STUDY ON THE INFLUENCE OF THE TRANSFER RATIO VALUES ON THE DYNAMIC PARAMETERS OF MECHANIC ECCENTRIC PRESSES

Corneliu BURLACU, Dan MIRCEA
Technical University „Gh. Asachi" Iassy

Abastract. The increase of the productivity of mechanic eccentric presses may be achieved on the basis of knowing the influence of several factors on the dynamic behavior of these machines. This paper presents the influence of the transmission ratio on the values of the dynamic parameters (the rotation speed of the main shaft, the motor moment and the consumed power) based on a mathema-tical model.

1. INTRODUCTION

This paper presents a dynamic model which (relative to other models) is much closer to the physical model of the driving mechanism. This model was obtained on the basis of the known method of the reduction of all the components of the driving mechanism to an equivalent shaft, on which is actioning on one side the motor moment from the motor source, and-on the other side-the resisting moment from the working process and from de friction processes.

As new elements of the proposed model we can enumerate the following:

- the evolution essentially nonlinear of the force from the working process;
- the friction force from the slider guidings is considered as having a essentially non-linear character too;
- the friction moments from the structure of the kinematic chain are considered different at the start relative to the function on the working process.

2. PRESENTATION OF THE MATHEMATICAL MODEL

At the achievement of the mathematical model, we considered that the reduced inertia moment of the mobile sub-assembly is variable.

The ecuations which describe the movement of the system were inferred starting from Lagrange ecuations:

$$\frac{d}{dt}\left(\frac{\partial E_c}{\partial \dot{q}}\right)+\frac{\partial E_c}{\partial q}=0 \qquad (1)$$

If it is considered as general coordinate the rotation angle of the main shaft crank, then q'=? , and if we accept that the kinetic energy is $E_c=J\cdot(?^2/2)$-were J is the sum of the inertia moments reduced at the main shaft, the moving ecuations of the driving mechanism in the working phase are:

$$\begin{cases} \dfrac{d\omega}{dt} = \dfrac{M_{mv}\left(\frac{1}{i}\right) - M_{mv}\left(\frac{\omega}{\omega_{0m}}\right)\cdot\left(\frac{1}{i^2}\right) - R(F_d + F_f + G)[\sin\alpha - (\frac{\lambda}{2})\sin 2\alpha]}{J_{red} + m_c R^2[\sin\alpha - (\frac{\lambda}{2})\sin 2\alpha]^2} - \\ \qquad - \dfrac{M_f - 2m_c R^2[\sin\alpha - (\frac{\lambda}{2})\sin 2\alpha](\cos\alpha - \lambda\cos 2\alpha)\cdot\omega^2}{J_{red} + m_c R^2[\sin\alpha - (\frac{\lambda}{2})\sin 2\alpha]^2}; \\ \dfrac{d\alpha}{dt} = \omega. \end{cases} \qquad (2)$$

The parameters who appear in relation (1) have the following signifiance: α -the rotation angle of the main shaft; ? -angular speed of the main shaft; $?_{0m}$-the synchronism angular speed of the electric motor; i-transmision ratio between the motor and the main shaft; R- the crankpin radius (eccentricity) of the main shaft (adjustable in the case of the presses type PAI); ?-the mechanic characteristic of the press (?=L/R, where L-is the length of the driving rod); $J_{red.const}$-the sum of the constant inertia moments at the main shaft; m_c-slider mass; G-the weight of the slider with the elements due to this; M_{mv}-the virtual maximum moment of the motor, parameter introduced at the linearisation of the mechanical characteristic of the motor, in the working zone; F_d-the deformation force developed for the working process; F_f-the friction force from the slider guidings; M_f-the friction moment on the flywheel togheter with the working mechanism.

3. WORKING OUT THE RESULTS

The study was made on the press PAI 63. The variations of the main parameters were in the neighbourhood of the characteristics of the press (in the actual construction): nominal force F_N = 63tf; motor type ASI 132M-38-6 (with the characteristics: P = 5,5 kW, n_0 = 1000 rot/min, n_n = 960 rot/min); the transmision ratio between motor and the flywheel: i = 0,10128; the frecquency of the slider drives: n = 90 cd/min; the crankpin radius: adjustable between 5 and 60 mm; the length of the driving rod: adjustable between 572 and 622 mm; the friction moment of the flywheel together with the driving subassembly: M_f = 199,6 N·m; the slider mass: m_c = 170 kg; the driving rod mass: m_B = 89 kg; the inertia moment of the flywheel: J_v = 264 N·m.

In fig.1 we present the evolutions of the dynamic parameters in the case that the discussed parameters have the values from the press PAI 63.

In fig. 2 we present the influence of the transmission ratio when the other parameters have the values: g = 2 mm; R = 60 mm; L_b = 572 mm; M_f = 200 N·m; F_f = 500 N; F_{di} = 300 kN; F_{df} = 500kN; m_c = 170 kg; m_b = 90 kg; J_v = 264 N·m; $\alpha_i = 160^0$; motor 1 (ASI 132 M-38-6).

In table 1, I is the transmission ratio between the driving motor and the flywheel, $?_{max}$-is the maximum value of the angular speed of the main shaft, $?_{min}$-is the minimum value of the angular speed of the main shaft, $?_{med}$-is the medium value of the angular speed of the main shaft, P_{max}-is the maximum value of the consumed power, P_{min}-is the minimum value of the consumed power, P_{med} –is the medium value of the consumed power; M_{max}-is the maximum value of the motor moment; M_{min}-is the minimum value of the motor moment; M_{med}-is the medium value of the motor moment; T_{ca}-is the duration of the active stroke.

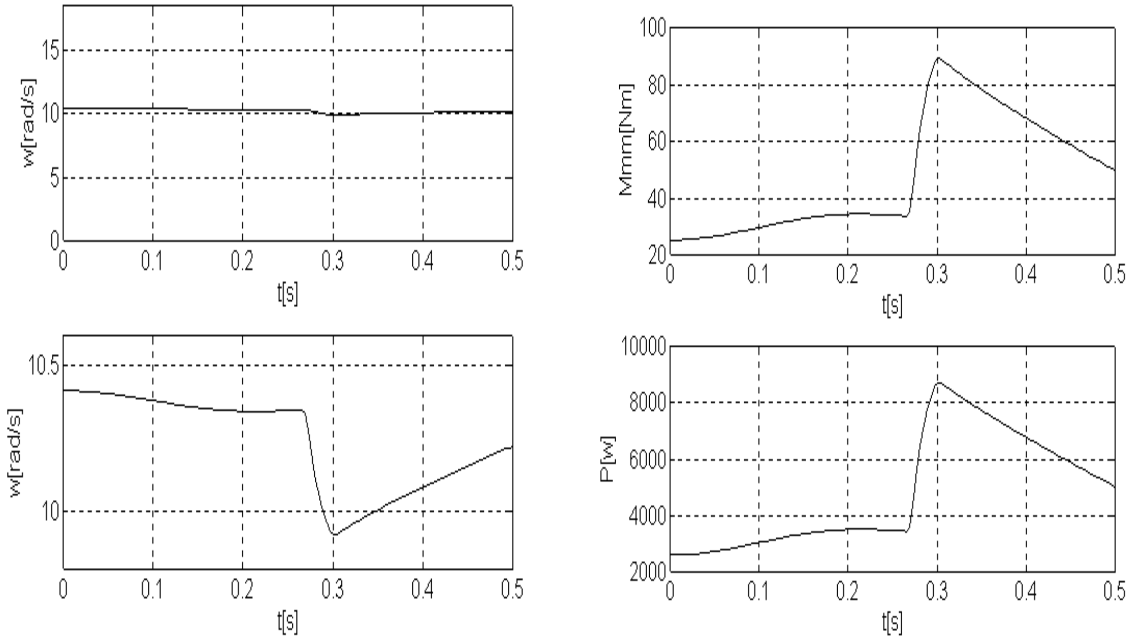
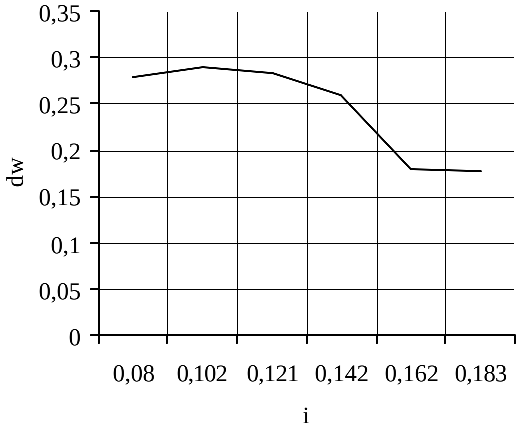
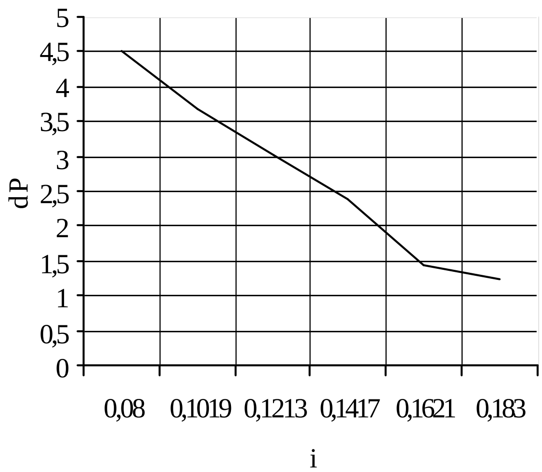


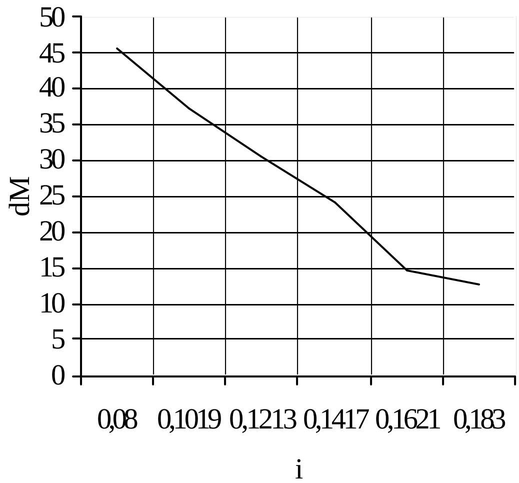
Fig.1 The evolutions of the dynamic parameters



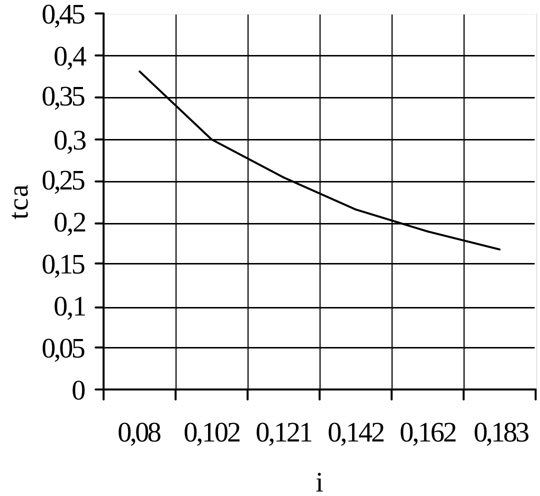
a) The falling of the angular speed



b) The falling of the active power



c) The fallinf of the motor moment



d) The evolution of the duration of the active stroke

Fig. 2

Table no.1

i	$?_{max}$ [s^{-1}]	$?_{min}$ [s^{-1}]	$?_{med}$ [s^{-1}]	P_{max} [kw]	P_{min} [kw]	P_{med} [kw]	M_{max} [N·m]	M_{min} [N·m]	M_{med} [N·m]	T_{ca} [s]
0,08	8,2806	8,0024	8,1415	6,1593	1,6481	3,9037	61,574	15,9222	38,7481	0,3819
0,1019	10,5138	10,2241	10,3689	5,7902	2,1026	3,9464	57,7149	20,38	39,0474	0,3006
0,1213	12,4773	12,1948	12,3361	5,5148	2,4967	4,0058	58,8503	24,2703	39,5603	0,2531
0,1417	14,5317	14,2718	14,4018	5,2825	2,9092	4,0959	52,4447	28,3659	40,4053	0,2171
0,1621	16,5733	16,3927	16,4830	4,7629	3,3191	4,0411	7,0956	32,4611	39,7784	0,1902
0,183	18,6528	18,4747	18,5638	4,9911	3,7375	4,3638	9,4391	36,6582	43,0486	0,1689

4. FINAL OBSERVATIONS AND CONCLUSIONS

From the analize of the results obtained, the following conclusions can be drawn:
- the model allows the optimization of the design of mechanic eccentric presses;
- the model allows the study of the influences of a large number of parameters;
- there is also the possibility to simulate different regimes of loading, by modifying the evolution and the values of the deformation force and also by modifying the period of the application of the deformation force and of the beginning moment of the deformation process; in this way we can study the implications of some processes corectly positioned but also some processes total disadvantageous from the point of view of the position of the working stroke in the descending stroke of the slider;

The evolutions presented in fig. 1 are theoretical evolutions, obtained in the conditions in which the parameters of the influence have known values and predictable evolutions. It is obvious that these evolutions will be modified in the case of appearance of some perturbing factors, which can determine the elaboration of some methods for diagnosing the functioning state of the machine or the tools.

REFERENCES

[1] Burlacu C, *Theoretical and experimental researches on the optimization of the design, construction and exploitation of mechanic eccentric presses from the point of view of dynamic bedavior of mechanical structure and the driving system,* Doctor’s title thesis, Technical University “Gh. Asachi”, Iasi, 2000.
[2] Burlacu C, Drutu C, *Equipment and method for measuring the dynamic characteristics of the structure of mechanic presses,* TSTM-5, Bacau, 1999.
[3] Burlacu C, *The optimization of the structure of mechanic eccentric presses by using their answer at trying with a pulse type force,* Constructia de Masini, nr. 9, 2000.
[4] Burlacu C., Zetu D., *Study on the dynamic behavior of mechanic eccentric presses on the basis of a simulation model*, Vol. “Optimum technologies, technologic systems and materials in the machine building field”-TSTM 8, Editat sub egida Academiei Romane-Filiala Iasi, Bacau, 2003 (p. 161-164).