A Computational Technique used for the Designing-Checking-Optimization of a Wine Plant Functioning

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Abstract: The scope of the present paper is to present an automatization mode of a wine plant computation, using on this purpose the computation technique, respectivelly, the computer-assisted command automatization of the functioning process of the wine plant. So, in the first part of the paper, starting from the computation mathematical apparatus of the wine plant technological parameters, an application has been realised using Visual C++ 6.0 software for the computation and optimization of wine plant technological parameters. In the second part of the present paper, using two interfaces (a hardware interface and a software one), it has been realised an application of autmatization of wine production when four identical wine plants are computer-controlled and commanded, the scope of the application being the correlation of parallel functioning of these ones.

Key-Words: designing-checking-optimization, wine plant functioning, automatization application

1 Introduction

The wine production relays on the phenomena characteristics to fermenting-soaking process of the wine pressing that gets into contact to the mare, these phenomena are based on the colouring agents properties of dissolving-under some circumstances-within the wine pressing that increases the alcohol content [1].

The wine plant has as a main component the wine kit, an horizontal container divided into four distinctive compartments, having equal contents by volume, closed to both ends by two ellipsolidal covers. It has a large utility in the wine productions, being used both for a certain production line and as a self sustaining. This equipment is used for the primar wine production of red and black grapes in order to extract the flavour and colour out of the gapes and, further on, for stabilizing these two components into the wine pressing.

2 The computation of the specific parameters of the wine kit [2]

The specific parameters of the wine kit are: container volume: V = 184 [m^3]; inner diameter: D_i = 3800 [mm]; cylindrical part lenght: L = 15000 [mm]; kit gauge (L x l x h):17450 x 4000 x 5700; kit net mass; container mass when full of liquid.

The designing thicknesses computation of the wine kit has been done by the help of a computation programme in Visual C++ 6.0 software [3] (Fig. 1).

2.1. Volumes'computation

$$V = V_{cil} + 2V_{cap}$$

where:

V_{cil} = volume of cylindrical part [m^3];
V_{cap} = volume of a semi-ellipsoidal cover [m^3].

$$V_{cil} = \frac{\pi \cdot D_i^2}{4} \cdot L = 170{,}117 \left[m^3\right] \Rightarrow 2V_{cap} = V - V_{cil} \Rightarrow \tag{1}$$
$$\Rightarrow V_{cap} = \frac{V - V_{cil}}{2} = 6{,}941\left[m^3\right]$$

$$\begin{cases} \mathbf{V_{cil} = 170{,}117\left[m^3\right]} \\ \mathbf{V_{cap} = 6{,}941\left[m^3\right]} \end{cases} \tag{2}$$

2.2. Designing thicknesses computation of container elements

a. designing thickness of cylindrical element submitted to inner pressure:

$$S_{p_1} = \frac{p_c \cdot D_i}{2 \cdot \sigma_a \cdot z - p_c} + C_1 + C_{r_1}, \tag{3}$$

where:

p_c – computation pressure;
D_i – element's inner diameter;
σ_a – admisible stress;
z – welded point strength coefficient;
C_1 – admixture for plan condition;

C_{r1} – admixture for roundness.

$$p_c = p_n = \rho_l \cdot g \cdot H = 0{,}043 \text{ [MPa]}, \quad (4)$$

where:

p_h – hydrostatical pressure;
ρ_l – working medium density;
g – gravity acceleration.

b. designing thickness of ellipsoidal ends submitted to inner pressure:

$$S_{p_2} = \frac{p_c \cdot R}{2 \cdot \sigma_a \cdot z - p_c} + C_1 + C_{r_1}, \quad (5)$$

where:

R – radius of curvature at the centre of ellipted bottom;

$$R = \frac{D^2}{4H} = \frac{3800^2}{4 \cdot 950} = 3800 \, [\text{mm}], \quad (6)$$

where:

$$H = 0{,}25 \cdot D = 950 \text{ [mm]},$$

where:

$$R = D_i \Rightarrow S_{p2} = S_{p1} = 6 \text{ [mm]}$$

c. designing thickness of dividing walls:

$$\sigma_{max} = \frac{0{,}75 \cdot p_c \cdot b^2}{h^2 (1 + 1{,}61\alpha^3)}, \quad (7)$$

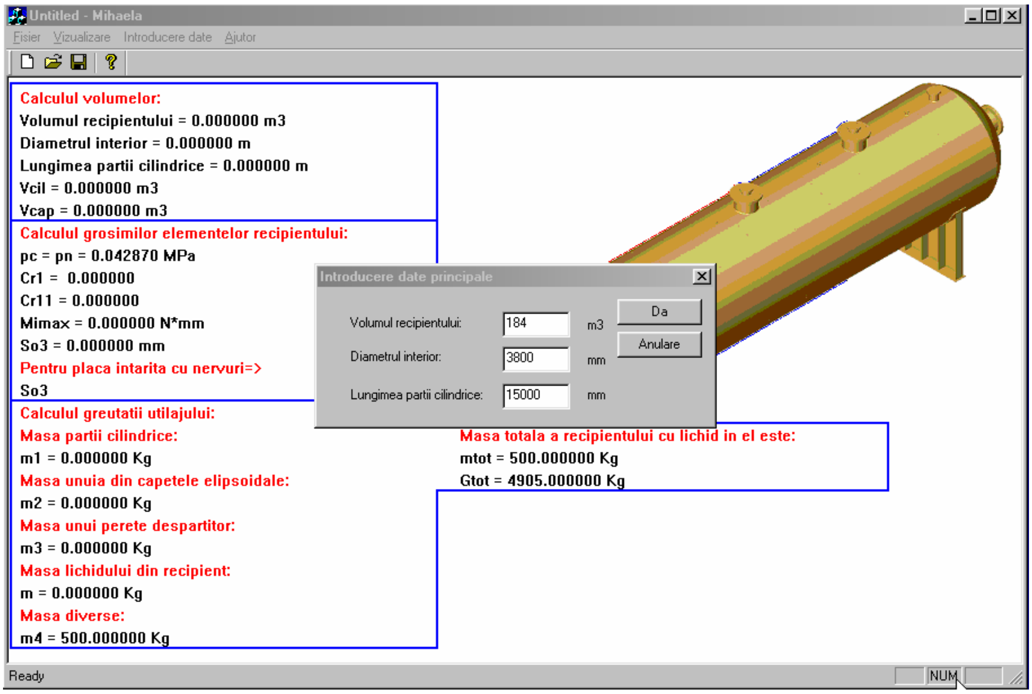

Fig. 1

where:

$$\alpha = \frac{b}{a} = 0{,}21 \, ; \; h = S_{p0} \quad (8)$$

$\sigma_{max} = \sigma_a = 136$ [MPa] $\Rightarrow$

$$S_{03} = 12{,}2 \, [mm] \quad (9)$$

2.3. Computation of kit weight

a. Cylindrical part mass:

$$m_1 = \pi \cdot D \cdot L \cdot S_{p1} \cdot \rho_{otel} = 8434{,}2 \text{ [Kg]} \quad (10)$$

where:

ρ_{otel} = steel density, [Kg/m^3]

b. Mass of one of the ellipsoidal ends:

$$m_2 = \frac{\pi \cdot D_{desf}^2}{4} \cdot S_{p_2} \cdot \rho_{otel} = 825{,}96 \, [kg] \quad (11)$$

where:

$$D_{desf} = 1{,}21 \, D_m + 2 \, h = 4{,}725 \text{ [m]} \quad (12)$$

c. Mass of one of the dividing walls:

$$m_3 = \frac{\pi \cdot D_i^2}{4} \cdot s_{p_3} \cdot \rho_{otel} = 1256 \, [kg] \quad (13)$$

d. Mass of the liquid inside the container:

$$m = V \cdot \varphi \cdot \rho_{lichid} = 19739{,}8 \text{ [Kg]} \quad (14)$$

e. Mass of miscellaneons:

$$m_4 = 500 \text{ [Kg]}$$

So, the total mass of the container full of liquid is:

$$m_{tot} = m + m_1 + 2m_2 + 3m_3 + m_4 = 225100 \text{ [Kg]} \quad (15)$$

The total weight of the conainer full of liquid is:

$$G_{tot} = m_{tot} \cdot g = 225100 \cdot 9{,}81 = 2208231 \text{ [N]} \quad (16)$$

3. Automatization of the wine production

Automatization imposes a series of aspects refering to command and control actions about kits and equipments included into the structure of an industrial process.

The computer "sends" and "gets" digital signals, through which, the computer communicates to the outside, to the biotic medium as part of it.

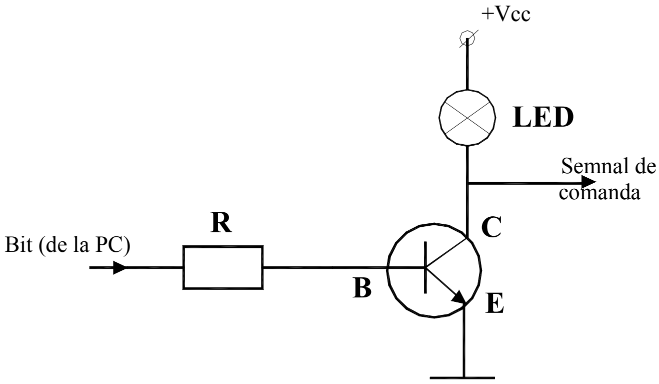

Fig. 2

Using the scheme presented in fig. 2 and multiplicating it according to the available limit of the computer port, an automatization application of an essential point of a wine production, namely, the wine kit will be described.

In order to create the automatization application of the considered process, the following characteristics will be taken into account:

1. the wine kit contains four distinctive compartments;
2. each compartment is endowed with at least a liquid providing entrance;
3. each compartment is endowed with at least a liquid discharge;
4. the main role of the wine kit is that of stocking with the view to fermenting process;
5. inside a compartment liquids can be placed coming from one of the four distinctive plants and, they can be discharged to one of the four purifying plants.

Each of the four plants may execute the following technological operations: the reception, the crush and the removal of grapes, wine pressing clarification, wine pessing fermentation, aging and obsolescence of wine. The five functional characteristics of the kit can be seen in Fig. 3.

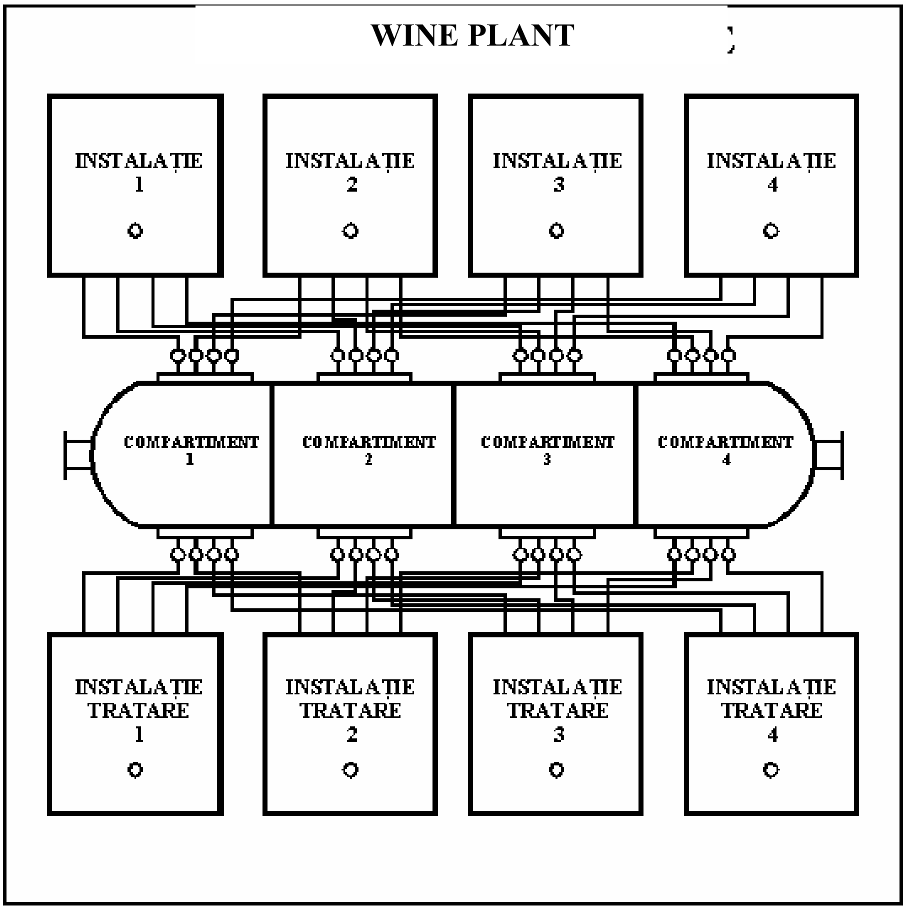

Fig. 3

Considering the kit proposed in Fig. 3, in Fig. 4 it is presented the schematic circuit that is to be used in the presented application. Thus, the command elements in Fig. 3 (relays, engines, etc) have been replaced by leds. For manipulating 40 command elements, a multiplex scheme commanded by LPT port of the computer has been used.

For commanding the wine plant it has been used a graphic interface built in Visual C++ 6.0. software and presented in Fig. 5.

In the figure above, the plant (the automatized area) comprises four wine plants and four purifying plants. The wine plants (crush) send the wine pressing to the wine kit compartments, where from, the wine pressing is further on sent to the purifying plants.

In order to illustrate the programme functioning, the figure above is taken into consideration, where, initially, the entire plant must be started by pushing the button "General Start", below this button there is a source-code.

After the general start, the plants that have to function are selected and the press button "Start" corresponding to each of the four plants is pushed, below each press button there is also a source-code.

Then, the value of the bit that is to be transmitted to the LPT port is established. There is no order that has to be followed when a plant is started or stopped, the only caution is that before shutting down the programme, the "General Start" press button must be pushed, this button having the role of "cleaning" the LPT port.

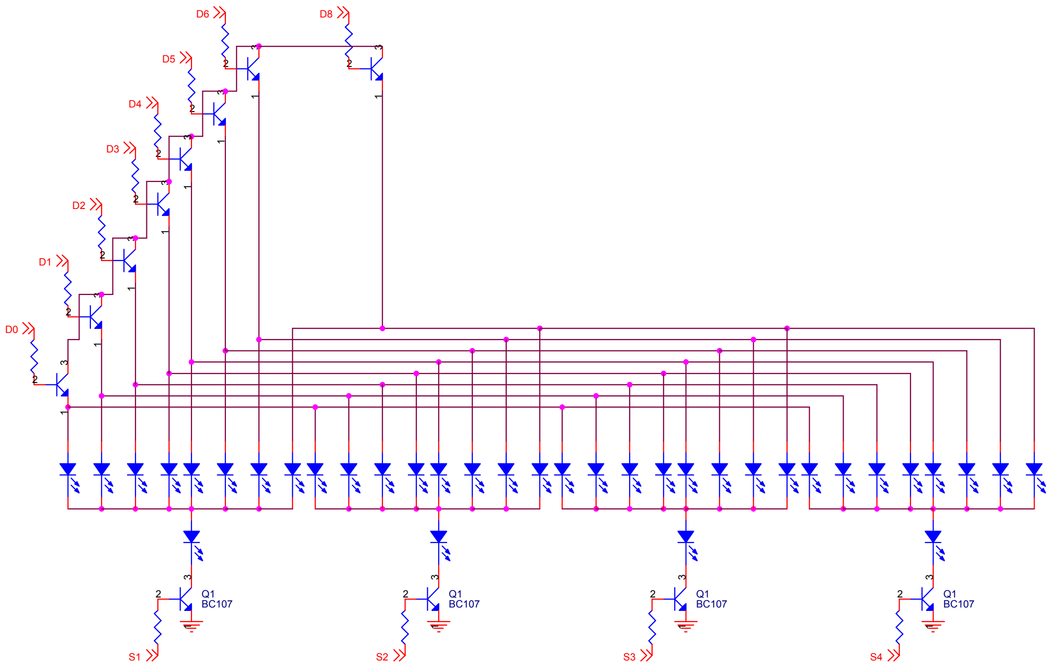

Fig. 4

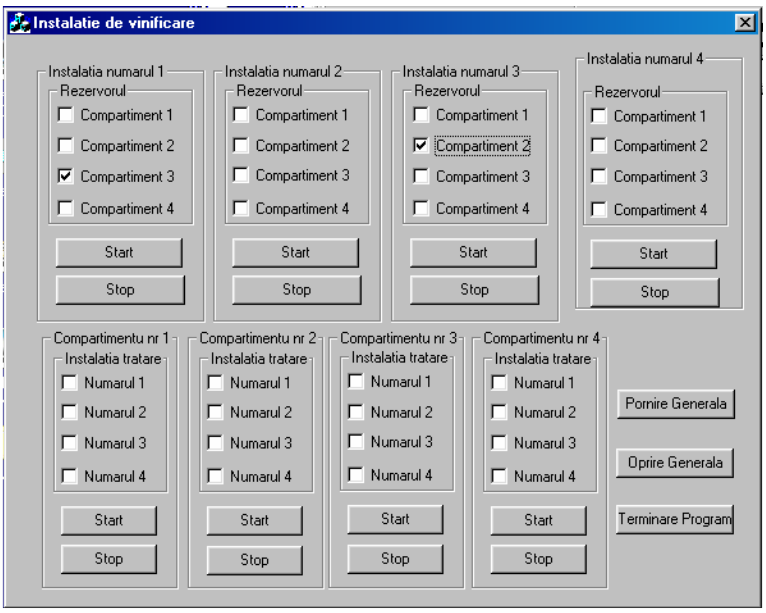

fig. 5

4. Conclusion

The advantages of a wine production automatization are:

- efficient monitoring of the technological process;
- reducing the breaking risk of the technological process following some deflections, by introducing the possibilities of removing the flow sheet from one spoiled process line to another process line;
- noticing in usage time of any deflection within the flow sheet and the possibility of a rapid intervention in order to fix it.

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