

## CONTRIBUTIONS TO THE REALISATION OF STANDS FOR THE EXPERIMENTAL STUDY OF THE PARAFFIN ELECTROMECHANICAL ACTUATOR

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**Abstract:** In this article are presented a few stands for the experimental data collecting in the case of theoretical and experimental study of the paraffin electromechanical actuators. For this purpose, is analysed the evolution of the thermal process inside the bellow and are presented a series of results of the research effectuated in this direction. This type of paraffin electromechanical actuators has a wide utility range. Thus, they may be used as components within the low voltage acting systems, characterised by reduces geometrical dimensions, constructive simplicity and easy handling.

**Keywords:** experimental stand, electromechanical actuator, bellow, paraffin, thermal process.

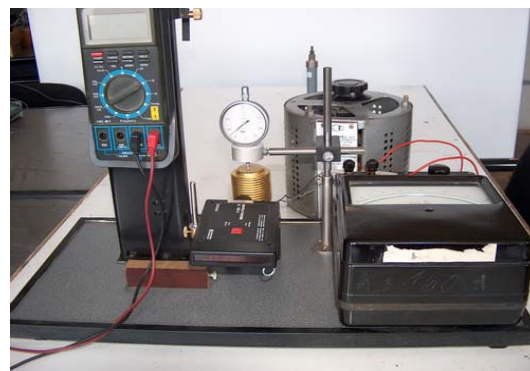
### Introduction

The realisation and study of the electromechanical actuators is one of the main research directions in the field of the low voltage acting. Thus, is imposed the investigation of new models of actuators and establishing the conditions of experimentation that should reflect the real functioning characteristics of the electromechanical actuators.

In this sense, it is necessary the realisation of experimental stands for the study of paraffin electromechanical actuators at no load operation and on-load operation, as well as for the study of the thermal process inside the bellow.

### Contributions to the realisation of the experimental stand for the study at no load operation of the electromechanical actuators.

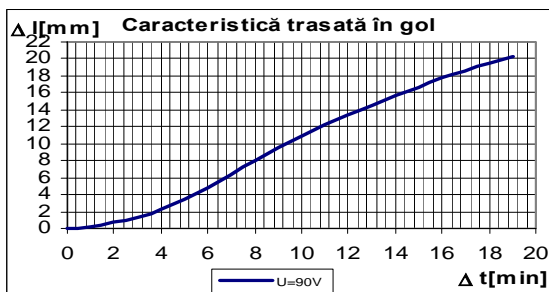
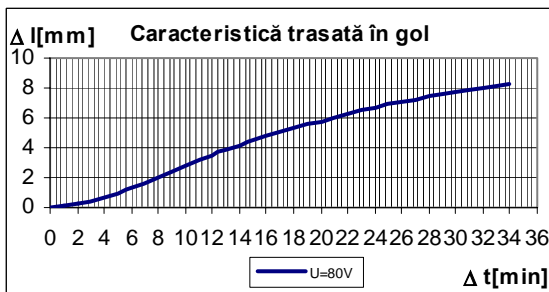
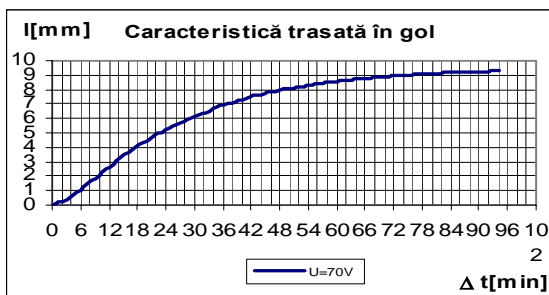
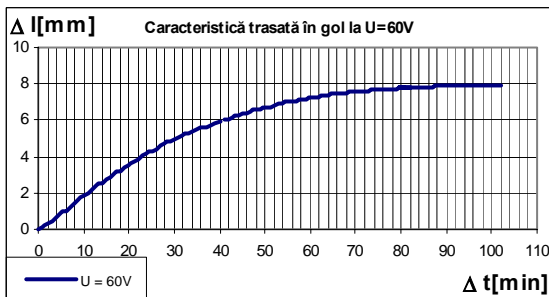
For the development of the experimental study has been conceived a test stand (presented in figure 1), mainly constituted from an adjustable source of alternative power, a voltmeter (type D61, with the following measurement domains: 75 V, 150 V, 300 V) and a milliamperimeter type D61, with the following measurement domains: 100 mA and 200 mA).



**Figure 1. Experimental stand for the study at no load operation of the paraffin electromechanical actuators**

The adjustable source has been connected, through the measurement group mentioned above, with the trial platform, mainly formed of a paraffin electromechanical actuator, a comparison clock and an infrared thermometer. The actuator is made of a Beryllium bronze bellow in which is inserted a quantity of paraffin. The comparison clock has the role of measuring the displacement caused by the detention of the elastic siphon at the moment the paraffin is melted under the action of a resistors heating source.

The infrared thermometer has the role to measure the temperature in various points of the bellow.



**Figure 2. The static characteristics of the electromechanical thermometer at no load operation**

By means of the experimental stand at figure 1 has been effectuated empty functioning tests for the next values of the stage signal: 60 V, 70 V, 80V and 90 V.

In figure 2 are represented the characteristic curves of the paraffin electromechanical actuator corresponding to the no load operation.

**Contributions regarding the realisation of the experimental stand concerning the study at on-load operation of the electromechanical actuators.**

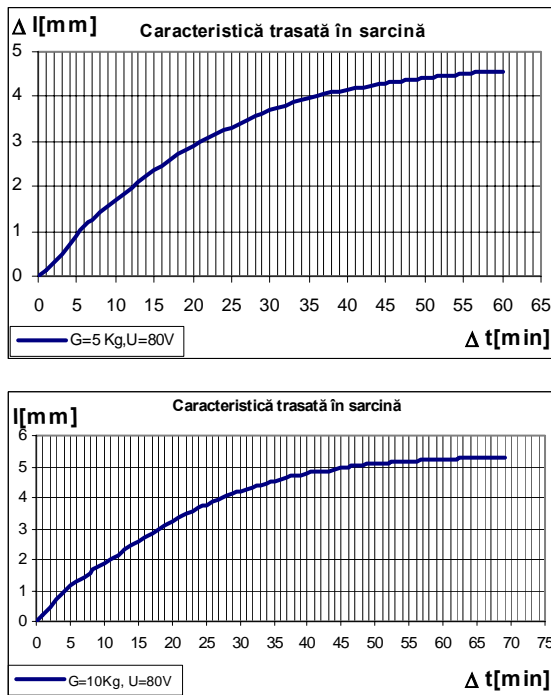
The stand presented in figure 3 is destined for the experimental tests effectuated to obtain the static characteristics at on-load operation of the electromechanical actuator with bellow.



**Figure 3. Experimental stand for the study of on-load operation of the paraffin electromechanical actuators**

The stand presented in figure 3 is analogous to the one presented for the empty functioning test, being adapted to the conditions of charge functioning test by means of equipping it with a support that allows placing weights that action over the bellow. Thus, have been realised weights of 5 Kgf and 10 Kgf.

The results of the experiment are graphically represented at figure 4.

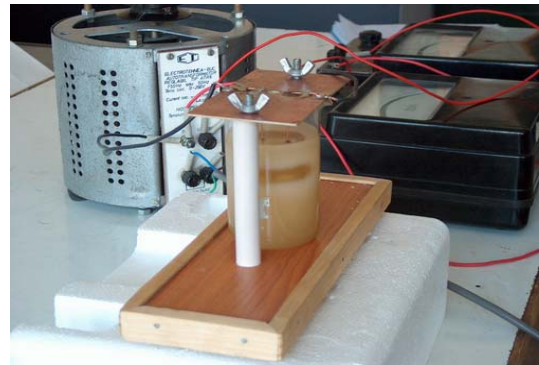


**Figure 4. The static characteristics of the electromechanical actuator at on-load operation**

**Contributions regarding the realisation of an experimenat stand for the study of evolution of the thermal process inside the bellow.**

Considering the experimental study of the evolution of the thermal process, it has been conceived a experimental stand mainly made up of an adjustable source of alternative power, a voltmeter (type D61, having the following measurement fields: 75 V, 15° V, 300 V) and a milliamperimeter (type D61, having the following measurement fields: 100mA and 200mA). The adjustable source has been connected through the mentioned measurement group, at the test platform, mainly constituted of a thermo-resistant glass recipient, in which is introduced the melted paraffin and in which is immersed the heating group constituted of four resistors serially coupled, having various forms, dimensions and powers.

The glass recipient is covered by an electro-isolating lid, fixed on two vertical supports, that also sustain the two terminals used to make the connection with the alimentation source. The stand destined to the study of the evolution of the thermal process is presented at figure 5.



**Figure 5. Contributions regarding the realization of an experimental stand for the study of the evolution of the thermal process inside the bellow.**

The experimental study regarding the identification of the mathematical pattern of the paraffin actuator highlighted the fact that the evolution of the thermal process inside the bellow is realised in a heterogeneous way, being registered, among other issues, a superior temperature in the upper side of the bellow and an inferior temperature at its lower part.

Within this study has been proposed the following objectives:

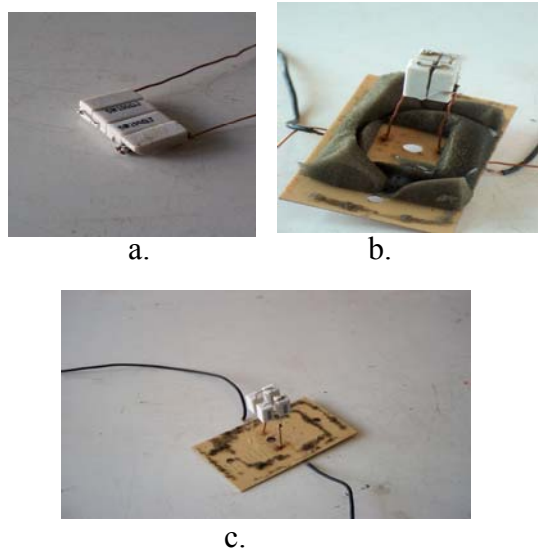
- the influence of the force of heating resistors over the evolution of the thermal process;
- the influence of placing the heating resistors inside the recipient;
- the influence of the type and of the geometrical configuration of the used resistors.

To obtain the conclusions regarding the highlighted research directions, has been elaborated a test programme that contain five distinct cases.

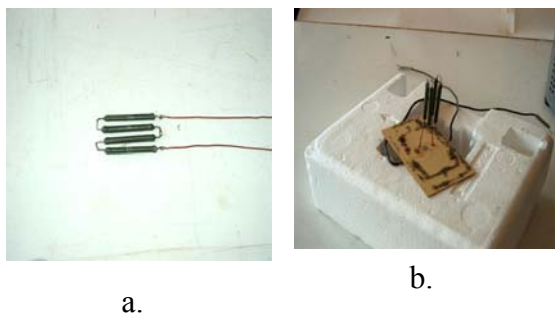
Case I – characterised for using four identical rezistors of 5 W and 100Ω, connected in series, vertically, disposed one over another, by figure 6.

Case II - – characterised for using four identical rezistors of 5 W and 100Ω, connected in series, vertically, disposed one over another, by figure 6b.

Case III - – characterised for using four identical rezistors of 5 W and 100Ω, connected in series, vertically, disposed one over another, by figure 6c.



**Figure 6. Resistors of 5 W and 100 $\Omega$ , connected in series, a and b – disposed one near another, c – disposed at distance.**



**Figure 7. Resistors of 9 W and 750 $\Omega$ , connected in series, a – disposed at distance, b – disposed one near another**

Case IV - – characterised for using four identical resistors of 9 W and 750 $\Omega$ , connected in series, vertically, disposed at distance one from another, by figure 7a.

Case V - – characterised for using four identical resistors of 9 W and 750 $\Omega$ , connected in series, vertically, disposed one near another, by figure 7 b.

#### **Research directions regarding the evolution of the thermal process inside the bellow.**

-Improving the support system so as to make possible the visualisation of the melted area at its upper portion, in the glass recipient, vertically positioned;

-Measuring the temperature at various points of the bellow by means of thermal translators placed in the studied areas;

-The study of the evolution of the thermal process not only at the heating of the bellow but also at its cooling.

#### **Conclusions**

1. The increase of the stage signal leads to the shortage of the duration of the transitory regime and of the time constant T, for small values (60V and 70 V) as well as for the bigger ones 880v and 90 V). In other words, by increasing the stage value, the mechanical processes developed by the electromechanical actuator become more rapid.

2. The experimental tests effectuated at the study of the electromechanical actuator with Beryllium bronze bellow underlined the fact that at charges higher 10 kgf appear the first leaks of melted paraffin, as a consequence of the fissures of the bellow;

3. The experimental tests highlighted the fact that the air inclusions have negative effects over the evolution process, especially at the charge tests it was noticed that air intrusions lead to the reduction of the bellow dilatation. To eliminate the mentioned deficiencies is imposed the utilisation of a vacuum environment installation to fill the bellow with paraffin.

#### **References**

- [1]. GAVRILIU, M.G. *Studiu privind proiectarea, realizarea și testarea unor noi variante de motoare solare*. Proiect de diplomă. Coordonator științific: prof. univ. dr. ing. Dorel Cernomazu. Suceava: Universitatea „Ștefan cel Mare”, Facultatea de Inginerie Electrică, 1997.
- [2]. JEDER, M. *Studiul motoarelor solare. Contribuții la realizarea unor actuatoare cu lichid folosite ca propulsoare la rotația motoarelor solare*. Proiect de diplomă. Coordonator științific: prof. univ. dr. ing. Dorel Cernomazu. Suceava: Universitatea „Ștefan cel Mare”, Facultatea de Inginerie Electrică, 1997.