УДК 681.5.033
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MODELING PACKAGING MACHINE SYSTEMS ON THE BASIS OF PROPORTIONAL PRESSURE REGULATOR

Introduction. The vertical multithreading packaging machines that work with two rolls, usually used for packaging melkoportsionnogo granular, liquid, paste and small-piece products in flat chetyrehshovnye packages manufactured from a variety of heat-sealable or heat sealable film materials, as well as filtrobumagi, polyethylene laminated paper and aluminum foil. Thus the opposing surfaces of such packets may be made of different materials. When forming the package is necessary to provide a pressure control system of the tension roll materials. As a control device, consider the use of MX PRO proportional pressure regulator in the automatic control system. The important problem in the operation of automatic control systems (ACS), the gas pressure is required to ensure the dynamic quality and, above all, lack of self-oscillating uncontrolled processes that reduce the service life of systems and precision gas flow measurement [1]. Therefore, in the scientific literature, little attention has been paid to the study of factors affecting the dynamic processes [2, 3].

Research results. The objective of this work is to develop a mathematical model of the compressed air pressure regulator, which takes into account the possibility of the separation of elements of the moving system from each other when moving between stops (pneumatic cylinders) guide rollers (Figure 1). Gas pressure regulator is designed to maintain a constant pressure at the inlet of the guide and control system supporting rolls. Consider the application of a proportional pressure regulator on the vertical machine model multithreaded **ВАЭМ** 4 / 10-10 / 5. It consists of a fixed device on the frame of unwinding rolls 1 and 2 (Fig. 1) of the packaging web; mechanisms 3 slitting blades roll tape on the mating; walking roller device 4 feeding the packaging material and forming a package; managing them photosensor reading from the tape special tags that define the packet length; threaded dispenser (not shown) formed in fasuyuschego packages packaging products; unit 5, the welding edge of the mating tape longitudinal seams; device 6, a double transverse welding seam packets with simultaneous cutting of the material between the seams; interlocked with him Markers, marks the date (6 digits) in the cross seam; the conveyor belt 7, leading from the machine finished packaging unit 8; as well as on the electrical cabinet and microprocessor control system.

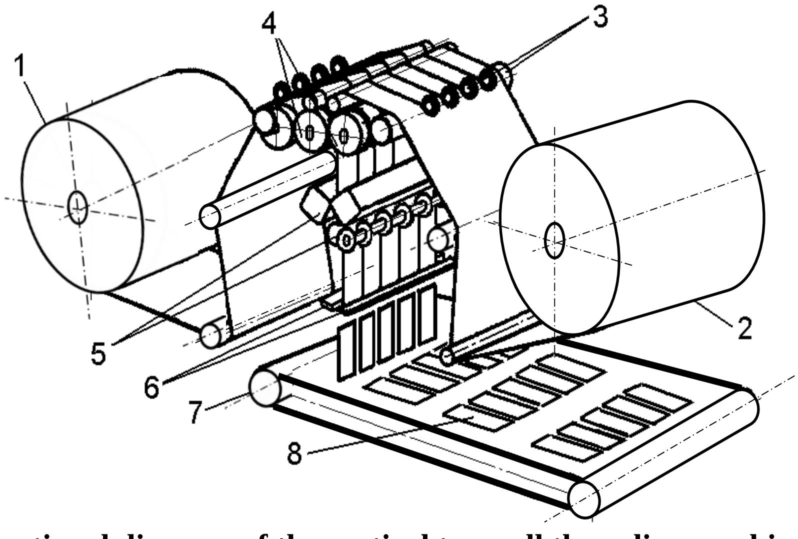

Figure 1 **- The functional diagram of the vertical two roll threading machine models ВАЭМ 4/1-10/5**

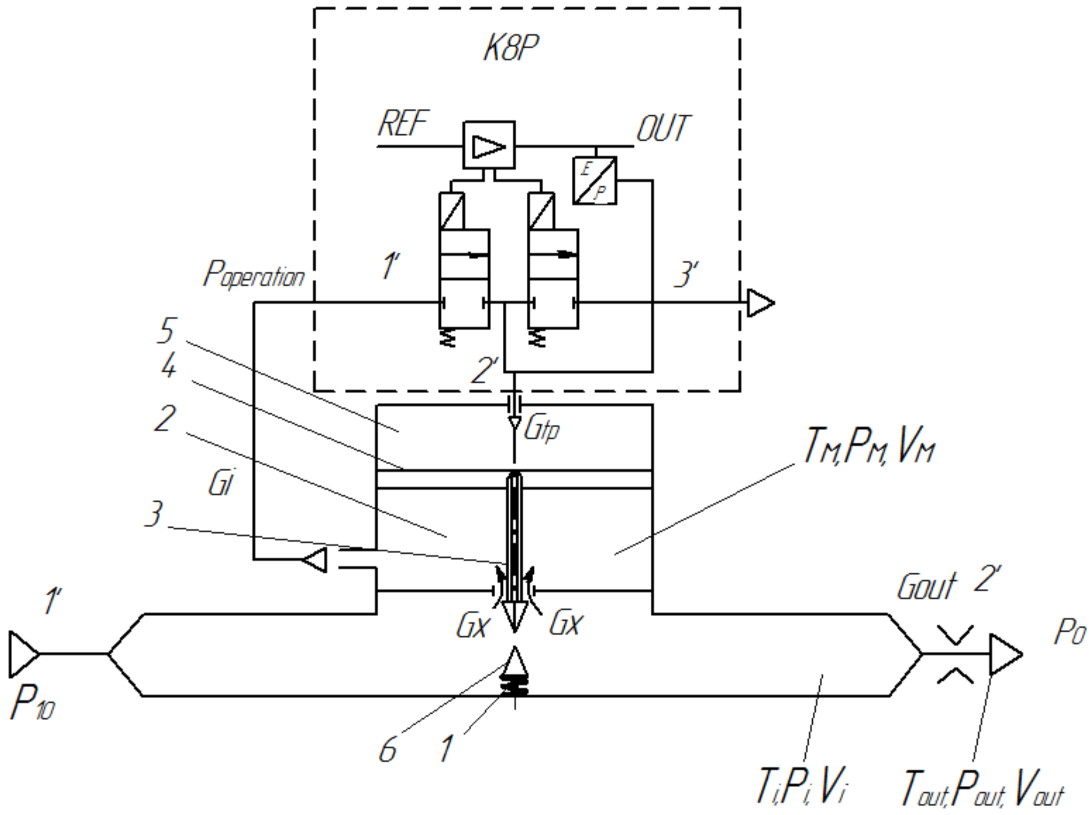

Figure 2 - **The generalized design pressure regulator circuit given the attached highways**

The mathematical model is described by the pressure regulator controller design scheme in the working position, shown in Fig. 2. In the derivation of equations The following assumptions were made: a working body - ideal gas; heat exchange between the gas and the walls of regulator absent; gas temperature at the flow part remains constant; transient gas flow in a quasi-stationary inductors. We consider a generalized design scheme (Figure 2) pressure regulator based affiliate highways, maintains a constant pressure for a compiled an example of proportional pressure regulators MX-PRO CAMOZZI. The studies examined the proportional pressure regulator of the MX series, in which, instead of the handle with a spring mounted K8P proportional pressure regulator that regulates the control pressure in the pilot chamber. Figure 2 shows a pneumatic system elektroproportsional nym K8P series regulator consisting of a hollow rod 3 coupled to the piston 4 and the membrane mass m, and a piston 6 fixed on the rod by means of elastic coupling and the gas spring 1 rigidity C1. Camera 2, makes it possible to maintain the set pressure on the main channel 1 '- 2' and maintain the pressure signal for the channel feedback system control valves 2/2 K8P pressure. The pressure in the control chamber 5 allows the membrane 4 and set the desired output pressure from the regulator. Channel 3 'is an exhaust channel when you reset the air. [4] The piston 3 and the membrane under the action of control pressure $P_{operftion}$ by upravlyayuchih valves K8R - - management. The equation of equilibrium of the membrane as a dynamic link lumped m, Cпр,ξ - represented as:

$$m\frac{d^2x}{dt^2}+\xi\frac{dx}{dt}+C_{np}x-F_{01}+F_{02}-F_{\Sigma}=0, \qquad (1)$$

when F_{Σ} - nonlinear sum of the friction forces, and aerodynamic lift forces acting on the membrane

$$
\begin{cases}
C_c \cdot \dfrac{dP_c}{dt} = G_{i+1} - G_{out}, \\
G_x = \mu_x \pi d_c x P_{10} \sqrt{\dfrac{2}{RT_{10}} \dfrac{k}{k-1} \left[\left(\dfrac{P_1'}{P_{10}} \right)^{\frac{2}{k}} - \left(\dfrac{P_1'}{P_{10}} \right)^{\frac{k+1}{k}} \right]}, \text{при } \dfrac{P_1'}{P_{10}} > \pi_{кр}, \\
G_x = \mu_x \pi d_c x P_{10} \sqrt{\dfrac{k}{RT_{10}}} \left(\dfrac{2}{k+1} \right)^{\frac{k+1}{2(k-1)}}, при \dfrac{P_i}{P_{10}} \le \pi_{кр}, \\
G_i = \mu_i S_i p_i \sqrt{\dfrac{2}{RT_i} \dfrac{k}{k-1} \left[\left(\dfrac{p_{i+1}}{p_i} \right)^{\frac{2}{k}} - \left(\dfrac{p_{i+1}}{p_i} \right)^{\frac{k+1}{k}} \right]}, \text{при } \dfrac{p_{i+1}}{p_i} > \pi_{кр}, \\
G_i = \mu_i \pi S_i P_i \sqrt{\dfrac{k}{RT_i}} \left(\dfrac{2}{k+1} \right)^{\frac{k+1}{2(k-1)}}, при \dfrac{P_i}{P_{10}} \le \pi_{кр}, \\
m \dfrac{d^2 x}{dt^2} + D \dfrac{dx}{dt} + C_{пр} x - F_{01} + F_{02} - F_{\Sigma} = 0, \\
F_{\Sigma} = -p_m S_m + p_i S_c - p_{10} S_T + p_a S_m, \\
m \dfrac{d^2 x}{dt^2} + \xi \dfrac{dx}{dt} + C_{пр} x - p_{01} + p_{02} + p_m S_m - p_i S_c + p_{10} S_p + p_a S_m = 0
\end{cases}
\qquad (2)
$$

and the stem; $C_{пр}$ - spring rate, N / m; m - mass of the moving system, in kilograms; ξ - damping; F_{01}, F_{02} - a prior effort to mechanical springs 1 (Figure 1) and the gas spring in the chamber 5. The assumptions of the mathematical model was also priynyato: little impact friction forces and lift the flow into static and dynamic characteristics of the system: $F_{\Sigma} = -p_m S_m + p_i S_c - p_{10} S_T + p_a S_m$, when p_m - the pressure in the cavity nadmembrannoy; S_m - membrane area; p_a - atmosphere pressure; S_c - the valve seat area; S_T - plate area. μ_i - flow rate; x - valve membranes move; R - the gas constant; T_i - stagnation temperature; k - adiabatic index; p_i - absolute pressure; S_i - flow area; $\pi_{кр}$ - critical pressure ratio. In the calculation model, the following assumptions [2]: a working body - ideal gas; pressure on the regulator inlet temperature constant, P_0 = const, T_0 = const; mode gas leak into the cavity of the consumer - critical; heat exchange between the gas and the walls of the structure is absent. Assuming that the state of the gas in the cavity varies adiabatically, we can write (2): wherein μ_x - flow rate in the section of the rod 3 (Figure 1); d_c - диаметр поршня на штоке 3; x- ход тарелки клапана; G_{i+1} - mass flow rate, determined K8R control valves; V_c - the volume of the chamber cavity 2; G_i - mass flow K8R power; C_c .- changes in pressure tank (gas spring stiffness). Our method of experiment is to control the pressure in the job robochem intervals using a pressure regulator. In parallel with experimental studies analizarovalas and analytical model was built based on the generalized equation of energy conservation.

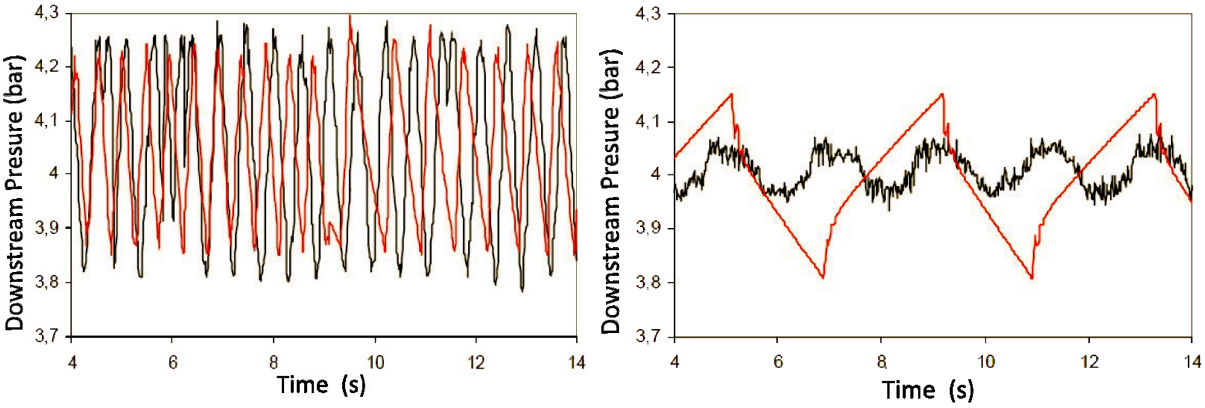

Figure 3 **- The calculation results (---) and measurement (---) output pressure controlled by using different volumes:** ***a*) V = 0.003 m^3 , *b*) V = 0.05 m^3.**

Conclusions. The resulting system of equations (2) describes the operation of the gas pressure regulator with the attached package and capacity upravlyayuchih elements. For a given flow rate of gas through the regulator and the desired value of the output pressure Pout (Figure 2) on its moving parts set the balance of power. When changing the gas flow rate through the regulator, for example, by increasing consumer pressure Pout at the output will decrease, whereby the out of balance forces on the sensor controller - the piston, which would increase the throttling area between the piston 6 and the piston 3. The pressure rod output increases to the required Pout and going to restore the balance of forces on the moving parts of the regulator. When reducing the flow through the regulator outlet pressure regulation occurs in a similar manner. In accordance with the assumptions, equations describing gas-dynamic processes in gas pressure regulator, the energy losses are taken into account by means of the flow rate. With the help of modeling the behavior of the working environment (3), in the controller and the output from it is possible to estimate the value of performance test systems, possible deviations from the established ranges controlled variables and achieve a stable position raochih processes in mechanical systems controlled by regulators.

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