PRELIMINARY RESEARCH CONCERNING THE ELECTROMECHANICAL ACTUATORS WITH PARAFFIN

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Abstract: *Within this article are presented a few theoretical aspects regarding the realization of paraffin electromechanical actuators. For this purpose, it is presented a paraffin electromechanical actuator utilized for the collecting of experimental data, that aims to obtain the transitory process type and the index function that describes the process type, being presented a series of results of the research effectuated in this field. This variety of paraffin electromechanical actuators has a wide range of utilization fields. In consequence, they may be used as components within the low voltage action systems characterised by small geometrical dimensions, constructive simplicity and easy handling, with applicability in the agriculture field.*
Keywords*: electromechanical actuator, bellow, paraffin, transitory process.*

Introduction

Nowadays, in the field of the mechanical action has developed a variety of methods and devices, based, in their functioning, on the conversion techniques of the various power sources. An actuator is defined as a device through which the power obtained by means of physical principles and effects, is transformed in mechanical energy, that is necessary to the action in the rotation or translation movement of some devices.

Generally, the structure and function of the most types of actuators is based on one or more action techniques, like: electromagnetic, hydraulic, pneumatic, electrothermic, electrochemic, etc.

Further more are presented the aspects regarding the realization and the experimental study of the paraffin electromechanical actuator utilized as propulsion element within solar engines.

Considerations regarding the realization of a paraffin electromechanical actuator

The paraffin electromechanical actuator presented in longitudinal section in figure 1 is destined for the experimental tests effectuated to obtain the static characteristics at on-load operation and no load operation.

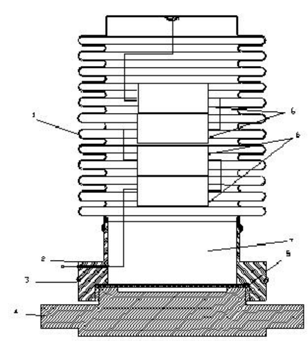


Figure 1. Paraffin electromechanical actuator, in which 1- bellow; 2-flanch, 3- coupling conductor; 4- lid; 5- collar; 6- resistors; 7- paraffin.

The actuator itself is mainly made of a bellow realized of Beryllium bronze in which is extant a quantity of paraffin, necessary to the experimental determinations.

The bellow is hermetically closed by means of a threaded lid.

Under the action of a thermic power source, the paraffin placed inside the elastic chamber is melted, and its dilatation through the melting process determines the relaxing of the bellow. The utilized thermic source is represented by four heating resistors connected in series, with no free space between them, alimented from an adjus Tabel source of alternative power.

Considerations regarding the study at on-load operation of the paraffin electromechanical actuator

Any multitude of fundamental components with technical character interconnected for the purpose of realising a peculiar technical function is a **technical process** characterised by an input value *xi (t)* and an output value *xe (t).*
The situation in which the output value of the process is constant is called stationary regime of the process. The period between two stationary regimes is called **the transitory regime of the process**, characterised by : the duration of the transitory regime, the time constants and the dead time of the process.
The delay of a process id due to the modification of one of the values and is characterise by the time constant of the process, T and by the dead time of the process Tm.
For the identification of the processes and for the study of their transitory regime, one of the utilised methods is to determine the index function that represents the variation curve in time of the output value in the transitory process that appears because of a signal stage unity at entrance.
For the studied case, are interesting the elements proportional with the time constant, namely the PT1 type element (proportional element with a time constant) and PT2 (proportional element with two time constants).
Within the study further developed, the electromechanical actuator is analyzed as a process with an input value represented by the tension of alimentation of the resistors inserted in the silphon and with an output value represented by the variation of length Δ1f the silphon after the dilatation of the paraffin deposited inside the silphon.

To identify the equation of the process and to study the transitory regime, the silphon is excited with a signal-stage at entrance. For this purpose is has been used the experiment presented in figure 2.

Figure 2. Experimental stand for testing the paraffin electromechanical actuators.

The experimental data has been processed by using the characteristic programmes of linearization and graphic representation.

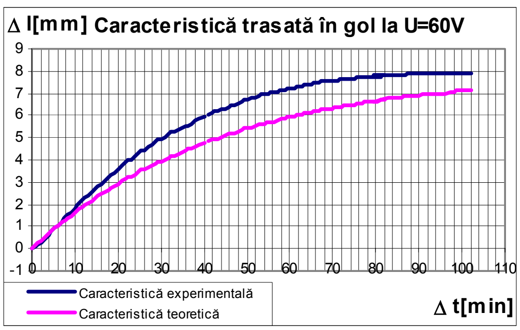
The identification of the mathematical model of the paraffin electromechanical actuator

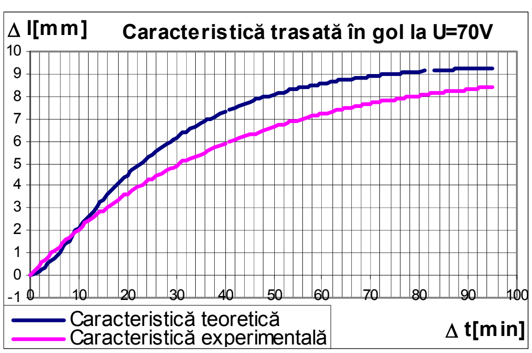
For the comparative study of the mathematical model, the modification of the stage signal was realised by the modification of the alimentation voltage of the resistors inserted in the bellow. Thus, were utilised various values of the alimentation voltage of the resistors and namely: 60 V, 70 V, 80 V, 90 V.
Analyzing the forms of the static characteristics at on-load operation, was obtained the equations that describe the index functions related to the transitory processes, presented in Tabel 1.
Is noticed that for the alimentation voltages of 60 V and 70V, the function of the actuator id characterised by a PT1 type process, and for the alimentation voltages of 80 V and 90 V by a PT2 type transitory process.

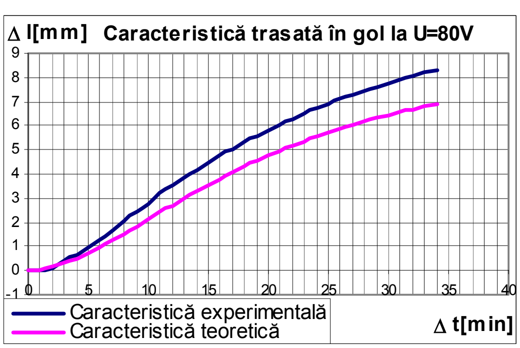
Tabel 1. The equations of the transitory processes at no load operation

U [V]	Ecuatia procesului
60	$2610 \cdot \frac{dX_e(t)}{dt} + X_e(t) = 7.91 \cdot X_i(t)$
70	$2400 \cdot \frac{dX_e(t)}{dt} + X_e(t) = 9.28 \cdot X_i(t)$
80	$6.55 \cdot \frac{d^2 X_e(t)}{dt^2} + 1.658 \cdot \frac{dX_e(t)}{dt} + 0.12 \cdot X_e(t) = X_i(t)$
90	$1.319 \cdot \frac{d^2 X_e(t)}{dt^2} + 0.437 \cdot \frac{dX_e(t)}{dt} + 0.049 \cdot X_e(t) = X_i(t)$

In figure 3 are represented the experimental and theoretical characteristics Δ1=f(t) obtained at no load operation of the paraffin electromechanical actuator.







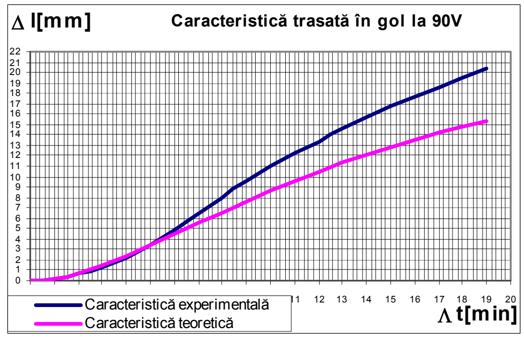
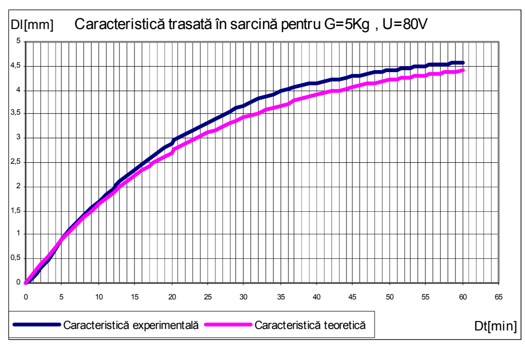


Figure 3. The static characteristics of the electromechanical actuator with paraffin at no load operation.

The identification of the mathematical pattern of the paraffin electromechanical actuator at on-load operation

The experimental study a ton-load operation is obtained by the actuator's solicitation with weights of 5 Kgf and 10 Kgf, the value of the alimentation voltage of the resistors being of 80 V. In both cases the index reply shows elements of type PT1.



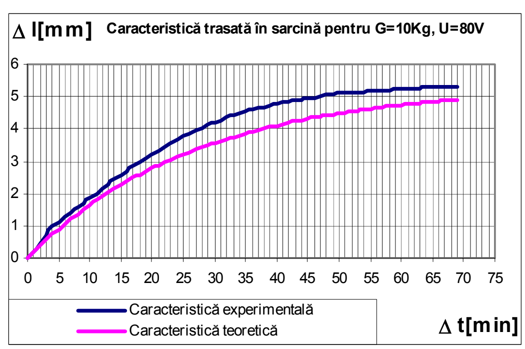


Figure 4. The static characteristics of the electromechanical actuator with paraffin at on- load operation

In figure 4 are represented the experimental and theoretical characteristics Δ1=f(t) obtained at on-load operation of the paraffin electromechanical actuator
In Tabel 2 are presented the equations that describe the transitory processes

Tabel 2. The equations of the transitory processes at on-load operation

G [Kgf]	Ecuatiile procesului
5	$1440 \cdot \frac{dX_e(t)}{dt} + X_e(t) = 4.8 \cdot X_i(t)$
10	$1620 \cdot \frac{dX_e(t)}{dt} + X_e(t) = 5.31 \cdot X_i(t)$

Conclusions

1. Although the electromechanical actuator with bellow represents the advantage of a relatively simple construction, its usage is limited by the danger of the fissuring of the bellow at high charges.
2. The test executed within the work with . Beryllium bronze electromechanical actuator have highlighted the fact that at charges higher than 10 Kgf appear the first leaks of melted paraffin, as a consequence of the fissuring of the bellow.
3. For the study of the transitory regime as well as for the study of the mathematical pattern of the paraffin electromechanical actuator has been effectuated the following actions with a preliminary character:
-it has been realised an experimental stand having the possibility of effectuating the empty functioning trials and the charge ones;
-there have been scheduled trials of empty functioning for the following values of the stage signal: 60V, 70 v, 80 V and 90 v, as well as in charge of 5 Kgf and 10 Kgf.
4. Within the test there have been used elements of heating resistors of various forms, dimensions and capacities.
5. At small values of the stage signal (60 V and 70 v), the mathematical pattern that may be associated to the paraffin electromechanical actuator is associated to the element type PT1, and for higher values of the stage signal (80 V and 90 V), the mathematical model of the paraffin electromechanical actuator evolve towards the PT2 type element.
6. At the tests effectuated at on-load operation the mathematical pattern of the paraffin electromechanical actuator is evolving, even in the case of high values of the stage signal, by a characteristic that may be associated to a PT1 type element.
7. Increasing the value of the stage signal leads to reducing the duration of the transitory regime and of the time constant T, for the low values (60 V and 70 V) as well as for the higher values (80 v and 90 V). In other words , by increasing the value of the stage, the mechanical processes developed by the electromechanical actuator become more rapid.
8. The experimental tests underlined the negative effect of the air inclusions over the evolution of the process, especially at charge tests. It has been noticed that air inclusions reduce the lineary dilatation of the bellow. To eliminate the deficiencies mentioned above is imposed the utilisation of a vacuum environment installation for filling the bellow with paraffin.

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