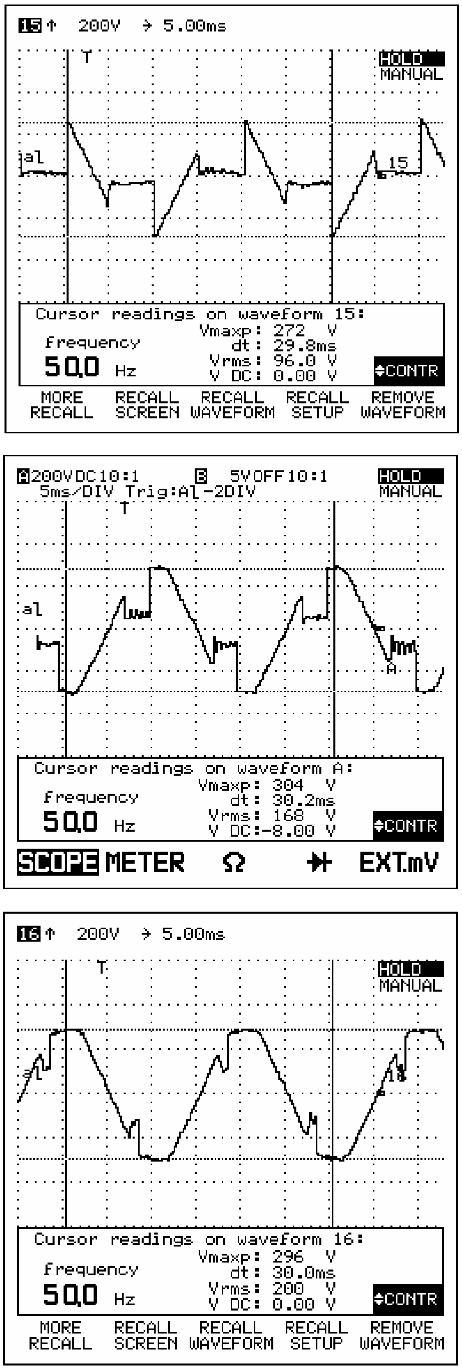


Figure 12: The shape of the motor supply voltage

These results and the system good operation confirm that the proposed solution is useful for the particular applications designated in the paper introduction

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