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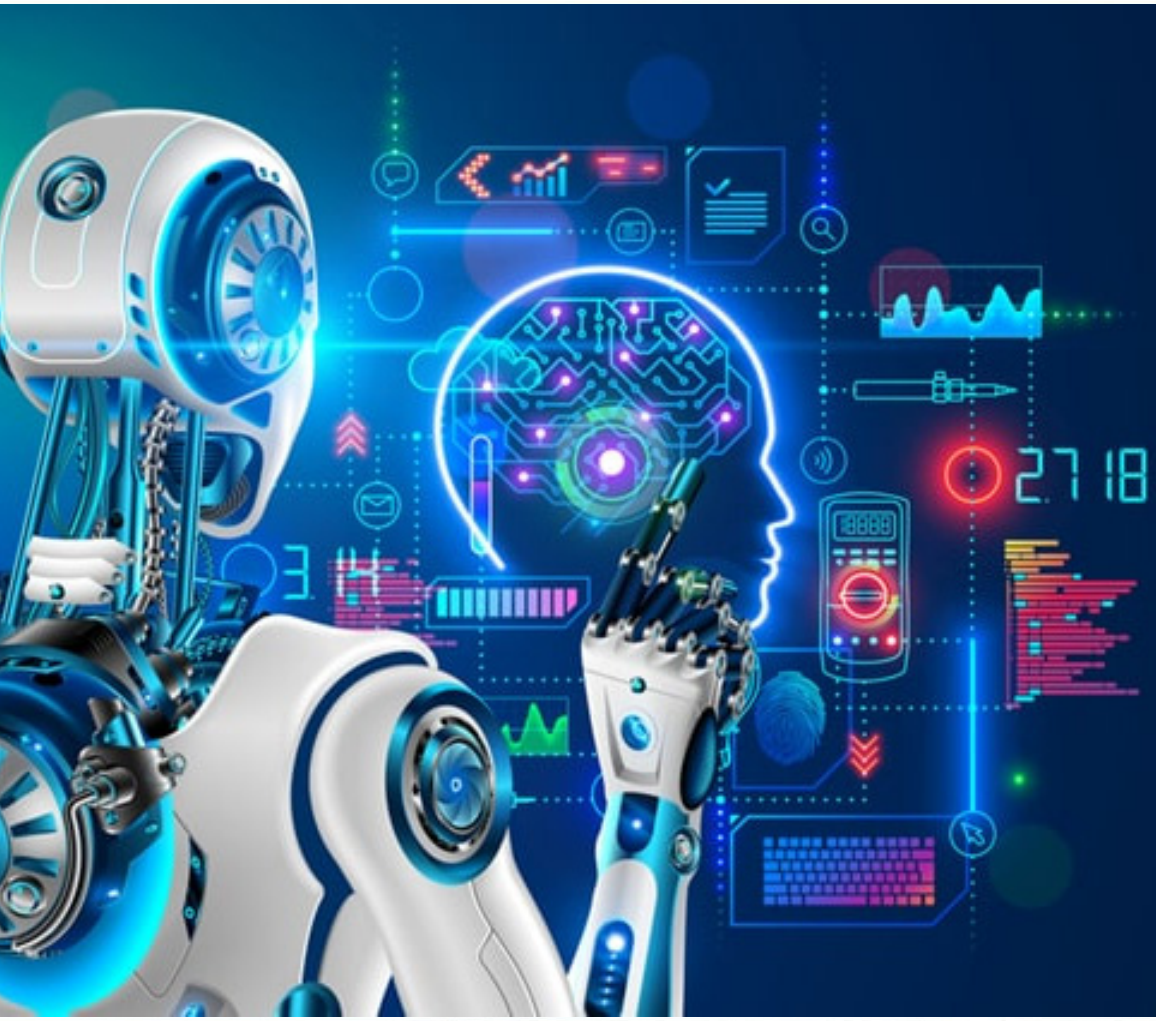

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OPTIMIZATION OF THE DESIGN OF AN ENERGY- AND RESOURCE-EFFICIENT PRESSING DEVICE FOR CONVERTING DRIED LEAVES, FALLEN FOLIAGE, AND PLANT RESIDUES INTO LOCALLY PRODUCED ORGANIC FERTILIZERS

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Abstract: The article considers the issues of developing energy-efficient press equipment intended for processing organic waste, particularly dried leaves and plant residues. The environmental and economic advantages of densification technology through pressing organic waste are substantiated. The main technological parameters of the pressing process are analyzed, and constructive solutions aimed at reducing energy consumption are proposed. According to the research results, the use of energy-efficient press equipment allows reducing the volume of organic waste, decreasing the amount of harmful emissions released into the atmosphere, and obtaining environmentally friendly organic fertilizer.

Key words: organic waste, pressing, energy efficiency, leaf waste, environmental efficiency, organic fertilizer.

Annotatsiya: Maqolada organik chiqindilarni, xususan, qurigan barg va o‘simlik qoldiqlarini qayta ishlash uchun mo‘ljallangan resurs va energiya tejamkor presslovchi qurilmani yaratish masalalari ko‘rib chiqilgan. Organik chiqindilarni presslash orqali zichlashtirish texnologiyasining ekologik va iqtisodiy afzalliklari asoslab berilgan. Presslash jarayonining asosiy texnologik parametrlari tahlil etilib, energiya sarfini kamaytirishga qaratilgan konstruktiv yechimlar taklif etilgan. Tadqiqot natijalariga ko‘ra, energiya tejamkor presslovchi qurilmalardan foydalanish organik chiqindilar hajmini kamaytirish, atmosferaga chiqariladigan zararli moddalar miqdorini qisqartirish va ekologik toza organik o‘g‘it olish imkoniyatini beradi.

Kalit so‘zlar: organik chiqindilar, presslash qurilmasi, resurs va energiya tejamkorlik, barg chiqindilari, ekologik samaradorlik, organik o‘g‘it tayyorlash.

Аннотация: В статье рассмотрены вопросы создания об энергоэффективного прессового оборудования, предназначенного для переработки органических отходов, в частности сухих листьев и растительных остатков. Обоснованы экологические и экономические преимущества технологии органических отходов методом прессования. Проанализированы основные технологические параметры процесса прессования и предложены конструктивные решения, направленные на снижение энергозатрат. Результаты исследования показывают, что применение энергоэффективного прессового оборудования позволяет сократить объем органических отходов, уменьшить количество вредных выбросов в атмосферу и получить экологически чистое органическое удобрение.

Ключевые слова: органические отходы, прессовочные устройство, энергоэффективность, листовые отходы, экологическая эффективность, подготовления органическое удобрение.

INTRODUCTIONS

Today, ensuring environmental sustainability, the rational use of natural resources, and the growing demand for organic fertilizers in agriculture necessitate the search for alternative technological solutions. In particular, dried leaves, fallen foliage, and various plant residues generated during agricultural and municipal activities accumulate in large quantities as waste and are often disposed of inefficiently. Recycling these wastes to produce locally sourced organic fertilizers represents an environmentally and economically relevant challenge.

The use of pressing technologies in converting plant residues into organic fertilizers makes it possible to reduce their volume, improve storage and transportation convenience, and accelerate subsequent biological decomposition processes. However, most existing pressing devices are characterized by high energy consumption, structural complexity, and insufficiently efficient use of resources. Therefore, the development of energy- and resource-efficient pressing equipment and the optimization of their design are of significant scientific and practical importance.

This study examines issues related to optimizing the design of a pressing device used in the process of converting dried leaves, fallen foliage, and plant residues into locally produced organic fertilizers. The main objective of the research is to reduce energy consumption during the pressing process, increase equipment productivity, and ensure the environmental efficiency of the technological process. This approach contributes to the introduction of innovative technologies in the recycling of agricultural waste.

REVIEW OF LITERATURE ON THE SUBJECT

The issue of converting dried leaves, fallen foliage, and plant residues into locally produced organic fertilizers is closely linked to environmental sustainability, rational resource use, and improvements in agricultural efficiency. In recent years, scientific research in this field has gained particular significance. The ecological foundations of organic waste recycling are extensively addressed in the studies of Abdurakhmonov A.A., who substantiates the assessment of organic waste as a secondary resource, demonstrates the potential for improving soil fertility through recycling, and highlights the reduction of negative environmental impacts. This approach emphasizes the necessity of ensuring environmental safety when recycling dried leaves and plant residues as fertilizers.

In studies by Ibragimov B.Sh. and Karimov U.R. devoted to technologies for recycling agricultural waste, the processes of processing biomass waste using mechanical and thermomechanical methods are analyzed. The authors emphasize the economic and technological efficiency of waste compaction, shredding, and pressing technologies, substantiating that the use of energy-efficient equipment is a key factor in reducing production costs. These scientific perspectives support the need to optimize the design of pressing equipment.

Issues related to resource-efficient technologies and the design of environmentally safe equipment are thoroughly analyzed in the works of Ganiyev R.G., where minimizing energy consumption, simplifying structural elements, and ensuring the sustainability of production processes are considered key criteria. According to the author's approach, the constructive optimality of recycling equipment determines not only technical efficiency but also economic performance. This serves as an important methodological basis for improving pressing devices intended for organic fertilizer production.

The constructive solutions of pressing equipment and issues related to their calculation are detailed in the studies of Kuznetsov V.P. The author pays particular attention to the stress state of press mechanisms, the efficiency of energy transmission, and the determination of optimal geometric parameters of working components. These scientific insights provide an important theoretical foundation for developing design solutions aimed at reducing energy losses and increasing equipment reliability in the pressing of biomass waste.

In international scientific literature, studies conducted by Rahman M. and Salam P. recognize sustainable technologies aimed at converting waste into resources as a key direction in agricultural development. The authors emphasize that increasing energy efficiency in biomass waste processing, reducing the carbon footprint, and

expanding local fertilizer production can lead to economic and environmental sustainability. This perspective substantiates the relevance of optimizing the proposed pressing device design from a global standpoint as well.

Overall, the analyzed scientific sources indicate that the development of an energy- and resource-efficient pressing device and the optimization of its design for converting dried leaves and plant residues into organic fertilizers are economically justified. These studies provide a solid theoretical and methodological foundation for the present scientific article.

RESEARCH METHODOLOGY

In this study, information on the processing of dried leaves and plant residues using a pressing device was obtained through laboratory experiments, technical observations, and an analysis of existing scientific sources. The collected data were analyzed using comparative analysis, techno-economic assessment, and methods for calculating energy and resource consumption.

ANALYSIS AND RESULTS

Today, population growth, accelerated urban expansion, and the intensification of agricultural activities are leading to a steady annual increase in the volume of organic waste. In particular, during autumn seasons, organic wastes such as dried leaves, fallen foliage, and plant residues are often burned or stockpiled in open areas without effective processing. Greenhouse gases generated from these accumulated wastes and their release into the atmosphere (as a result of burning) cause environmental problems and lead to air pollution [1].

One of the most promising directions in organic waste processing involves compacting waste using mechanical equipment and subsequently utilizing it as organic fertilizer. These processes are often characterized by increased transportation-related operating costs. Therefore, the development of energy-efficient, compact, and environmentally compliant pressing devices remains an urgent scientific and practical challenge.

The main objective of this article is to conduct scientific and analytical research aimed at designing energy- and resource-efficient pressing devices for processing dried leaves, fallen foliage, plant residues, and other organic wastes that are currently considered environmental problems, as well as to scientifically substantiate their environmental effectiveness.

As the research object, the process of producing locally sourced organic fertilizers by pressing dried leaves and plant residues was selected, focusing on the development of a new-design mechanical pressing device that is economically efficient and resource- and energy-saving [2, 3].

The following methods were applied in the study:

- scientific and rational analysis of the chemical properties of organic waste;
- development of a new pressing device design based on scientific analysis of the physical properties of leaves, foliage, and plant residues;
- ensuring resource efficiency during the pressing process by reducing energy, time, and labor consumption;
- comparative analysis of scientific and technological solutions for creating a compact pressing device against analogous designs based on scientific principles;
- scientific substantiation of methods for the economic assessment of environmental efficiency.

The technology of producing local fertilizers by pressing dried leaves, fallen foliage, and plant residues has several significant advantages:

- it enables a reduction in waste volume by up to 8–10 times;
- it significantly reduces transportation and storage costs;
- it allows processing together with additional organic waste while preserving the natural composition of organic matter;
- it creates a basis for obtaining organic fertilizers used to improve soil fertility.

At the same time, the efficiency of the pressing process largely depends on the energy consumption and design solutions of the equipment.

Principles for Designing Energy-Efficient Pressing Devices. When designing energy- and resource-efficient pressing devices, attention should be paid to the following key engineering requirements:

- selection of optimal shapes and dimensions of the pressing chamber;
- improvement of the sequential motion trajectory rules of pressing components;
- ensuring energy efficiency and increasing production speed by reducing friction forces within the pressing chamber;
- effective use of automated systems to facilitate easy control of the pressing device and its electric drive.

In developing the proposed pressing device, the efficient use of smooth-surface screw mechanisms makes it possible to create low-energy-demand mechanisms. This approach can reduce overall energy consumption by 20–30% [4, 5].

Assessment of Environmental Efficiency. The environmental efficiency of the energy- and resource-efficient pressing device was evaluated based on the following indicators:

• reduction in the amount of harmful gases released into the atmosphere;

• elimination of the need to burn waste;

• assessment of the agro-ecological effectiveness of locally produced fertilizers obtained from processed dried leaves, fallen foliage, and plant residues.

The research results indicate that locally produced fertilizers obtained from granular organic waste processed by pressing increase soil fertility, improve soil structure, enhance microbial activity, and reduce the need for mineral fertilizers.

The obtained results demonstrate that the implementation of energy- and resource-efficient pressing equipment is justified not only economically but also environmentally. By designing and assembling the proposed pressing device, it becomes possible during autumn seasons to process dried leaves, fallen foliage, and dry grass from urban municipal services into compacted local fertilizers, thereby expanding opportunities to improve agricultural land productivity. In addition, the device can be effectively applied in agriculture by pressing post-harvest crop residues, such as stems and leaves, in farming operations and converting them into locally produced organic fertilizers [6].

The conducted analyses and scientific approaches indicate that optimizing the design of a pressing device for converting dried leaves, fallen foliage, and plant residues into locally produced organic fertilizers is one of the key factors in ensuring energy and resource efficiency. Through technological improvement of the pressing process, it becomes possible to significantly reduce waste volume, optimize energy consumption, and enhance the quality of the final product.

By scientifically substantiating the selection and optimization of the main structural elements of the pressing device, its operational efficiency can be increased. The use of energy-efficient technical solutions contributes to reducing production costs and lowering the environmental burden, thereby ensuring the sustainability of the organic fertilizer production process.

CONCLUSIONS AND SUGGESTIONS

In conclusion, optimizing the design of a pressing device intended for processing plant residues has significant scientific and practical importance for the development of waste-free technologies in agriculture, the expansion of local organic fertilizer production, and environmental protection. The research findings may serve as a theoretical and methodological basis for the future development and practical implementation of energy-efficient agrotechnical equipment.

The pressing device for organic waste represents an effective and environmentally safe method for processing dried leaves, fallen foliage, and plant residues.

• the development of an energy- and resource-efficient pressing device design significantly reduces energy consumption;

• organic fertilizers obtained through pressing help reduce negative environmental impacts and contribute to improving ecological infrastructure in both urban and rural areas.

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