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Improved algorithm for calculating engineering parameters of a garbage truck compaction plate mechanism considering hydraulic cylinder wear

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Abstract

The article presents a scientifically based, improved methodology for the design calculation of the parameters of a garbage truck's sealing plate mechanism, developed through an analysis of scientific literature and taking into account the wear of its hydraulic cylinder, in order to determine the main geometric, force, and speed characteristics. The drive for the working components of the sealing plate mechanism is hydraulic and is powered by the garbage truck's pump station. The application of the proposed improved engineering calculation methodology allows for a significant reduction in design time and avoids unnecessary costs associated with conducting complex experimental and theoretical studies. Using the developed methodology, the main geometric, force, and speed parameters of the garbage truck's sealing plate mechanism were determined, taking into account the wear of the hydraulic cylinder. It has been established that further refinement of the engineering calculation methodology for the garbage truck's sealing plate mechanism using a load-sensitive scheme requires additional research.

Keywords: algorithm, design calculation method, hydraulic drive, consideration of wear, wear rate, wear intensity, hydraulic cylinder, mechanism, sealing plate, garbage truck, municipal solid waste.

Introduction

One of the priority directions of modern mechanical engineering is improving the reliability and wear resistance of machine executive mechanisms [1, 2], particularly in municipal equipment, which includes garbage trucks [3], that are mainly equipped with hydraulic drives for their working components [4, 5]. One of the main technologies for the primary processing of municipal solid waste (MSW), aimed at reducing transportation costs and minimizing the negative impact on the environment, is the compaction of waste directly during loading into the garbage truck. This approach makes it possible to significantly reduce transportation costs and decrease the area of landfills required for MSW disposal, which is of great economic and environmental importance. The process of compacting MSW in a garbage truck is carried out using a sealing plate, which is driven by a working hydraulic cylinder. During operation, this hydraulic cylinder is subject to intense wear due to a large number of operating cycles and high compaction forces caused by the nonlinear compression characteristics of MSW. Hydraulic cylinders are typically made of alloy steels; however, to increase their service life, it is advisable to apply wear-resistant coatings. The development of an improved method for the design calculation of the parameters of the garbage truck's sealing plate mechanism, taking into account the wear of its hydraulic cylinder, will contribute to more effective planning of the renewal, maintenance, and repair of garbage trucks.

Analysis of recent research and publications

Article [6] presents an analytical and statistical study of a model range of specialized equipment, including an analysis of its technical characteristics, for the purpose of developing a kinematic diagram of the compaction mechanism in a garbage truck; calculations were performed based on a method for modeling the structure of component assemblies. The modeling was performed in SolidWorks Simulation. The developed kinematic diagrams of the components and assemblies for briquetting and compacting MSW operate at the rated power characteristics of the hydraulic equipment due to the distribution of drive power across the most energy-intensive operations. The usage of the principles of moments of inertia and the gravitational forces of the own mass of solid waste, made it possible to significantly (by 25%) reduce the energy intensity of the compaction process.

In [4], based on the results of computer modeling of the hydrodynamic processes of working fluid flow through a hydraulic valve, the values of pressure losses were determined. To reduce these losses, a design improvement to the hydraulic valve was proposed that does not affect its functional characteristics. Implementing these changes made it possible to reduce pressure losses in the working zone of the hydraulic distributor, which contributes to a reduction in total energy losses in the hydraulic drive system.

The research paper [7] studies the peculiarities of the process of pressing wood chips in screw presses and analyzes the processes occurring in specific sections of the screw. The identified dependences make it possible to calculate the loads on the screw flights and determine the power required to carry out the compaction process. In addition, the level of raw material heating and the specific energy consumption arising during compaction were determined.

Scientific article [8] presents a structural analysis of a garbage truck's compaction plate. In the first stage, parametric modeling was performed of the assembly consisting of the compaction plate, the counter-pressure plate, the rear section of the garbage truck, and the material being compacted. Dynamic modeling of the solid waste compaction process in the garbage truck was performed, and the mechanical stresses for the compaction plate were loaded into the SolidWorks Simulation. The finite element method was used, resulting in the determination of the values and distribution of equivalent stresses calculated according to the von Mises criterion, as well as the displacements and relative deformations of the compaction sealing plate of the analyzed garbage truck.

An exponential dependence of the change in the wear rate of the working hydraulic cylinder of the garbage truck's sealing plate mechanism on the magnitude of the compaction force was established in [9]. Taking this dependence into account makes it possible to improve the efficiency of maintenance and repair planning, which generally contributes to the improvement of the operational characteristics of garbage trucks. To make the analysis of the process more visual, a graphical relationship was plotted between the wear rate of the working hydraulic cylinder of the sealing plate mechanism of a garbage truck and the compaction force, which confirmed the sufficient consistency of the obtained results. It was established that for a Ukrainian-made KO-436 series garbage truck, the wear rate of the working hydraulic cylinder of the sealing plate mechanism, in accordance with the observed pattern, is 0.257 μm/h, and an increase in the pressing force from 30 MN to 150 MN results in a 3.6-fold decrease in the wear rate of the working hydraulic cylinder of the hydraulic press mechanism. This result is explained by the characteristics of the contact interaction between the working surfaces and the specifics of the mechanism's operation under different load levels.

The study [10] provides a comprehensive analysis of the kinematics and dynamics of the scraper pressing mechanism in a garbage truck using numerical methods. To study the mechanism's operation under actual working conditions over a full cycle lasting 18 seconds, a multi-body model was developed and integrated with a hydraulic simulation model. The model was validated by calculations at steady-state time points, which demonstrated high convergence. The results showed that the mechanism operates in steady-state conditions almost all the time, with hydraulic cylinder rod speeds ranging from 0.08 to 0.15 m/s. The speed and acceleration of the hydraulic cylinder fluctuate significantly when the mechanism accelerates or decelerates; however, the effect of inertia is negligible. The forces applied to the joints are greatest at the end of the pressing process. Notably, the force applied to the joint connecting the scraper plate and the sliding plate is the highest: three times higher than that applied to the joint between the sliding plate and the pressing hydraulic cylinder, and one and a half times higher than that between the scraper plate and the scraper hydraulic cylinder. The results of the study can be applied to the design process of garbage trucks in special and specialized vehicles in general or used as a guideline for improving performance and optimizing the weight, force, and materials of the mechanism.

According to research data [11], among the main components of side-loading garbage trucks, the hydraulic system has the shortest service life before failure, which is one of the key factors contributing to increased wear and tear on these vehicles. According to the results of the study [12], the structure and most common causes of failures in the hydraulic equipment of garbage trucks have been identified, among which hydraulic cylinders account for 34.92% (wear of seals and cuffs, rod, failure of piston fasteners, rod bending, mechanical damage), hydraulic pumps – 16.40% (wear of the working surfaces of the housing and gears, leakage through seals, formation of cracks in the housing), pipelines and flexible hoses – 15.34% (hose ruptures, degradation of pipelines), and hydraulic distributors – 13.23% (wear of sealing elements and spools, housing cracks).

Article [13] presents several design options for compaction mechanisms in garbage trucks and conducts a comparative analysis of their design and functionality. A kinematic analysis is performed on a mechanism used for a wide range of compaction through translational motion. Determining the motion characteristics of the working components of these mechanisms is necessary for a full understanding of their operation, especially for designing and improving their functional parameters to achieve low energy consumption.

An analysis of the causes of typical technical failures in garbage truck units, presented in [14], showed that a significant proportion of malfunctions (about 45%) is associated with hydraulic drive failure. The main causes of such failures are manufacturing defects resulting from the use of low-quality components, as well as significant fluctuations in loads on working parts. Studies of working part failures indicate that the majority of malfunctions arise from defects in heat treatment and deviations in geometric dimensions during machining (35%), errors during assembly, adjustment, and tightening of threaded connections (30%), as well as poor-quality welding (30%). It has been established that the majority of failures (80–90%) are caused by wear and corrosion damage to the working surfaces of parts, with failure occurring after a critical level of degradation is reached, i.e., when the unit or its assembly reaches its limit technical condition. In particular, approximately 28% of all failures of hydraulic drive components occur in hydraulic cylinders, which is associated with wear of mating surfaces and deformations of the piston rod and cylinder during operation. A durability analysis showed that the average service life of hydraulic drive components, particularly hydraulic cylinders, is approximately one-third of their maximum service life; that is, 45–55% of the service life specified by the manufacturer is not actually achieved. The majority of hydraulic cylinder failures during the early stages of operation or after repairs are attributed to piston rods (31%) and sealing cuffs (42%). In addition, an analysis of hydraulic system component failures revealed that the primary manifestation of malfunctions is the loss of external and internal sealing caused by contamination of the working fluid, which leads to disruption of the normal operation of the units.

The scientific article [15] describes a mechanism for compacting solid waste using a transfer mechanism, which has been used with great success in the design of modern garbage trucks. In [16], a simulation using Finite Elements Analysis method (FEA) was performed to analyze the behavior of a similar compression plate structure in a garbage truck.

The study [17] provides a detailed distribution of the main causes of garbage truck failures, indicating that the key factors contributing to malfunctions are external and internal leaks in hydraulic systems. In particular, external leaks account for about 48% of all recorded failures and are mainly caused by damage to flexible hoses and pipelines, as well as leaks in the sealing elements of hydraulic cylinders and other components. Such defects lead to working fluid leaks, which negatively affect the overall functioning of the hydraulic system, reducing its efficiency and increasing the risk of serious accidents. In addition, internal leakage is a significant and fairly common cause of failures, accounting for approximately 36% of all malfunctions. This occurs due to a violation of the integrity between the working chambers of hydraulic components, leading to the flow of hydraulic fluid into non-working areas and a reduction in system pressure. Most often, such failures are observed in critical components of the hydraulic system, such as spool valves, relief and check valves, hydraulic cylinders, and hydraulic pumps. Since these units perform the primary functions of garbage trucks, their failure due to internal leaks significantly reduces the overall performance and reliability of the equipment.

A study [18] found that "conical" wear of the hydraulic cylinder rod in the range of 0.2–0.4 mm along its length prior to the first major repair leads to a 7.2% decrease in pressure in the hydraulic system, an 11.4% increase in specific fuel consumption, and a 26% increase in carbon monoxide content in the exhaust gases. Further increase in rod wear in the working section to 0.6–0.7 mm causes a 13.4% decrease in hydraulic system pressure, a 21.3% increase in specific fuel consumption, and a significant increase in exhaust gas toxicity ranging from 25% to 59%, exceeding permissible regulatory limits. A value of no more than 0.4 mm is proposed as the maximum permissible wear limit for the geometric parameters of the hydraulic cylinder rod in the hydraulic drive systems of construction and road machinery. In addition, it has been established that rod wear negatively affects the physicochemical properties of the working fluid, in particular increasing the content of iron and mechanical impurities by approximately two times, which requires more frequent replacement of the working fluid and leads to its overconsumption. Overall, this significantly reduces the efficiency and durability of the hydraulic drive, shortening its service life in construction and road machinery.

Article [19] presents a structural analysis of the wear parts in the compaction mechanism of a garbage truck. 3D parametric modeling was performed for the compaction plate, the dump body, the compaction material, the push plate, and the wear parts. Dynamic modeling of the solid waste compaction process inside the body was performed, and the mechanical stresses on the wear parts obtained as a result of the dynamic modeling were imported into the finite element analysis module of the SolidWorks software.

The paper [20] notes that wear of sealing elements in hydraulic systems causes the gradual infiltration of working fluid into non-operational cavities of hydraulic machines. Although this process is not always visible externally, it leads to unproductive power losses in the hydraulic drive, which, in turn, causes excessive consumption of fuel and lubricants, as well as a reduction in the power of the working components. Power losses caused by seal degradation can result in non-optimal hydraulic motor operating conditions, which negatively affects the overall efficiency of the hydraulic drive system. The mechanical system "hydraulic cylinder – sealed piston – compressed hydraulic fluid" is examined, for which the relationship between the hydraulic cylinder's efficiency and the degree of leakage is established. The amount of piston sinkage when using VMGZ working fluid is also determined, and the mechanism of fluid leakage through the hydraulic cylinder's sealing elements is analyzed.

The authors of the article [21], in their analysis of operational observations of garbage trucks, found that the largest proportion of failures is associated with wear and corrosion damage to the working surfaces of the working equipment components. Failures of hydraulic cylinders caused by wear of mating surfaces and deformations of the piston rod and cylinder during operation account for 32% of the total number of hydraulic drive component failures. This situation is explained by uneven loading of the body and intense abrasive effects under the demanding operating conditions of garbage trucks. An investigation into the causes of failures revealed that the primary factor is the wear of the working surfaces of key hydraulic drive components, specifically spools and hydraulic manifold housings, as well as hydraulic cylinder rods. It has been determined that the dominant failure mechanism is hydro-abrasive wear, which occurs as a result of untimely replacement of the hydraulic fluid and the use of low-quality or worn sealing elements, such as hydraulic cylinder seals. This facilitates the entrance of dust and wear products into the sliding zone, which accelerates the degradation of working surfaces. As one of the promising methods for restoring worn parts in operation, chromium plating in a cold self-regulating electrolyte is proposed, which ensures the production of high-quality chromium coatings with high productivity.

The paper [22] investigates a rear-loading garbage truck, which is considered as a system consisting of several main components: the vehicle chassis, the truck body, a hydraulic cylinder, a compaction mechanism, and a push plate. The garbage truck body is rigidly mounted on the chassis frame, providing a reliable structural foundation for all operational activities. Located at the rear of the vehicle is the compaction mechanism, which is responsible for receiving waste and initially compacting it before further transfer into the body. After initial compaction, the waste is pushed into the garbage truck body by a scraper that interacts with the compaction mechanism. Each load of compacted waste, as well as the portion of waste being loaded, is gradually pushed toward the rear of the truck body. At the same time, the push plate continuously moves backward, creating the necessary pressure for compaction and uniform distribution of waste throughout the body. The push plate assembly consists of a front plate, frame, guide rail frame, cylinder supports, and other components. As a critically important load-bearing component of rear-loading garbage trucks, the mechanical characteristics of this plate directly affect the vehicle’s performance, determining the efficiency of loading, compaction, transportation, and unloading of solid waste.

The scientific article [23] presents a nonlinear mathematical model that is described by a system of differential equations with corresponding boundary conditions and characterizes the operation of the hydraulic drive of a garbage truck’s compaction pressing plate mechanism, particularly during the static compaction of solid waste, which is a significant stage in its initial processing. At the same time, despite the model’s high accuracy and level of detail, it does not account for the effect of wear on the power hydraulic cylinder, which is one of the key elements of the hydraulic drive. Ignoring this factor may limit the model’s applicability for long-term forecasting of the mechanism’s performance under real operating conditions, where hydraulic cylinder wear significantly affects the system’s performance and reliability.

The materials of the work [24], based on a detailed analytical study of a mathematical model, identify the main dependencies of the functioning of vibrating and vibro-impact machines operating with a hydraulic pulse drive equipped with a single-stage pulsator valve. The developed model made it possible to describe the dynamic processes occurring in the hydraulic system and the machine’s working parts, as well as to analyze the nature of pressure pulse formation and their effect on the kinematic and force parameters of vibrational motion. The study established relationships between the design parameters of the hydraulic pulsation drive, its operating modes, and the dynamic characteristics of the machines, specifically the amplitude and frequency of oscillations, as well as the energy of impact pulses. The results obtained made it possible to determine the conditions for stable operation of vibrating and vibro-impact machines, estimate the effectiveness of using a hydraulic pulse drive in various operating modes, and formulate recommendations for optimizing the parameters of the pulse valve to improve the performance, reliability, and energy efficiency of such machines, which is necessary for the further development of a methodology for the design calculation of their parameters.

However, during the review of the available literature, the authors did not identify a comprehensive methodology for the design calculation of the parameters of a garbage truck’s sealing plate mechanism that takes into account the wear of its hydraulic cylinder.

Aims of the article

Development of a scientifically based, improved method for the design calculation of the parameters of a garbage truck’s sealing plate mechanism, taking into account the wear of its hydraulic cylinder, with the aim of determining its main geometric, force, and speed parameters.

Methods

The following methods were used in this study: analysis of scientific literature; synthesis of mathematical relationships between the main geometric, force, and speed parameters of the equipment; and a systematic approach to account for the interaction of all the machine’s subsystems.

Results

Figure 1 shows a schematic diagram of a garbage truck’s operation during the static compaction of municipal solid waste (MSW), taking into account hydraulic cylinder wear [23], in which the following structural elements and values are indicated: PP – pressing plate; HC – hydraulic cylinder; HD – hydraulic distributor; P – hydraulic pump; SV – safety valve; F – filter; T – working fluid tank. The diagram also shows the following main geometric, kinematic, and force parameters: p_1, p_2, p_3, p_4 – pressures at the pump outlet, hydraulic cylinder inlet, hydraulic cylinder outlet, and filter inlet, respectively; W_1, W_2, W_3, W_4 – volumes of pipelines between the pump and hydraulic distributor, hydraulic distributor and hydraulic cylinder inlet, hydraulic cylinder outlet and hydraulic distributor, hydraulic distributor and filter; Q_P – actual pump flow rate; S_P – nominal cross-sectional area of the distributor opening; S_f – surface area of the filter element; k_f – specific filter capacity (not shown in the diagram); μ_d – dynamic viscosity coefficient (not shown in the diagram); D, d – diameters of the piston and rod; G_p – weight of the pressing plate; G_c – weight of the hydraulic cylinder; G_{W1} – weight of the waste above the pressing plate; G_{W2} – weight of the waste outside the pressing plate; F_{FR} – friction force between the pressing plate and the guides; F_{TW} – the friction force between the MSW and the body; F_C – the force developed by the hydraulic cylinder; h_1, h_2 – the heights of the bottom and top of the press plate; b – the width of the press sealing plate (not shown in the diagram); δ – the thickness of the press plate; α – the angle of inclination of the press plate; x – the displacement of the press plate.

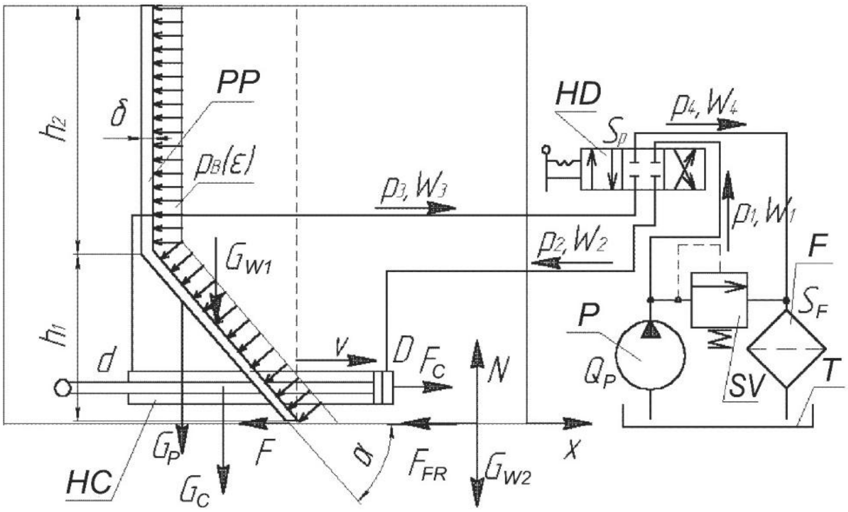

Fig. 1. Schematic diagram of the hydraulic drive for the pressing plate during static compaction of MSW, taking into account hydraulic cylinder wear

Let's determine the area of the pressure chamber of the hydraulic cylinder in the garbage truck's sealing plate mechanism

$$S_{C1} = \pi D^2/4 \ \text{[m}^2\text{]},$$

where S_{C1} – the cross-sectional area of the pressure chamber of the hydraulic cylinder in the sealing plate mechanism of a garbage truck, m^2; D – the diameter of the hydraulic cylinder piston in the garbage truck's sealing plate mechanism, m.

The wear rate of the working hydraulic cylinder in the sealing plate mechanism of a garbage truck is determined according to the formula in [9]:

$$v_u = 7.153 \cdot 10^{-5} e^{-1.047 \cdot 10^{-8} p_2 S_{C1}} [\mu\text{m/s}], \tag{2}$$

where v_u – rate of wear on the hydraulic cylinder, μm/s; p_2 – pressure in the pressure chamber of the hydraulic cylinder of the garbage truck's sealing plate mechanism, Pa.

Determination of the duration of MSW compaction in a garbage truck, taking into account the wear of the hydraulic cylinder of the sealing plate [25]:

$$t \approx \frac{1}{\beta_p} \ln\left[\frac{p_2 S_{C1}^2}{m_r \beta_p (Q_P - \alpha_\sigma)} + \frac{\beta_\sigma}{\beta_p (Q_p - \alpha_\sigma)}\right] \ \text{[s]}, \tag{3}$$

where α_σ, β_σ – approximation coefficients for the dependence of working fluid losses on the duration of hydraulic cylinder wear; m_r – the reduced mass of the moving parts, kg; β_p – the coefficient of approximation of the dependence of the MSW compaction pressure on the duration of the process; Q_P – actual pump flow rate, m³/s.
Let's calculate the number of trips the garbage truck will make:

$$n_T = n_{WD} \frac{T - 2l_0 / v}{t_L + 2l_L / v + t_U}, \tag{4}$$

where n_{WD} – number of working days; T – duration of the workday, hours; l_0 – zero (initial) mileage, km; v – speed, km/h; t_L – loading time, hours; l_L – distance to the solid waste landfill, km; t_U – unloading time, hours.

Determination of the number of operating cycles of the hydraulic cylinder in the garbage truck's sealing plate mechanism:

$$n_{c.HC} = n_P \frac{Vk_c}{V_C}, \quad (5)$$

where V – the volume of the garbage truck's body, m^3; k_c – solid waste compaction ratio; V_C – volume of the solid waste container, m^3.

Determination of the wear of the working hydraulic cylinder in the compaction plate mechanism of the garbage truck using the following formula:

$$u = v_u t n_{c.HC} \text{ [µm]}. \quad (6)$$

The flow loss coefficient of the working fluid from the high-pressure region to the low-pressure region, taking into account hydraulic cylinder wear, is determined using the formula [26]:

$$\sigma = \frac{\pi D\left(\delta_0 + 10^{-6}u\right)^3}{12\nu\rho_{WF} l} \text{ [m}^5\text{/(N·s)]}, \quad (7)$$

where δ_0 – nominal clearance, m; ν – kinematic viscosity of the working fluid, m²/s; ρ_{WF} – density of the working fluid, kg/m³; l – length of the circular clearance, m.

Let's calculate the friction distance

$$s = 2x_{\max} n_{c.HC} \text{ [m]}, \quad (8)$$

where $x_{\max}$ – length of stroke of the hydraulic cylinder in the sealing plate mechanism of the garbage truck, m.

Determination of the wear rate of the hydraulic cylinder in the garbage truck's sealing plate mechanism using the following formula:

$$I_h = u/s. \quad (9)$$

Determination of the required chromium content in the protective coating of the hydraulic cylinder for the sealing plate mechanism of a garbage truck [27]:

$$C_{Cr} = 1.36\cdot10^3 I_h + C_{Fe}(9.08 - 0.416C_{Ni}) + 75.6 \text{ [\%]}, \quad (10)$$

where C_{Cr} – chromium content in the coating Fe-Cr-Ni, %; C_{Fe} – iron content in the coating Fe-Cr-Ni, %; C_{Ni} – nickel content in the coating Fe-Cr-Ni, %.

The parameters of the sealing plate mechanism on a garbage truck, taking into account the wear of its hydraulic cylinder, calculated using the proposed method, are shown in the Table 1.

Table 1

The main parameters of the sealing plate mechanism on a garbage truck, taking into account the wear of its hydraulic cylinder

S_{C1}, m^2	$v_{u.рeu}$, µm/s	t, s	n_P, trips	n_{cHC}, cycles	u, µm	σ, m^5/(N·s)	s, m	I_h, µm/m	C_{Cr}, %
$9.5\cdot10^{-3}$	$7.15\cdot10^{-5}$	74.9	719	14380	77	$1.424\cdot10^{-10}$	25884	$2.97\cdot10^{-3}$	46.6

The parameters of the sealing plate mechanism on a garbage truck, taking into account the wear of its hydraulic cylinder, were obtained based on the following initial data: D = 0.11 m; p_2 = 9.68 MPa; Q_P = 55 l/min; α_σ = -3.573·10^{-9} m^3/s; β_σ = 1.443·10^{-9} m^3/s^2; m_p = 330 kg; β_P = 0.00217; n_{WD} = 127 days; T = 8 hours; l_0 = 3 km; v = 60 km/h; t_3 = 0.389 hours; l_L = 30 km; t_U = 5.6·10^{-3} hours; V = 10 m^3; k_c = 2.2; V_C = 1.1 m^3; δ_0 = 0.136 mm; ν = 1.83·10^{-5} m^2/s; ρ_{WF} = 890 kg/m^3; l = 0.12 m; $x_{\max}$ = 0.9 m; C_{Fe} = 25 %; C_{Ni} = 25 %.

The usage of the proposed improved method for engineering calculations of the parameters of a garbage truck's sealing plate mechanism, taking into account the wear of its hydraulic cylinder, makes it possible to significantly reduce design time and avoid unnecessary costs associated with labor-intensive experimental and theoretical research.

The development of an improved method for engineering calculations of the sealing plate mechanism in a garbage truck using a load-sensitive model requires further research.

Conclusions

Scientifically based improved algorithm for the design calculation of the parameters of a garbage truck's sealing plate mechanism, taking into account the wear of its hydraulic cylinder, is proposed, which allows to determine its main geometric, force, and speed parameters. It has been established that the development of an improved methodology for engineering calculations of the sealing plate mechanism of a garbage truck using a load-sensitive scheme requires further research.

References

1. Dykha A., Sorokatyi R., Pasichnyk O., Yaroshenko P., Skrypnyk T. (2020, December) Machine wear calculation module in computer-aided design systems. In IOP Conference Series: Materials Science and Engineering, 1001(1), 012040, https://doi.org/10.1088/1757-899X/1001/1/012040

2. Kindrachuk M.V., Kharchenko V.V., Marchuk V.Y., Humeniuk I.A., Leusenko D.V. (2024) Methodology for Selecting Compatible Metal Materials for Friction Pairs During Fretting-Corrosion Wear. Metallophysics & Advanced Technologies, 46(7), 637-648, https://doi.org/10.15407/mfint.46.07.0637

3. Holenko K., Dykha O., Koda E., Kernytskyy I., Horbay O., Royko Y., Fornalchyk Y., Berezovetska O., Rys V., Humenuyk R., Berezovetskyi S., Żółtowski M., Baryłka A., Markiewicz A., Wierzbicki T., Bayat H. (2024) Structure and strength optimization of the Bogdan ERCV27 electric garbage truck spatial frame under static loading. Applied Sciences, 14(23), 11012, https://doi.org/10.3390/app142311012

4. Petrov O., Kozlov L., Lozinskiy D., Piontkevych O. (2019) Improvement of the hydraulic units design based on CFD modeling. In: Lecture Notes in Mechanical Engineering XXII, 653-660, https://doi.org/10.1007/978-3-030-22365-6_65

5. Polishchuk L.K., Piontkevych O.V., Svietlov A.V., Adler O.O., Lozinskyi D. (2025) Development and optimization of the control devicefor the hydraulic drive of the belt conveyor. Informatyka, Automatyka, Pomiary w Gospodarce i Ochronie Środowiska, 15, 124-129, http://doi.org/10.35784/iapgos.7051

6. Savinkin V.V., Kuznetsova V.N., Abilmazhinova A.S. (2020) Development of an Energy-Efficient Rotary Inertia Device for Briquetting Household Solid Waste (HSW). World of transport, 18(1), 38-57, https://doi.org/10.30932/1992-3252-2020-18-38-57

7. Tataryants M.S., Zavinsky S.I., Troshin A.G. (2015) Development of a methodology for calculating loads on the screw and energy consumption of screw presses. ScienceRise, 6 (2), 80-84, https://doi.org/10.15587/2313-8416.2015.44378

8. Voicu G., Lazea M., Constantin G.A., Stefan E.M., Munteanu M.G. (2020) Finite element analysis of the compaction plate from a garbage truck. In E3S Web of Conferences, 180, 04006, https://doi.org/10.1051/e3sconf/202018004006

9. Bereziuk O.V., Savulyak V.I., Kharzhevskyi V.O., Alekseiev A.Ye. (2024) Determination of the regularity of the rate of wear of the working hydraulic cylinder of the mechanism of the sealing plate of the garbage truck from the pressing force. Problems of Tribology, 29(1/111), 38-44, https://doi.org/10.31891/2079-1372-2024-111-1-38-44

10. Pham M.Q., Vu T.V., Tran L.Q., Nguyen H.H., Hong T.D. (2024) Study on Kinetics and Dynamics of the Scraping-pressing Mechanism of the Compactor Garbage Truck. FME Transactions, 52(4), 603, http://dx.doi.org/10.5937/fme2404603Q

11. Nosenko A.S., Domnickij A.A., Altunina M.S., Zubov V.V. (2019) Theoretical and experimental research findings on batch-operation bin loader with hydraulically driven conveying element. MIAB. Mining Informational and Analytical Bulletin, 11, 119-130, http://dx.doi.org/10.25018/0236-1493-2019-11-0-119-130

12. Lobov N.V., Maltsev D.V., Genson E.M. (2019) Improving the process of transport of solid municipal waste by automobile transport. Proceedings of IOP Conference Series: Materials Science and Engineering. IOP Publishing, 1(632), 012033, https://doi.org/10.1088/1757-899X/632/1/012033

13. Voicu G., Lazea M., Zabava B.S., Tudor P., Moise V. (2019) Cinematical analysis of the pre-taking and pre-compacting mechanisms of some garbage trucks. Journal of Engineering Studies and Research, 25(2), 56-62, https://doi.org/10.29081/jesr.v25i2.35

14. Kotomchin A.N., Lyakhov Yu.G. (2019) Analysis of failures of knots and units of construction, road, lifting and transport machines and specialized motor transport on the example of MUE «Communalderservice». Engineering & Computer science, 3, 174-178.

15. Anghelache D., Tăbăraşu A.M., Persu C., Dumitru I., Stroescu G., Dumitru D., Voicu G. (2020) Aspects regarding the operation of mobile technical systems for collection and compaction by translation of municipal waste. ISB-INMA TEH' 2020, Agricultural and mechanical engineering, Bucharest, Romania, 30 October 2020, 181-185, https://www.cabidigitallibrary.org/doi/pdf/10.5555/20210291248

16. Lazea M., Voicu G., Constantin G.A., Zabava B.Ş., Tudor, P. (2021) Translation compaction systems used in waste collection and transportation. Acta Technica Corviniensis-Bulletin of Engineering, 14(1), 97-100, https://www.cabidigitallibrary.org/doi/full/10.5555/20209905712

17. Kabashev R.A. (1997) Road and construction machines: abrasive wear of the working parts of earthmoving machines. Almaty: Gylym.

18. Nurakov S.N., Savinkin V.V. (2008) About development methods for calculating the wear of the rod cylinder interface of hydraulic machines. Proceedings of the Karaganda State Technical University, 3 (32), 96.

19. Lazea M., Constantin G.A., Stoica D., Voicu G. (2020) Fem structural analysis for wear parts supporting counterpressure plate from a municipal solid waste truck. Revista romana de materiale-romanian journal of materials, 50(2), CP1-CP3, https://doi.org/10.1051/e3sconf/202018004006

20. Shalapai VV, Machuga OS (2023) Vtraty potuzhnosti u hidrotsylindri vnaslidok protikannia hidravlichnoi ridyny cherez neshchilnist [Power loss in the hydraulic cylinder due to hydraulic fluid leakage through non-tightness]. Comprehensive quality assurance of technological processes and systems –2023: Proceedings of the XIII International Scientific and Practical Conference, May 25-26, 2023, Chernihiv. National University "Chernihiv Polytechnic", 287-289.

21. Kargin R.V., Yakovlev I.A., Shemshura E.A. (2017) Modeling of workflow in the grip-container-grip system of body garbage trucks. Procedia Engineering, 206, 1535-1539, https://doi.org/10.1016/j.proeng.2017.10.727

22. Ding F.S., Lyu H.M., Chen J., Cao H.R., Zhang L.X. (2025) Multi-Objective Optimization Design of the Ejector Plate for Rear-Loader Garbage Trucks. Strojniški vestnik-Journal of Mechanical Engineering, 71.5-6, 169-178, https://doi.org/10.5545/sv-jme.2024.1185

23. Bereziuk O.V. (2005) Vibratsiinyi hidropryvod plyty presuvannia tverdykh pobutovykh vidkhodiv u smittievozakh [Vibration hydraulic drive of the solid waste pressing plate in garbage trucks] Diss. Cand.of Eng.Sciences: 05.02.03 –Drive systems, Vinnytsia, 217.

24. Iskovich-Lototsky R., Kots I., Ivanchuk Y., Ivashko Y., Gromaszek K., Mussabekova A., Kalimoldayev M. (2019). Terms of the stability for the control valve of the hydraulic impulse drive of vibrating and vibro-impact machines. Przeglad Elektrotechniczny, 4(19), 19-23, https://doi.org/10.15199/48.2019.04.04

25. Bereziuk O.V., Savulyak V.I., Kharzhevskyi V.O., Ivanov S.Cv., Alekseiev A.Ye. (2025) Analytical study of an improved mathematical model of the hydraulic drive of the garbage truck's sealing plate mechanism, taking into account the wear of its hydraulic cylinder. Problems of Tribology, 30(4/118), 62-71, https://doi.org/10.31891/2079-1372-2025-118-4-62-71

26. Perekrestov A.V. (1983) Zadachi po obiemnomu hidropryvodu [Problems on volumetric hydraulic drives]. Kyiv: Vyscha Shkola. Golovne vydannya. 144 p.

27. Bereziuk O.V., Savulyak V.I., Kharzhevskyi V.O., Alekseiev A.Ye. Dependence of wear intensity on the coating material of the hydraulic cylinder of the garbage truck's sealing plate // Problems of Tribology. 2024. No. 29(4/114). P. 40-46. https://doi.org/10.31891/2079-1372-2024-114-4-40-46

Березюк О.В., Савуляк В.І., Харжевський В.О., Ivanov S.Cv., Алексеєв А.Є. Удосконалений алгоритм інженерних розрахунків параметрів механізму ущільнюючої плити сміттєвоза із урахуванням зносу його гідроциліндра.

У статті на основі аналізу наукових літературних джерел розроблено науково обґрунтовану удосконалену методику проєктного розрахунку параметрів механізму ущільнюючої плити сміттєвоза з урахуванням зношування його гідроциліндра для визначення основних геометричних, силових і швидкісних характеристик. Привод робочих органів механізму ущільнюючої плити є гідравлічним і живиться від насосної станції сміттєвоза. Застосування запропонованої удосконаленої методики інженерного розрахунку дозволяє істотно скоротити тривалість проєктування та уникнути невиправданих витрат, пов'язаних із проведенням складних експериментальних і теоретичних досліджень. За допомогою розробленої методики визначено основні геометричні, силові та швидкісні параметри механізму ущільнюючої плити сміттєвоза з урахуванням зносу гідроциліндра. Встановлено, що подальше вдосконалення методики інженерного розрахунку механізму ущільнюючої плити сміттєвоза із використанням схеми чутливої до навантаження потребує додаткових досліджень.

Ключові слова: алгоритм, методика проєктного розрахунку, гідропривод, урахування зносу, швидкість зношування, інтенсивність зносу, гідроциліндр, механізм, ущільнююча плита, сміттєвоз, тверді побутові відходи.