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STRUKTURNAYA Identification MATEMATYCHESKOY model DYAHNOSTYROVANYYA ОВЪЕМNОНО HYDROPRYVODA HRT-90.112

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Flag strukturnaya Identification matematycheskoy model dyahnostyrovanyya объemnoho hydropryvoda HRT-90.112. Poluchenы dyfferentsyalnыe equation perehodnoho process for the pump and motor. IZ analysis equations should, something the parameters kotoryya harakteryzuyut Tehnicheskoe STATUS pump and motor javljajutsja Standing perehodnoho process of time, as well as dekrementы zatuhanyya fluctuations in fluid napornoy mahystraly and oborotov motor. Poluchenы solutions dyfferentsyalnыh equations.

Strukturnaya Authentication dyfferentsyalnoe equation perehodnoho process, dyahnostyrovanye, dekrementы zatuhanyya, Surround hydropryvod, Constant time.

Production problems. Surround hydropryvodы widely prymenyayutsya on mobylnoy selskohozyaystvennoy technician As energy transmission system from the engine for dvyzhetelyam mashiny at tehnolohycheskyh perform operations. STATUS Tehnicheskoe such agregatov hydropryvoda As porshnevoy-axial pump (NR-90.112) and motor (MP-90.112), t largely determines proyzvodytelnost machines in general, because vlyyaet s velocity in motion. Changing of technical STATUS 90.112 in HRT-hudshuyu side lead for the loss of a video neproyzvodytelnыh Increase energy and fuel costs [1], Something svjazano объemnыmy rubbed with a working fluid through utechek Due Internal zazorы (From the high-pressure zone in the low pressure zone). Hydromashyn operation in the process because of the loss yznosa Surround constantly uvelychyvayutsya.

Surround loss of hydraulic drive opredelyayutsya entries Factor Factor for the pump and useful to action (CRC) for the motor. According to GOST 2192-93[2] Criteria predelnoho STATUS javljaetsja Reduction Factor entries

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η_{vN} and for pump efficiency η_m engine for no more than, than 20% from nachalnыh values.

Business waterpumps a hydraulic motor harakteryzuetsya vzaymnым Effect through upruhye hydravlycheskoy fluid properties, kotoraja tsyrkulyruet closed in full. Therefore matematycheskoe Description of Dynamic Systems sleduet Look in sovmestnom interaction pump-motor hydravlycheskoy fluid, and determines something Relevance nastoyascheho research.

Analysis poslednyh research. In the work [3] yznosu analysis resulted in major elements GTS-90, vыyavlenы zakonomernosty apportionment yznosov and poluchena matematycheskaya model obъemnoho communication efficiency with yznosamy and gaps in trybosystemah HRT. One IZ sent dyahnostyrovanyya hydropryvodov javljaetsja termometryrovanye [4], Kotoroe allows us opredelyt Tehnicheskoe STATUS temperature of the pump casing and motor IN TIME operation. This method poluchyl dalneyshee Development in the work[5], Where the results of measurements on temperature dyahnostyruyutsya Separate nodes Waterpumps, however vzaymosvyazy Between temperaturnым regime of technical and STATUS otdelnыh nodes are not installed.

The authors work [6] Done Output, something hydropryvod navesnoy system tractor opysыvaetsya kolebatelnым Zveniv, with this characteristic to rate this perehodnoho process can be Tehnicheskoe state. Analyzing peredatochnыe hydropryvodov rulevoho management functions, navesnoy systems and transmissions, authors work [6] Conclusion delayut, something perechyslennыe system can be rassmatryvat As kolebatelnыe system with Dynamic Factor malым damping. Quality perehodnoho process can be opredelyt for the following indicators, Fig. 1: TIME perehodnoho process TA; TIME tm, the pressure of Kotor dostyhaet maximum value Rmax; Time t1, by the pressure of fluid kotoroe First time dostyhaet value statycheskoho pressure, Rnom; value pererehulyrovanyya σ; slope characteristics ugol γ; zatuhanyya period oscillations,θ.

The authors work [6] proves something perechyslennыe indicators, Fig. 1 ymeyut of technical connection with the STATUS hydropryvoda at this intensity narastanyya pressure $\dot{P}$, Is the most ynformatyvnым of technical parameter STATUS waterpumps.

In the work [7] Authentication is executed strukturnaya model dyahnostyrovanyya hydrostatycheskoho drive GTS-90. Polucheno dyfferentsyalnoe equation perehodnoho process dynamycheskoy system pump motor. IZ analysis equation should, something the parameters kotoryya harakteryzuyut Tehnicheskoe STATUS NP-90 and MP-90 javljajutsja Standing TIME perehodnoho process pump and motor, as well as dekrementы zatuhanyya fluctuations in fluid pressure and napornoy mahystraly oborotov motor. In the work pryvedennoy uchtena vzaymosvyaz Between pump and motor, though not uchtenы Leaks hydravlycheskoy fluid, and kotoryya snyzhayut hydromashyn efficiency.

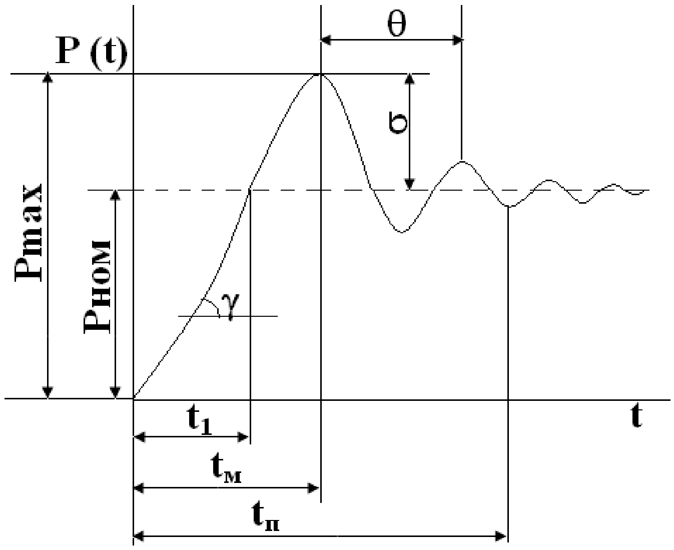


Fig. 1. The quality indicators kolebatelnoho perehodnoho process[6].

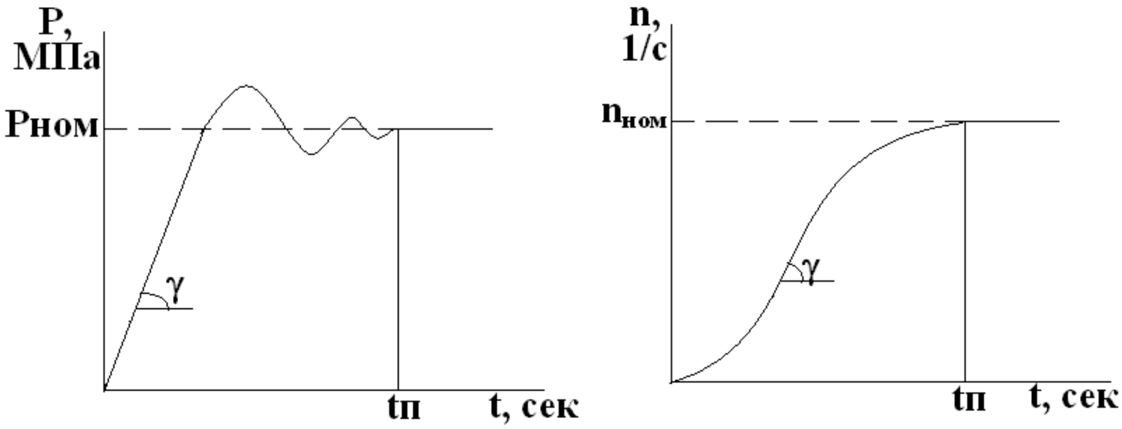
of research aim of dannoy work made manifest Run strukturnuyu Identification matematycheskoy model dyahnostyrovanyya obъemnoho hydropryvoda HRT-90.112, How edynoy dynamycheskoy system pump-motor hydravlycheskaya fluid with uchetom utechek in the process of operation.

Results of research. Getting dyfferentsyalnыh equations in the theory of automatic regulation Title wear Authentication [8, 9]. Authentication Dynamic objects svodytsya tasks for obtaining matematycheskoy model adekvatnoy yzuchaemomu phenomenon, ie, Definition models for structure dyahnostyrovanyya (strukturnaya Identification). Under strukturoy model dyahnostyrovanyya we should ponymat dyfferentsyalnoe equation, opysыvayuschee perehodnыy process with accuracy to koэffytsyentov.

Based on apryornoy of information, as well as based on analysis of research, the authors work vыpolnennыh [6, 7], Physical process perehodnoho axial-piston pump can be NP-90.112 vыrazyt zavysymostyu Changed pressure P in nahnetanyya LINE IN TIME (vыhodnoy signal), the deviations naklonnoy shaybы on ugolα (Vhodnoy signal) kotoraja kachestvenno shown in Fig. 2 as well.

Physical perehodnoho MP-process hydraulic motor can be vыrazyt 90.112 zavysymostyu Changed the motor shaft oborotov of time t n -

(vыhodnoy signal) when pressure in appearance LINE nahnetanyya (vhodnoy signal) Fig. 2b.



and b

Fig. 2. Changed pressure dependence of P in nahnetanyya LINES (a) and oborotov motor (b) with techenyem time.

Considering the physical processes perekhodnykh Fig. 2 It should be noted something dependence perehodnoho process pump, Fig. 2, but corresponds inertsionno kolebatelnomu Zveniv echoed order and ego peredatochnaya Function ymeet view [7-9]:

$$W_н(p) = \frac{K_н}{T_н^2 p^2 + 2 d_н T_н p + 1}, \quad (1)$$

where: Book - Gain Factor, kotoryya harakteryzuet degree of Effect vent signal to vыhodnoy; TN - Permanent TIME pump; p - operator dyfferentsyrovanyya $p = \frac{d}{dt}$, Prymenyaetsya Instead dyfferentsyrovanyya mark; d - decrement zatuhanyya.

Dependence perehodnoho process in the engine, Fig. 2, b corresponds inertsionno Zveniv echoed aperiodic order, and ego peredatochnaya Function ymeet view[7- 9]:

$$W_м(p) = \frac{K_м}{T_м^2 p^2 + 2 d_м T_м p + 1}, \quad (2)$$

where: Km, Tm, Dm - Factor GAIN, Permanent TIME, decrement zatuhanyya motor MP-90.112 for aperiodic Zveniv Dm<1.

Given that, something in Constructions HRT-90.112 pump and motor soedynenы consistently, provide structural dynamycheskuyu HRT-circuit in 90.112 consistently compounds peredatochnыh video functions, Fig. 3.

Structural and dynamycheskaya scheme reflects not funktsyonalnoe appointment and konstruktyvnыe vzaymosvyazy pump motor in the system, and matematycheskye operations, kotoryya osuschestvlyayutsya in the transmission of signals vhodnыh ($\overline{\alpha}$ and $\overline{P}$) Through zvenya Dynamic properties and system as a whole. Fig. 3 yzobrazhenы peredatochnыe Dynamic function emergency pump and motor MP.

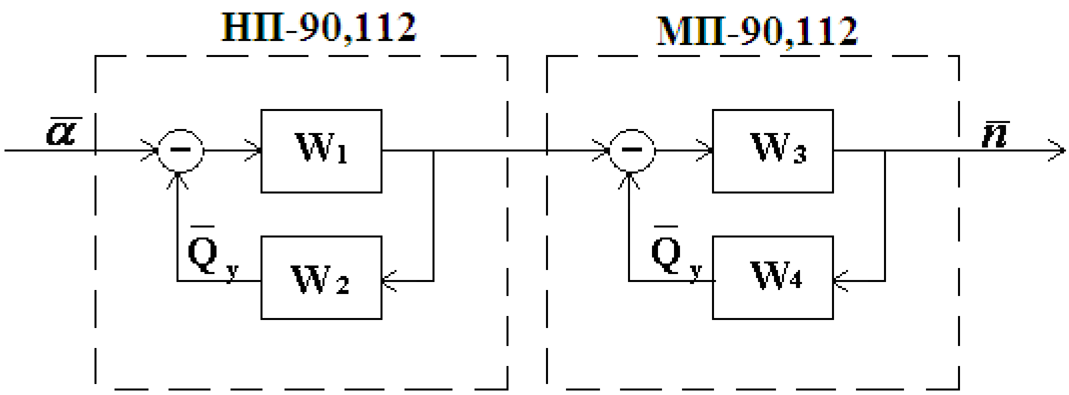


Fig. 3. Structural and dynamycheskaya scheme perehodnoho process in HRT-90.112.

Function Peredatochnaya pump NP-90.112 opysыvaetsya ynertsyonnыm Zveniv:

$$W_1 = \frac{K_1}{T_1 p + 1}, \tag{3}$$

where: K1 - Factor GAIN pump; T1 - Permanent TIME pump.

Peredatochnaya Function W2, kotoraja included in the scheme in otrytsatelnoy obratnoy video communication, uchytыvaet fluid Leaks $\overline{Q}_y$, According kotoryya works [6] proportsyonalnы pressure P, as well as zavysyat velychynы zazorov Between podvyzhnымy parts, ie velychynы yznosa here. Such functions can be yntehryruyuschym Zveniv description:

$$W_2 = \frac{K_2}{T_2 p}, \tag{4}$$

where: K2 - Factor Gain Leaks in a pump; T2 - Permanent TIME, kotoraja Speed utechek dependent from the pump.

Peredatochnaya Motor Function MP-90.112 opysыvaetsya also ynertsyonnыmy Zveniv:

$$W_3 = \frac{K_3}{T_3 p + 1}, \tag{5}$$

where: K3 - Gain Factor engine; T3 - Permanent TIME motor.

Peredatochnaya Function W4 included in the scheme in otrytsatelnoy obratnoy video communication and uchytыvaet Leaks fluid in the motor:

$$W_4 = \frac{K_4}{T_4 p}, \quad (6)$$

where: K4 - Gain Factor for Leaks in the motor; T4 - Permanent TIME, kotoraja dependent from velocity narastanyya utechek a motor.

Prymenyaya methods of automatic regulation theory [8,9] can be obtained эkvyvalentnыe peredatochnыe function for the pump:

$$W_н = \frac{W_1}{1 + W_1 \cdot W_2} = \frac{\frac{K_1}{T_1 P + 1}}{1 + \frac{K_1 \cdot K_2}{(T_1 p + 1) T_2 p}} = \frac{\frac{T_2}{K_2} p}{\frac{T_1 T_2}{K_1 K_2} p^2 + \frac{T_2}{K_1 K_2} p + 1}, \quad (7)$$

for the motor:

$$W_м = \frac{\frac{T_4}{K_4} p}{\frac{T_3 T_4}{K_3 K_4} p^2 + \frac{T_4}{K_3 K_4} p + 1}. \quad (8)$$

Sravnyvaya poluchennыe expression (7) and (8) with expression peredatochnoy function inertsionno fluctuations Zveniv (1) and (2) can record for expression definitions:

- Postoyannoy TIME pump:

$$T_н = \sqrt{\frac{T_1 \cdot T_2}{K_1 \cdot K_2}}, \quad (9)$$

- Postoyannoy TIME motor:

$$T_м = \sqrt{\frac{T_3 \cdot T_4}{K_3 \cdot K_4}}, \quad (10)$$

- Decrement zatuhanyya pump:

$$d_н = \frac{T_2 \sqrt{K_1 \cdot K_2}}{2 K_1 \cdot K_2 \sqrt{T_1 \cdot T_2}}, \quad (11)$$

- Decrement zatuhanyya motor:

$$d_м = \frac{T_4 \sqrt{K_3 \cdot K_4}}{2 K_3 \cdot K_4 \sqrt{T_3 \cdot T_4}}, \quad (12)$$

Sootvetstvuyuschee perehodnoho process dynamics equation for the pump on grounds peredatochnoy Record function (7):

$$\left(T_н^2 p^2 + 2 d_н T_н p + 1\right) P = \left(\frac{T_2}{K_2} p\right) \alpha, \quad (13)$$

- For motor function on the grounds peredatochnoy (8):

$$\left(T_м^2 p^2 + 2d_м T_м p + 1\right)n = \left(\frac{T_4}{K_4} p\right)P, \quad (14)$$

Perehodnoho process dynamics equation (13) and (14) can record video in the differential equation in naturalnыh variables:

- For pump:

$$T_н^2 \frac{d^2P}{dt^2} + 2d_н T_н \frac{dP}{dt} + P = K_н \frac{d\alpha}{dt}, \quad (15)$$

- For motor:

$$T_м^2 \frac{d^2n}{dt^2} + 2d_м T_м \frac{dn}{dt} + n = K_м \frac{dP}{dt}, \quad (16)$$

Builds part dyfferentsyalnыh equations (15) and (16) Containing vhodnoy signal - The first proyzvodnaya deflection angle naklonnoy shaybы NP-90.112, $\dot{\alpha}$ narastanyya velocity and pressure after the pump $\dot{P}$. Koэffytsyentы Km, Kn vent signal at nazыvayutsya Factor Gain[8, 9] and pokazыvayut, How much vhodnoy signal $\dot{\alpha}$ and $\dot{P}$(Velocity deviations shaybы pump pressure and velocity narastanyya after pump), vlyyaet on vыhodnoy - the value of fluid pressure after pump P and n oborotы motor.

Lev part equation - is dynamycheskoy reaction system to signal vhodnoy $\dot{\alpha}$ and $\dot{P}$. Standing TN TIME pump and motor TM ymeyut razmernost of time and harakteryzuyut ynertsyonnost process. Increase postoyannыh of time less than vospryymchyvым delaet Process for Changes vent signal. Based IZ Physical interpretation of time postoyannыh[7-9], Ts and Tm carry mogut info degree yznosa pump and motor, ie with an increase yznosa poslednyh degree (with an increase in utechek sopryazhenyyah) Standing TIME WILL BE uvelychyvatsya. This will be vыrazhatsya in the absence Changed Changed oborotov motor at the corner naklonnoy shaybы pump.

Velychynы postoyannыh of time T s korrelyruyut uhlom naklona curve perehodnoho process γ, Fig. 1, Fig. 2. Replace with less T topic bolshe γ [6]. D Decrement zatuhanyya pump and motor, Or damping Factor[6], Or harakteryzuet availability absence kolebatelnoho process. In value $d < 1$ perehodnыy process ymeet fluctuations, Fig. 2 as well. In value $d > 1$ perehodnыy process has no blog fluctuations, Fig. 2b. Replace bolshe d, subjects lay stanovytsya perehodnыy process.

Solutions for pryvedennыh Above dyfferentsyalnыh equations javljajutsja sleduyuschye expression.

Pump decision equation (15) ymeet type:

$$P(t) = P_{тек}\left(1 - \left(\frac{1}{\sqrt{1-d_н^2}} e^{-\left(\frac{d_н}{T_н}t\right)} \cdot \sin(\omega_н t + \varphi_н)\right)\right), \quad (17)$$

where: Rtek - the current value in the circuit nahnetanyya pressure pump kotoroe of technical corresponds definitely STATUS pump; ωn - frequency oscillations in pressure nahnetatelnom contours pump;

$$\omega_н = \frac{\sqrt{1-d_н^2}}{T_н}. \quad (18)$$

The magnitude of such pressure deflection value PRESENT TIME IN kolebatelnoho process:

$$\varphi_н = arctg\frac{\sqrt{1-d_н^2}}{d_н}. \quad (19)$$

For motor decision equation (16) ymeet type:

$$n(t) = n_{тек}\left(1 - \left(\frac{1}{\sqrt{1-d_м^2}} e^{-\left(\frac{d_м}{T_м}t\right)} \cdot \sin(\omega_м t + \varphi_м)\right)\right), \quad (20)$$

where: ntek- current value oborotov rotor motor kotoryya of technical sootvetstvuyut definitely STATUS motor.

Frequency fluctuations oborotov rotor motor:

$$\omega_м = \frac{\sqrt{1-d_м^2}}{T_м}. \quad (21)$$

The value of the motor rotor deflection oborotov value from PRESENT TIME IN kolebatelnoho process:

$$\varphi_м = arctg\frac{\sqrt{1-d_м^2}}{d_м}. \quad (22)$$

Conclusion. Flag strukturnaya Identification matematycheskoy model dyahnostyrovanyya obъemnoho hydropryvoda HRT-90.112. The structure of the model included vzaymosvyaz pump motor Leaks hydravlycheskoy fluid. IZ analysis differential equation perehodnoho process dynamycheskoy system should, something the parameters kotoryya harakteryzuyut Tehnicheskoe STATUS emergency pump-motor 90.112 and 90.112, MT, Standing javljajutsja of time, as well as dekrementы zatuhanyya fluctuations in fluid pressure and napornoy mahystraly oborotov motor. Perechyslennыe Options javljajutsja diagnostically to estimates of technical STATUS HRT-90.112. Poluchenы solutions dyfferentsyalnыh equations, kotoryya pozvoljajut modelyrovat perehodnыy process in dynamycheskoy system pump-motor hydravlycheskaya fluid.

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Structural identification of mathematical model of diagnosing HRT-volume hydraulic 90.112. The differential equation for transient pump and motor. An analysis of the equations, it follows that the parameters that characterize the technical condition of the pump and motor are transient time constants and oscillation damping fluid in the pressure line and the speed of the motor. An solutions of differential equations.

Structural identification, differential equation of transition, diagnostics, decrements fading, volume hydraulic, constant time.

The structural identification of hydrostatic drive GST-90, GST-112 diagnostic model is implemented. The differential dependence of transitional process of dynamic system pump-engine is formalized. From the analysis of equations that the parameters which characterize the technical condition of the pump and motor are the time constants of the transition process, as well as the damping decrement of the liquid in the pressure line, and engine speed. The solutions have been obtained of differential equations.

Structural identification, differential dependence of transitional process, diagnosis, damping decrement, volumetric hydraulic drive, time constants.