УДК 621.65:532.5:666.9:004.94 **DOI 10.33042/2311-7257.2026.114.1.32**

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OPERATING PROCESS EFFICIENCY IMPROVING OF DIFFERENTIAL MORTAR PUMPS WITH LEVER–CRANK PUMP UNIT DRIVE MECHANISM

The influence of lever–crank pump unit drive kinematic parameters on operating process efficiency of differential mortar pumps during building mortar pipeline transport has been investigated. It is shown that material delivery formation character is governed by pump piston motion law determined by drive mechanism geometric parameters and hydraulic motor operating characteristics. A relation between working element motion velocity parameters, mortar mixture delivery non-uniformity, and dynamic load magnitude in pump unit elements has been established, which affects energy performance indicators of the material transport process. The influence of lever–crank mechanism geometric parameter ratio and drive operating modes on instantaneous theoretical delivery rate, moving link inertia forces, and pressure pulsation level in the discharge pipeline has been substantiated. Dependencies describing the influence of drive kinematic parameters on delivery uniformity and differential mortar pump operating efficiency have been determined. The obtained results can be used to substantiate rational pump unit drive parameters and operating modes of differential mortar pumps within technological systems for mechanized construction operations.

Keywords: *mortar pump, building mortar mixtures, lever–crank mechanism, drive kinematic parameters, mortar mixture delivery rate, delivery non-uniformity, pressure pulsations, volumetric efficiency coefficient, dynamic loads, mixture transport, pump unit*

Introduction

In modern construction practice, a significant share of technological operations is associated with transport and application of building mortar mixtures using plastering units and technological systems for mechanized finishing operations. A key component of such systems is positive-displacement mortar pumps, whose operating parameters determine delivery uniformity, transport energy consumption, and efficiency of mortar flow formation in transport pipelines. Particular importance is associated with application of differential mortar pumps, whose design ensures reduction of delivery pressure pulsations without additional compensating devices and enables improved application quality of building mortar mixtures on treated surfaces [1, 2].

At the same time, operation of existing differential mortar pumps shows that their efficiency is largely determined by pump unit drive kinematic characteristics, particularly by the motion law of the working element of the lever–crank mechanism. Application of conventional electromechanical drives with fixed rotational parameters limits the possibility of piston motion velocity regulation during the operating cycle, which leads to mortar mixture delivery non-uniformity, additional dynamic loads in mechanism joints, and reduced energy efficiency of material transport through pipeline systems [3-5].

In addition, interaction characteristics between pump unit working surfaces and abrasive building mortar environment, presence of variable inertia loads, and volume losses in working chambers determine the necessity of improving structural and kinematic parameters of the lever–crank pump unit drive mechanism to increase volumetric efficiency, reduce delivery pulsations, and ensure rational mortar pump operating modes under variable technological loads.

Despite numerous studies devoted to differential mortar pump design improvement and pump unit service life extension, comprehensive evaluation of lever–crank drive mechanism parameter influence on operating process efficiency during building mortar mixture transport remains insufficiently investigated. This necessitates further research aimed at establishing relationships between pump unit drive kinematic parameters and differential mortar pump performance indicators and substantiating directions for operating process efficiency improvement [6-8].

Analysis of Recent Research

Research on building mortar mixture transport using positive-displacement mortar pumps has long remained an important development direction for technological systems supporting construction process mechanization. Existing studies mainly focus on improving delivery uniformity, reducing pressure pulsations in discharge pipelines, extending pump unit service life, and improving structural parameters of working chambers and valve assemblies of mortar pumps [9, 10].

Studies devoted to double-acting differential mortar pumps show that application of the differential operating principle enables reduction of mortar mixture delivery non-uniformity without additional pressure pulsation compensators and improves material transport efficiency in pipeline systems. Considerable attention is also given to investigation of working chamber geometric parameter influence, piston-to-rod diameter ratio, and compensating cavity filling degree with working fluid on volumetric efficiency indicators and pressure variation characteristics in the discharge pipeline [3, 11].

A separate research direction addresses pump unit service life extension in differential mortar pumps through improvement of plunger unit design, sealing elements, and friction pair materials operating in environments with increased abrasive particle content. It has been established that interaction parameters between pump column working surfaces and transported medium significantly influence cylinder–piston group wear intensity, delivery losses, and energy performance of building mortar mixture transport [12].

At the same time, existing studies devote considerably less attention to influence of pump unit drive kinematic characteristics on operating process efficiency of differential mortar pumps. In particular, formation of the motion law of the lever–crank drive mechanism working element, its influence on mortar mixture delivery uniformity, dynamic load magnitude in mechanism joints, and energy performance of pipeline material transport remain insufficiently investigated.

Under current conditions of mobile technological system development for mechanized finishing operations, particular importance is associated with ensuring controllability of mortar pump working element motion parameters depending on transported medium properties and transport conditions. This necessitates research aimed at establishing relationships between lever–crank pump unit drive mechanism parameters and operating process efficiency of differential mortar pumps, as well as substantiating directions for further structural and kinematic improvement [13, 14].

At the same time, analysis of known structural configurations of pump unit drives in differential mortar pumps shows that the majority of serial machines are equipped with electromechanical drives using crank–lever motion conversion mechanisms whose parameters are structurally predefined and remain practically unchanged during operation. This limits the possibility of adjusting working element velocity characteristics depending on mortar mixture rheological properties and pipeline transport conditions [15].

One promising direction for improving operating process efficiency of differential mortar pumps is application of hydraulic pump unit drives, which expand control capability of working element motion kinematic parameters and reduce dynamic loads in mechanism elements. At the same time, existing hydraulic drive designs for positive-displacement pumps most commonly employ reciprocating hydraulic cylinders, whose application leads to increased drive structural complexity, larger equipment dimensions, and the need for implementation of complex reverse motion control systems [16].

In this regard, application of a hydraulic motor as a drive for the lever–crank mechanism of a differential mortar pump unit represents a promising solution, since it preserves the conventional motion conversion kinematic scheme, enables smooth regulation of working element displacement frequency, and improves operating process efficiency during pipeline transport of building mortar mixtures. However, influence of such drive parameters on differential mortar pump performance characteristics remains insufficiently investigated, which determines the necessity of appropriate theoretical and experimental studies.

Research Goal

The aim of this study is to improve operating process efficiency of differential mortar pumps by investigating influence of lever–crank pump unit drive kinematic parameters under hydraulic motor application on working element motion characteristics, mortar mixture delivery uniformity, and energy performance of pipeline transport.

To achieve this aim, the following research tasks are addressed:

– to analyse formation features of the working element motion law of a differential mortar pump with a lever–crank pump unit drive mechanism under hydraulic motor application;

– to establish relationships describing variation of pump section piston velocity characteristics during the operating cycle and their influence on mortar mixture delivery uniformity;

– to investigate influence of pump unit drive parameters on dynamic load magnitude in lever–crank mechanism elements;

– to determine influence of drive kinematic characteristics on volumetric efficiency and energy performance of building mortar mixture transport;

– to substantiate directions for improving operating process efficiency of differential mortar pumps based on hydraulic motor pump unit drive application.

Methodology and Results

Operating process efficiency of differential mortar pumps (Fig. 1, Fig. 2) is largely determined by working element motion kinematic parameters of the pump unit formed by the lever–crank drive mechanism.

The piston displacement law during the operating cycle directly influences mortar mixture delivery uniformity, pressure variation characteristics in the discharge pipeline, inertia load magnitude in mechanism elements, and energy performance of pipeline material transporting [6].

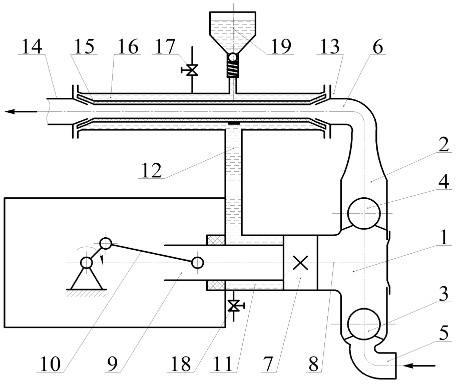

Fig. 1. Differential mortar pump with hydraulic pressure pulsation compensator: 1 – suction working chamber; 2 – discharge working chamber; 3 – ball suction valve; 4 – ball discharge valve; 5 – suction branch pipe;
6 – discharge pipeline; 7 – pump unit piston; 8 – piston rod; 9 – connecting rod; 10 – crank; 11 – rod-side chamber of the hydraulic compensator; 12 – drive chamber of the hydraulic compensator; 13 – hydraulic pressure pulsation compensator; 14 – discharge branch pipe for mortar mixture delivery; 15 – tubular rubber–fabric diaphragm; 16 – hydraulic compensator working fluid; 17 – hydraulic compensator filling valve; 18 – working fluid drain valve; 19 – automatic working fluid replenishment device

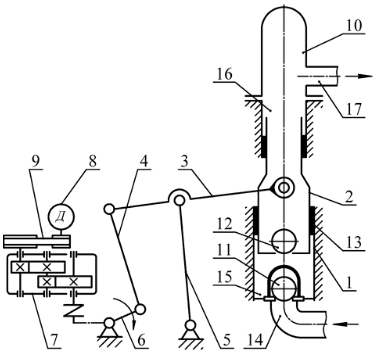

Fig. 2. Differential mortar pump with vertical through-flow plunger: 1 – vertical column; 2 – plunger; 3 – slotted lever (rocker link); 4 – connecting rod; 5 – support frame; 6 – crank; 7 – gearbox; 8 – electric motor; 9 – V-belt transmission; 10 – air pressure compensator; 11 – suction valve; 12 – discharge valve; 13 – seal; 14 – suction branch pipe; 15 – suction valve; 16 – discharge chamber; 17 – discharge pipeline

In conventional differential mortar pump designs, the pump unit is driven by an electric motor through a crank–lever motion conversion mechanism that provides constant rotational parameters of the driving link and, accordingly, a rigidly defined working element displacement law. Under such conditions, piston velocity varies according to a harmonic law, which leads to mortar mixture delivery non-uniformity during the operating cycle and generation of variable dynamic loads in mechanism elements. This, in turn, causes increased energy losses during pipeline material transport and reduces overall mortar pump operating efficiency [8].

Application of a hydraulic motor drive for the lever–crank pump unit mechanism expands control capability of working element motion kinematic parameters through adjustment of driving link rotational frequency depending on transported medium properties and pipeline transport conditions. This creates conditions for reducing mortar mixture delivery non-uniformity, decreasing pressure pulsation level in the discharge pipeline, and increasing pump unit volumetric efficiency.

Considering the above, improvement of differential mortar pump operating process efficiency should be addressed based on analysis of pump section piston motion kinematic characteristics determined by lever–crank mechanism geometric parameters and drive operating parameters [9].

For this purpose, a calculation scheme of the pump unit drive mechanism (Fig. 3) is considered, and analytical relationships describing working element displacement, velocity, and acceleration during the operating cycle are established.

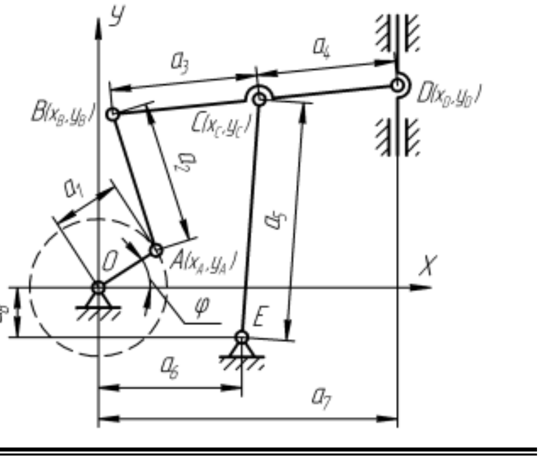

Fig. 3. Calculation scheme of the pump unit drive mechanism

Kinematic analysis of the pump section lever–crank mechanism involves determination of output link position, velocity, and acceleration (piston at point D) depending on crank rotation angle ϕ. A specific feature is application of a hydraulic motor, which enables smooth regulation of angular velocity ω.

For geometric analysis and determination of joint coordinates, a Cartesian coordinate system with origin at point O is introduced. Let link lengths be denoted as $a_1, a_2, \ldots, a_8$.

Coordinates of characteristic points of the mechanism are determined as follows.

For a point A (crank)

$$\begin{cases} x_A = a_1 \cos\phi \\ y_A = a_1 \sin\phi \end{cases}. \qquad (1)$$

For a point E (fixed support): $E(a_6, -a_8)$.

Point $B(x_B, y_B)$ and point $C(x_C, y_C)$ are from the conditions of constancy of link lengths $AB = a_2$, $BC = a_3$, $CE = a_5$. Since the link BCD is a rigid rocker, the points B, C, D lie on the same line (or have a fixed relative location).

A point D makes a reciprocating motion along a vertical guide: $x_D = a_7$.

To solve the equation of kinematic coupling in order to find the position of the piston y_D, we use the method of closed vector contours. For the contour $O-A-B-C-E-O$

$$\begin{aligned} (x_B - x_A)^2 + (y_B - y_A)^2 &= a_2^2 \\ (x_C - x_B)^2 + (y_C - y_B)^2 &= a_3^2 \,. \\ (x_C - a_6)^2 + (y_C + a_8)^2 &= a_5^2 \end{aligned} \qquad (2)$$

Taking into account the fact that D it moves along the line $x = a_7$, and the link CD has a length a_4

$$(a_7 - x_C)^2 + (y_D - y_C)^2 = a_4^2 \,. \qquad (3)$$

The use of a hydraulic motor instead of an electric motor changes the nature of the input link. The angular velocity of the crank $\omega = d\phi / dt$ is determined by the flow rate of the working fluid Q and the working volume of the hydraulic motor V_0

$$\omega = \frac{2\pi Q \eta_v}{V_0}, \qquad (4)$$

where η_v – volumetric efficiency.

The speed control $n = \omega / (2\pi)$ can be changed by changing the flow rate Q (throttle or machine adjustment), which allow to maintain the optimal supply mode of the hydraulic pump.

The speed of the piston $v_D = dy_D / dt$ is obtained by differentiating the equations of coupling by time

$$v_D = \frac{dy_D}{d\phi} \cdot \frac{d\phi}{dt} = v_q(\phi) \cdot \omega, \qquad (5)$$

where $v_q(\phi)$ – the ratio function of the velocity (analogous to the velocity at $\omega = 1$ рад/с).

Piston acceleration a_D

$$a_D = \frac{d^2 y_D}{dt^2} = \frac{dv_q}{d\phi}\omega^2 + v_q \frac{d\omega}{dt} \qquad (6)$$

With steady movement of the hydraulic motor ($d\omega / dt \approx 0$)

$$a_D \approx a_q(\phi) \cdot \omega^2 \qquad (7)$$

Thanks to the hydraulic drive of the lever-connecting rod mechanism, the law of movement of the piston $y_D(t)$ becomes controllable not only through geometry ($a_1 \ldots a_8$), but also through the function $\omega(t)$. This allows minimizing inertial loads at start-up by smooth build-up ω, ensuring stable supply with variable resistance in the pressure line, and eye-syncing the suction and discharge phases.

The position of the piston at an arbitrary moment of time depends on the angle of crank rotation and the geometric parameters of the mechanism and can be represented as a functional dependence

$$y_D = f(\varphi, a_i), \qquad (8)$$

where y_D – pumping unit piston movement, m;

φ – crank rotation angle, rad;

a_i – a set of geometric mechanism parameters.

The parameters a_i include

$$a_i = \{r, l, e, \lambda\}, \qquad (9)$$

where r – crank radius, m;

l – connecting rod length, m;

e – eccentricity of the slider motion axis relative to the crank rotation center, m;

$\lambda = \frac{l}{r}$ – dimensionless link length ratio.

For a central lever–crank mechanism, piston displacement is determined by the following relationship

$$y_D = r(1 - cos\varphi) + \frac{r^2}{l^2}(1 - cos2\varphi). \qquad (10)$$

Piston velocity is determined by differentiation of displacement with respect to time

$$v_D = \frac{dy_D}{dt}. \qquad (11)$$

Taking into account that

$$\frac{d\varphi}{dt} = \omega, \qquad (12)$$

we get

$$v_D = \omega f'(\varphi), \qquad (13)$$

or after substituting a specific dependency

$$v_D = r\omega\left(\sin\varphi + \frac{r}{l}\sin 2\varphi\right), \qquad (14)$$

where ω – crank angular velocity, rad/s.

Piston acceleration is determined by the second derivative of displacement with respect to time

$$a_D = \frac{d^2 y_D}{dt^2}. \qquad (15)$$

At a constant angular speed of crank rotation $\omega = const$ we have

$$a_D = \omega^2 \cdot f''(\varphi), \qquad (16)$$

or

$$a_D = r\omega^2\left(\cos\varphi + \frac{2r}{l}\cos 2\varphi\right) \qquad (17)$$

The obtained relationships describe kinematic parameters of pump unit piston motion and enable evaluation of lever–crank mechanism geometric parameter and hydraulic motor rotational frequency influence on differential mortar pump operating speed regime, mortar mixture delivery non-uniformity, and dynamic load level in mechanism elements.

For quantitative evaluation of lever–crank mechanism kinematic parameter influence on pump unit operation, it is advisable to move from basic kinematic relationships to instantaneous delivery rate, motion non-uniformity coefficient, and inertia load acting on moving links. Such an approach enables correlation between drive mechanism geometry and technological characteristics of mortar mixture pumping and allows evaluation of efficiency improvement potential of differential mortar pump operation [14].

$$q_m(\varphi) = F_n \cdot v_D(\varphi). \qquad (18)$$

where $q_m(\varphi)$ - instantaneous theoretical feed of the pumping unit, m³/s;

F_n - piston area, m²;

$v_D(\varphi)$ - instantaneous piston speed, m/s.

$$F_n = \frac{\pi \cdot d_n^2}{4}. \qquad (19)$$

where d_n - piston diameter, m.

$$Q_{сер} = \frac{1}{2\pi}\int_0^{2\pi} |q_m(\varphi)|\, d\varphi. \qquad (20)$$

where $Q_{сер}$ - average value of theoretical feed per cycle, m³/s.

$$\delta_Q = \frac{q_{max} - q_{min}}{Q_{сер}}. \qquad (21)$$

where δ_Q - feed unevenness coefficient;

q_{max}, q_{min} - maximum and minimum instantaneous feed value, m³/s.

$$F_{ін}(\varphi) = m_{пр}\, a_D(\varphi). \qquad (22)$$

where $F_{ін}(\varphi)$ - inertia force of moving links, N;

$m_{пр}$ - reduced mass of moving elements mechanism, kg;

$a_D(\varphi)$ - piston acceleration, m/s².

$$N_г(\varphi) = \frac{p(\varphi)\, q_m(\varphi)}{\eta_г}. \qquad (23)$$

where $N_г(\varphi)$ - instantaneous hydraulic power, W;

$p(\varphi)$ - pressure in the pressure line, Pa;

$\eta_г$ - hydromechanical efficiency of the drive.

$$k_p = \frac{q_{max}}{Q_{сер}}. \qquad (24)$$

where k_p - the coefficient of the mode intensity of supply, which characterizes the peak load of the pumping unita.

Relationships (18)–(24) show that improvement of differential mortar pump operating process efficiency is determined not only by average delivery rate but also by delivery variation characteristics during the cycle. With increasing piston velocity non-uniformity, amplitudes of instantaneous delivery rate, peak inertia force values, and energy consumption required to overcome local hydraulic resistance in the pipeline system increase. Therefore, selection of mechanism geometric parameters and hydraulic motor operating mode should ensure a compromise between productivity, delivery smoothness, and allowable dynamic load level in pump section elements.

To illustrate the obtained analytical relationships, graphical dependencies of pump unit piston displacement, velocity, acceleration, and theoretical delivery rate were constructed for varying geometric and operating parameters of the mechanism. Calculations were performed for a characteristic parameter range of construction mortar pumps, which enables evaluation of connecting rod length, hydraulic motor angular velocity, and l/r ratio influence on kinematic and technological performance indicators of the machine.

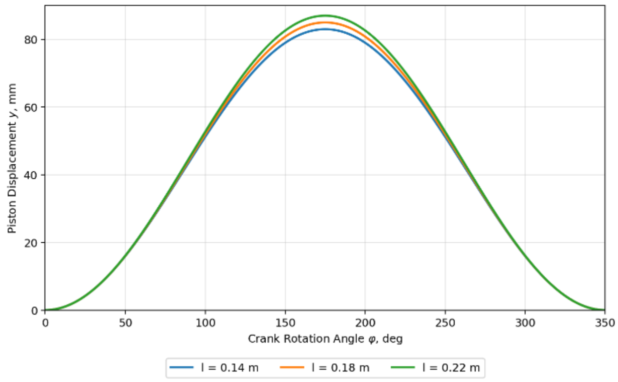

Fig. 4. Piston displacement dependency *y_D* from the angle of crank rotation *φ* at different values of connecting rod length *l*

Graphs in Fig. 4 show that increasing connecting rod length causes the piston displacement trajectory to approach a harmonic law, while stroke asymmetry within the cycle decreases. For smaller values of *l*, a more pronounced deviation from the sinusoidal law is observed, resulting in non-uniform velocity distribution during suction and discharge phases. Therefore, increasing the *l/r* ratio is advisable from the standpoint of piston motion equalization; however, it is accompanied by increased mechanism overall dimensions.

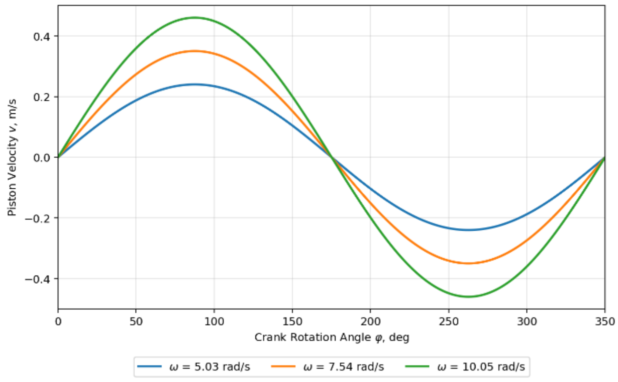

Fig 5. The dependence of the piston speed *v_D* on the crank rotation angle *φ* at different values of angular velocity *ω*

Fig. 5 shows that increasing crank angular velocity preserves the velocity curve shape while proportionally increasing their amplitude values. This indicates that hydraulic motor regulation enables prompt control of pump unit capacity without changing mechanism geometry. At the same time, excessive increase in ω leads to higher instantaneous flow velocities in the discharge pipeline, which may cause additional pressure losses and intensified delivery pulsations.

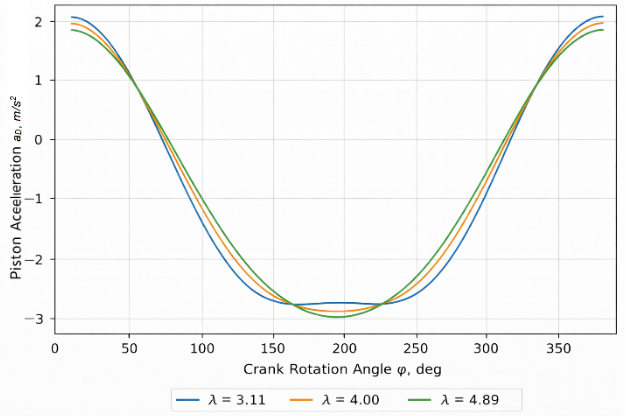

Fig. 6. Dependence of piston acceleration a_D on crank rotation angle φ at different values of the kinematic parameter λ = l/r

Analysis of Figure 6 shows that piston acceleration is most sensitive to changes in the ratio of connecting rod length and crank radius. At lower values of *λ*, sharper acceleration peaks are observed, which cause an increase in inertial loads on the connecting rod system and the pumping part. An increase in *λ* helps to smooth out acceleration extrema, and therefore reduces the dynamic tension of the mechanism and creates prerequisites for increasing its durability.

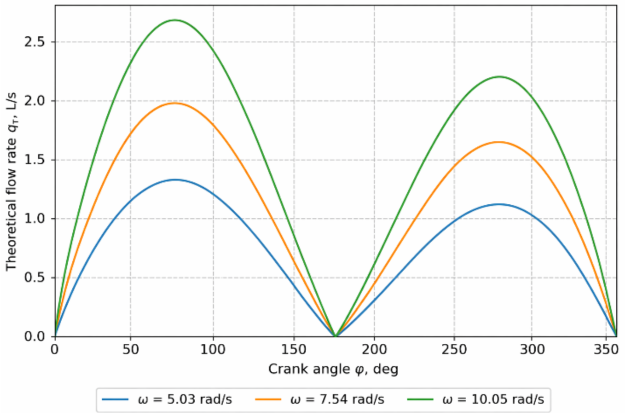

Fig. 7. Dependence of the theoretical supply *q_t* on the crank rotation angle *φ* at different values of angular velocity *ω*

Fig. 7 shows that instantaneous theoretical delivery rate has a pronounced cyclic character and is directly determined by the piston velocity variation law. Increasing hydraulic motor angular velocity raises the average delivery rate; however, it simultaneously increases peak delivery values, which requires coordination of drive operating mode with discharge pipeline capacity and pulsation compensator performance characteristics. In practice, this means that a rational drive operating mode should be selected with consideration of allowable pulsation level and energy consumption during mortar mixture transport.

The obtained graphical relationships confirm that controlled regulation of hydraulic motor angular velocity combined with a justified selection of lever–crank mechanism geometry is an effective means for improving delivery uniformity and reducing dynamic loads in the pump unit. From a practical standpoint, this enables adaptation of the differential mortar pump to transport of mixtures with different rheological properties, reduction of pressure pulsation amplitude, and improvement of technological process energy efficiency.

Conclusions

The study establishes that operating process efficiency of a differential mortar pump with a lever–crank pump unit drive mechanism is determined by combined influence of mechanism geometric parameters and hydraulic motor operating characteristics. The obtained analytical relationships for piston displacement, velocity, acceleration, instantaneous theoretical delivery rate, inertia load, and hydraulic power enable comprehensive evaluation of pump unit performance throughout the operating cycle. It is shown that increasing the connecting rod–to–crank radius ratio reduces piston stroke asymmetry and smooths acceleration peaks, while regulation of hydraulic motor angular velocity enables rapid control of productivity and mortar mixture delivery non-uniformity.

The constructed graphical relationships confirm that rational coordination between lever–crank mechanism geometry and drive operating mode reduces dynamic loads in the pump section, limits delivery pulsations, and improves energy efficiency of building mortar mixture transport. The practical significance of the obtained results lies in substantiation of pump unit drive parameters for differential mortar pumps under various operating conditions, selection of rational pumping regimes, and further development of automated hydraulic motor drive control systems.

References

1. Nerella, V. N., & Mechtcherine, V. (2018). Pumping of concrete: numerical simulation and experimental validation. Cement and Concrete Research, 106, 154–166. https://doi.org/10.1016/j.cemconres.2018.02.00

2. Davidchuk, V. G., & Barabash, I. V. (2021). Mechanoactivation of mixed binding agent and its influence on the strength of construction mortar. Modern Construction and Architecture, (7), 45–52. https://doi.org/10.31650/2786-6696-2021-7-45-52

3. Nie, Z., Chen, Y., Qi, Q., Zeng, J., & Lai, R. (2023). Investigating the effects of particle spatial evolutions on the vibration-induced compaction deformation of gap-graded mixtures via DEM models. Powder Technology. https://doi.org/10.1016/j.powtec.2023.118841.

4. Vasyliev, O. S., & Chyslo, A. V. (2025). Ustanovka dlia pryhotuvannia ta truboprovidnoho transportuvannia budivelnykh rozchyniv z pryvodom robochykh orhaniv vid odnoho elektrodvyhuna. Naukovyi visnyk budivnytstva, (112), 318–324. https://doi.org/10.33042/2311-7257.2025.112.1.39

5. Vasyliev, O. S., & Rohozin, I. A. (2013). The production unit for preparation and transportation of concrete. Eastern-European Journal of Enterprise Technologies, 2(7(62)), 34–36. https://doi.org/10.15587/1729-4061.2013.12383

6. Kaczynski, R., Vasyliev, O., & Vasyliev, I. (2018). The fracture process of the mortar pump’s work surfaces with abrasive particles. International Journal of Engineering & Technology (UAE), 7(3.2), 154–159. https://doi.org/10.14419/ijet.v7i3.2.14394

7. Korobko, B., Zadvorkin, D., & Vasyliev, I. (2018). Energy efficiency of a hydraulically actuated plastering machine. International Journal of Engineering & Technology, 7(3.2), 203–208. https://doi.org/10.14419/ijet.v7i3.2.14403

8. Korobko, B., & Vasyliev, I. (2017). Test method for rheological behavior of mortar for building work. Acta Mechanica et Automatica, 11(3), 173–177. https://doi.org/10.1515/ama-2017-0025

9. Korobko, B., Zadvorkin, D., & Vasyliev, I. (2017). Study of the operating element motion law for a hydraulic-driven diaphragm mortar pump. Eastern-European Journal of Enterprise Technologies, 4/7(88), 25–31. https://doi.org/10.15587/1729-4061.2017.106873

10. Buhaievskyi, M. V. (2024). Mathematical regression model of concrete placing productivity. Radioelectronic and Computer Systems, 3, 121–128. https://doi.org/10.32620/reks.2024.3.13

11. Bilgil, A. (2011). Mathematical modelling in placing of fresh concrete. Engineering, 3(3), 287–293. https://doi.org/10.4236/eng.2011.33023

12. Meiringer, M., & Kugi, A. (2023). Modelling and calibration of elastic boom of mobile concrete pump. Vehicle System Dynamics. https://doi.org/10.1080/00423114.2023.2177311

13. Jiang, S., Zhou, X., & Wang, F. (2022). Numerical simulation research on suction process of concrete pumping system. Powder Technology, 410, Article 117613. https://doi.org/10.1016/j.powtec.2022.117613

14. Zhao, X., Liu, Z., & Zhang, Y. (2024). One-dimensional modeling of pressure loss in concrete pumping pipeline. Applied Sciences, 14, Article 3101. https://doi.org/10.3390/app14073101

15. Paritala, S., Singaram, K., Bathina, I., Khan, M., & Jyosyula, S. (2023). Rheology and pumpability of mix suitable for extrusion-based concrete 3D printing – A review. Construction and Building Materials. 402. https://doi.org/10.1016/j.conbuildmat.2023.132962.

16. Buhaievskyi, M., & Petrenko, Y. (2024). Simulation of production and logistics for concrete plants. Radioelectronic and Computer Systems, 3 (111), 190-204. https://doi.org/10.32620/reks.2024.3.13.

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ПІДВИЩЕННЯ ЕФЕКТИВНОСТІ РОБОЧИХ ПРОЦЕСІВ ДИФЕРЕНЦІАЛЬНИХ РОЗЧИНОНАСОСІВ З ВАЖІЛЬНО-ШАТУННИМ МЕХАНІЗМОМ ПРИВОДУ НАСОСНОГО ВУЗЛА

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Досліджено вплив кінематичних параметрів важільно-шатунного механізму приводу насосного вузла на ефективність робочих процесів диференціальних розчинонасосів при транспортуванні будівельних розчинних сумішей трубопровідними системами. Показано, що характер формування подачі матеріалу визначається законом руху поршня насосної частини, який залежить від геометричних параметрів механізму приводу та режимних характеристик гідромотора. Встановлено взаємозв'язок між швидкісними параметрами руху робочого органа, нерівномірністю подачі розчинної суміші та величиною динамічних навантажень у елементах насосного вузла, що впливає на енергетичні показники процесу транспортування матеріалу. Обґрунтовано вплив співвідношення геометричних параметрів важільно-шатунного механізму та режимів роботи привода на миттєву теоретичну подачу, інерційні сили рухомих ланок і рівень пульсацій тиску в напірній магістралі. Визначено залежності, що описують вплив кінематичних параметрів привода на рівномірність подачі та ефективність функціонування диференціального розчинонасоса. Отримані результати можуть бути використані для обґрунтування раціональних параметрів привода насосного вузла та режимів роботи диференціальних розчинонасосів у складі технологічних комплектів механізованого виконання будівельних робіт.

Ключові слова: *розчинонасос, будівельні розчинні суміші, важільно-шатунний механізм, кінематичні параметри привода, подача розчинної суміші, нерівномірність подачі, пульсації тиску, об'ємний коефіцієнт корисної дії, динамічні навантаження, транспортування сумішей, насосний вузол*