World Conference on Engineering and Technological Sciences
Hosted Online from Rome, Italy
Date: 8th June, 2026
Website: https://econferencia.com

IMPROVED DESIGN OF A VACUUM-GENERATING FAN FOR PNEUMATIC SEEDERS

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Abstract

The article presents an improved design of a vacuum-generating fan intended for use in pneumatic seeders. In conventional pneumatic seeders, the vacuum level is commonly regulated by changing the rotational speed of the fan. Such an approach may increase energy consumption, accelerate wear of transmission components and reduce operational reliability. The proposed design makes it possible to regulate the vacuum level without changing the rotational speed of the fan. This is achieved by changing the blade pitch angle relative to the air flow. The methodological basis of the work is a structural and functional analysis of the fan unit, its drive mechanism, air channels and interaction with the seed metering devices of a pneumatic seeder. The proposed construction includes a main shaft driven by the tractor power take-off, a toothed belt transmission, a rotating fan shaft, adjustable blades, a blade pitch control mechanism, a fan housing, bearings, vacuum channels and the seeder frame. The study shows that increasing the blade angle can intensify air flow and generate a higher vacuum level for heavier seeds, whereas reducing the blade angle can lower the vacuum level for lighter seeds and prevent excessive seed attraction. The proposed solution is expected to improve seed singulation, reduce energy losses, extend the service life of transmission elements and increase the adaptability of pneumatic seeders to seeds with different physical and mechanical properties.

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Keywords: pneumatic seeder; vacuum-generating fan; blade pitch angle; seed metering device; air flow; energy efficiency; precision sowing.

Introduction

Pneumatic seeders play an important role in modern crop production because they provide precise placement of seeds at a predetermined distance and depth. In precision sowing, the quality of seed singulation and the stability of seed retention on the metering disc are directly related to the performance of the vacuum system. If the vacuum level is insufficient, seeds may fall from the holes of the metering disc before reaching the discharge zone. If the vacuum level is excessive, two or more seeds may be retained simultaneously, which leads to double sowing and non-uniform plant spacing.

The seed metering device is one of the most important working units of a pneumatic seeder. Its performance depends on the interaction between the seed plate, suction holes, cleaning device, air chamber, vacuum fan and seed delivery channels [1–3]. Therefore, the improvement of pneumatic seeders cannot be limited only to the geometry of the metering disc. It is also necessary to improve the vacuum-generating unit, because the stability of air flow determines the reliability of seed capture, retention and release.

In many existing designs, the vacuum level is controlled by changing the rotational speed of the fan. Although this method is technically simple, it has several disadvantages. First, frequent changes in fan speed increase the load on the drive and transmission system. Secondly, variation in rotational speed may reduce the stability of air flow during field operation. Thirdly, this method can increase energy consumption and accelerate the wear of belts, bearings and other moving parts.

A more rational solution is to control the vacuum level without changing the rotational speed of the fan. This can be achieved by changing the angle of the fan blades relative to the air flow. In such a system, the fan shaft continues to rotate at a constant speed, while the air flow rate and vacuum level are adjusted by changing the blade pitch angle. This approach may improve energy efficiency and increase the adaptability of the vacuum system to different seeds.

The aim of this article is to justify an improved design of a vacuum-generating fan for pneumatic seeders and to explain the functional principle of vacuum regulation by changing the blade pitch angle without changing the rotational speed of the fan.

Materials and Methods

The object of the study is the vacuum-generating fan used in pneumatic seeders. The proposed improvement is based on preserving the main structural elements of the existing fan unit while introducing a mechanism that allows the pitch angle of the fan blades to be changed relative to the air flow. During the improvement of the design, special attention was paid to the interaction between the drive mechanism, the fan blades, the air flow and the vacuum channels. The main requirement for the proposed construction is to ensure stable vacuum formation at a constant rotational speed of the fan shaft. The device consists of the following main components: a main shaft driven by the tractor, a toothed belt transmission, a rotating fan shaft, fan blades, a blade pitch adjustment mechanism, a fan housing, bearings, vacuum channels and the frame of the seeder. The main shaft receives rotational motion from the tractor and transmits it to the rotating fan shaft through the toothed belt transmission. The fan blades are mounted on the rotating shaft. A special adjustment mechanism is used to change the angle of the blades

relative to the air flow. This makes it possible to regulate the air flow intensity and vacuum level without changing the rotational speed of the fan.

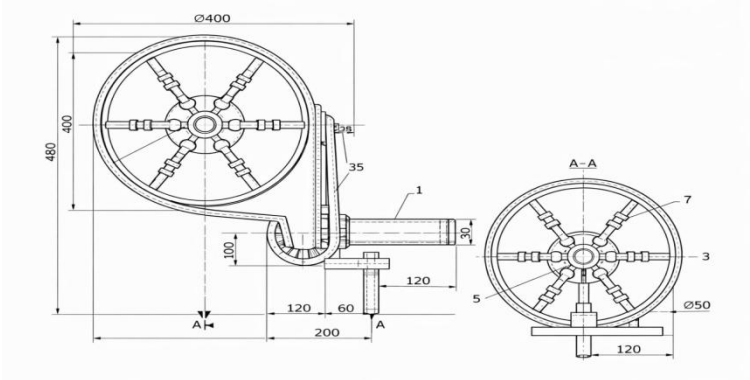

Figure 1. Working scheme of the vacuum-generating fan.

The fan housing ensures the correct direction of the air flow and supports the process of vacuum formation. The bearings provide stable rotation and reliable operation of the moving components. The vacuum channels transmit the generated vacuum from the fan unit to the seed metering devices of the pneumatic seeder. All these elements are mounted on the seeder frame, which ensures the structural stability and proper operation of the device during field conditions.

The operating principle of the proposed mechanism is based on the transmission of motion from the tractor power take-off to the main shaft and then through the toothed belt transmission to the fan shaft. The fan blades rotate together with the shaft, while their pitch angle can be changed by the operator using a control lever. By changing this angle, the operator regulates the vacuum level according to the type and physical properties of the seeds being sown.

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Research Results

In the proposed design, the rotational speed of the fan remains constant during operation. The vacuum level is regulated by changing the pitch angle of the fan blades relative to the air flow. This approach differs from traditional systems, where the vacuum level is mainly controlled by changing the rotational speed of the fan.

When heavier seeds are sown, the operator increases the pitch angle of the fan blades. As a result, the intensity of the air flow increases and the vacuum generated by the fan becomes stronger. This ensures more reliable holding of heavier seeds on the metering disc and reduces the probability of missed seeds during sowing.

When lighter seeds are sown, the blade pitch angle is reduced. In this case, the vacuum level decreases, which prevents excessive attraction of seeds to the metering disc. This is important because excessive vacuum may cause double seed capture and reduce the uniformity of sowing.

The generated vacuum is transmitted through the vacuum channels to the seed metering devices. A stable vacuum supply ensures the uniform holding and release of seeds, which contributes to the accurate distribution of seeds in the row. Thus, the improved fan design makes it possible to adapt the vacuum level to seeds with different sizes, masses and surface properties.

The proposed construction also allows the fan to operate under a more stable mechanical regime. Since the rotational speed is not frequently changed, the load on the transmission system is reduced. This can positively affect the service life of the toothed belt transmission, bearings and other moving parts.

Discussion

The proposed design has several advantages compared with conventional vacuum-generating systems used in pneumatic seeders. First, it eliminates the need to regulate the vacuum level by changing the rotational speed of the fan. This reduces dynamic loads on the drive mechanism and improves the stability of the fan operation.

Second, the constant rotational speed of the fan can reduce energy losses. In traditional systems, increasing the fan speed to obtain a higher vacuum level requires additional energy. In the proposed design, the air flow is regulated mainly by changing the blade pitch angle. Therefore, the system can generate the required vacuum level with less mechanical stress on the drive components.

Third, the improved design increases the adaptability of the pneumatic seeder. Agricultural seeds differ in size, mass, shape, surface roughness and aerodynamic behaviour. For this reason, the same vacuum level is not suitable for all seed types. The ability to adjust the blade angle makes it possible to select an optimal vacuum level for different crops and sowing conditions.

Fourth, the proposed construction may improve sowing quality. Stable and properly adjusted vacuum helps to reduce missed seeds and double sowing. As a result, seeds are placed more uniformly in the row, plant spacing becomes more regular, and the conditions for crop development are improved.

Another important advantage is the simplicity of the proposed solution. The construction does not require a complete redesign of the fan unit. The main improvement is related to the introduction of a blade pitch adjustment mechanism. This makes the design relatively simple for manufacturing, maintenance and practical use.

At the same time, the proposed design requires further experimental verification. In future research, it is necessary to determine the optimal blade pitch angles for

different types of seeds, measure the relationship between blade angle and vacuum pressure, and evaluate the effect of the improved fan on seed singulation accuracy. It is also important to study energy consumption, wear of transmission elements and the reliability of the mechanism under real field conditions.

Conclusion

The improved vacuum-generating fan proposed in this article makes it possible to regulate the vacuum level in pneumatic seeders without changing the rotational speed of the fan. The main technical feature of the design is the possibility of changing the pitch angle of the fan blades relative to the air flow.

The proposed construction has the following advantages: it allows the vacuum level to be adjusted according to the type of seed; reduces energy consumption; decreases the load on the fan drive and transmission mechanism; extends the service life of moving parts; improves the stability of vacuum formation; and increases the accuracy and quality of sowing.

For heavier seeds, increasing the blade pitch angle creates a stronger vacuum and ensures reliable seed holding. For lighter seeds, reducing the blade angle decreases the vacuum level and prevents excessive seed attraction. This makes the pneumatic seeder more adaptable to different crops and sowing conditions.

The application of the proposed improved vacuum-generating fan in pneumatic seeders is expected to increase energy efficiency, improve sowing quality and enhance the operational reliability of the machine. Further laboratory and field experiments are required to determine the optimal design parameters and to quantitatively evaluate the technical and economic efficiency of the proposed construction.

References

1. Ozduman company information service. (2020). Available at: https://www.ozduman.com/
2. Axmedov, A. A., & Jo‘rayev, B. M. (2020). Qishloq xo‘jaligi mashinalari. Tashkent, O‘zbekiston Milliy universiteti nashriyoti. (in Uzbek)
3. Bobrov, V. I., & Ivanov, A. P. (2017). Pnevmaticheskie seyalki: ustroistvo i ekspluatatsiya. Moscow, Agropromizdat. (in Russian)
4. GOST 31345-2007. (2007). Mashiny selskokhozyaistvennye. Seyalki pnevmaticheskie. Obshchie tekhnicheskie trebovaniya. Moscow, Standartinform. (in Russian)
5. Johnson, R., & Smith, D. (2020). Modern pneumatic seed drills and precision agriculture technologies. Berlin, Springer.
6. FAO. (2019). Advances in pneumatic seeding technologies for sustainable agriculture. Rome, FAO Publications.
7. Nesmiyan, A. Yu. (2002). Sovershenstvovanie tekhnologicheskogo protsessa vyseva semyan tykvy apparatom pnevmaticheskoi seyalki: diss. … kand. tekhn. nauk. Zernograd, 132 p. (in Russian)
8. Khalanskii, V. M., & Gorbachev, I. V. (2003). Selskokhozyaistvennye mashiny. Moscow, KolosS, 624 p. (in Russian)