REMOVAL OF MINERAL IMPURITIES FROM AFTER - HARVESTING RESIDUES OF CORN

Abstrakt

Due to the energy crisis, special attention is paid to the production and use of biofuels. After-harvesting residues of corn (AHRC) may become a perspective source of energy for grain dryers. The following components of the AHRC are distinguished: stem, leaves, rod and wrapper of the cob. The AHRC is about 55...60% of the total weight of the plant. The annual harvest of corn grain is more than 20 million tons. The calorific value at burning of wheat straw is 14.4 MJ/kg, AHRC - 15.7 MJ/kg. For comparison, the calorific value of wood on average is 14.24 MJ/kg, and natural gas is 33.5 MJ/m³ [1]. Using the AHRC can significantly reduce the need for imported gas.

One of the directions of the use of plant raw materials as fuel is the production of granules [2]. The technology involves purifying raw materials from impurities, crushing and granulation. For a similar scheme, granulated feeds are produced. When picking up a harvester, following transportation and reloading, various contaminants, including mineral impurities in the form of stones, fall into the green mass. Having hit the crusher stones lead to damage to parts of the crushing mechanism, an accident and even an explosion. Clearing straw from impurities in agriculture is carried out on pneumatic separating machines [3]. But in the technical literature there is no data available to the separation of mineral impurities from the AHRC.

As a result of the experiments, it was found that leaves and stalks can be separated by air from large stones, and the separation of rods from stones is complicated. Under the influence of air flow, the rods are rotated along the pneumatic separating canal and unfolded by a long axis in parallel with the air flow, which leads to a decrease in the area of the middle section and to the reduction of the aerodynamic resistance. Therefore, to provide the required force acting on the core from the air stream, they increase the air velocity, which causes the capture and joint movement of the stones. To improve the separation process of the AHRC from the stones, it is necessary to develop a nutritional mechanism of the separator, in which to predict the possibility of orientation of the rods in the pneumocaps to the long axis across the air flow. This will enable you to reduce the air velocity required for separation and increase the difference in aerodynamic forces acting on the stones and rods. Accordingly, at the same time, the energy intensity of the pneumatic separation process will decrease and the efficiency of separating the AHRC from the stones increases. The separation of small stones smaller than 3 mm only by air is impossible, since they are picked up by the air flow that moves at the speed necessary for separating the stems (7.5...12.5 m/s). For the separation of small stones, it is proposed to use grid separators with combined air purge. For the complete separation of mineral impurities from corn cores, it is recommended to use hydro-separators.

Key words: after harvesting residues of corn, biofuels, pneumatic separating, separated machines, plant raw materials as fuel, clearing straw from mineral impurities.

Introduction

Because of energy crisis, special attention is paid to the production and to use of biofuels. After harvesting residues of corn (AHRC) may become a perspective source of energy for grain dryers. The following components of the AHRC are distinguished: stem, leaves, rod and wrapper of the cob. The AHRC is about 55...60% of the total weight of the plant. The annual harvest of corn grain is more than 20 million tons. The calorific value at burning of wheat straw is 14.4 MJ/kg, AHRC - 15.7 MJ/kg. For comparison, the calorific value of wood on average is 14.24 MJ/kg, and natural gas is 33.5 MJ/m³ [1]. Using the AHRC can significantly reduce the need for imported gas.

One of the directions of the use of plant raw materials as fuel is the production of granules [2]. The technology involves purifying raw materials from impurities, crushing and granulation. For a similar scheme, granulated feeds are produced. When picking up a harvester, following transportation and reloading, various contaminants, including mineral impurities in the form of stones, fall into the green mass. Having hit the crusher stones lead to damage to parts of the crushing mechanism, an accident and even an explosion. Clearing...
straw from impurities in agriculture is carried out on pneumatic separating machines [3]. But in the technical literature there is no data available to the separation of mineral impurities from the AHRC.

**Aim of the research**
The purpose of the study is to determine the possibility of separating mineral impurities from the AHRC using pneumatic separation. Determine rational modes of pneumatic separation. Offer additional ways to clean AHRC from mineral impurities.

**Research results**
At the Department of Technological Equipment of Grain Production, ONAFT in the laboratory of ventilation and pneumatic transport conducted experiments to determine the possibility of separating mineral impurities from the AHRC. To determine the aerodynamic characteristics of the raw material was blown air in a laboratory analyzer-classifier. The dimensions of the samples presented on average were about 100...150 mm in length. Also samples of mineral impurities in the form of stones in the size from 1 mm to 5 mm were presented. The density of stones was 2000...3000 kg/m3. The ability to separate the mixture is determined by the hovering speed of the particles.

The dependence of the hovering speed of stones on the average diameter and density was determined analytically by the formula [4] for spherical particles:

\[
V = \sqrt{\frac{4p_R g d^2}{3\rho_p \mu}}
\]

where \(p_R\) is the density of stones, 
\(g\) - is the acceleration of free fall, 
\(d\) - is the average diameter of stones, 
\(\rho\) - is the density of air, \(\mu\) is the coefficient of aerodynamic resistance of stones to airflow.

In the calculations, the following values were assumed: 
\(g = 9.81\) m/s, \(p = 1.2\) kg/m\(^3\), \(\mu = 0.2\).

The average diameter of stones was determined by the formula:

\[
d = \sqrt[3]{abc}
\]

where \(a, \ b, \ c\) are respectively the length, width and thickness of the stone.

The values of the hovering speed for different anatomical particles of the AHRC are different. Experimental studies on determining the hovering speed of various parts of the AHRC showed that the lowest air flow rate was required for leaves (4.0...6.5 m/s), larger for stems (7.5...12.5 m/s). The hovering speed of the rods is in the range of 10...17 m/s. The moisture content of the samples was 11%. Density of the rods was 600 kg/m\(^3\). At a speed of 17 m/s stones with a diameter of up to 3 mm and the rods rise up together.

**Conclusions**
As a result of the experiments, it was found that leaves and stalks can be separated by air from large stones, and the separation of rods from stones is complicated. Under the influence of air flow, the rods are rotated along the pneumatic separating canal and unfolded by a long axis in parallel with the air flow, which leads to a decrease in the area of the midel section and to the reduction of the aerodynamic resistance. Therefore, to provide the required force acting on the core from the air stream, they increase the air velocity, which causes the capture and joint movement of the stones. To improve the separation process of the control panel from the stones, it is necessary to develop a feed mechanism of the separator, in which to predict the possibility of orientation of the rods in the pneumatic channel to the long axis across the air flow. This will enable you to reduce the air velocity required for separation and increase the difference in aerodynamic forces acting on the stones and rods. Accordingly, at the same time, the energy intensity of the pneumatic separation process will decrease and the efficiency of separating the AHRC from the stones increases. The separation of small stones smaller than 3 mm only by air is impossible, since they are picked up by the air flow that moves at the speed necessary for separating the stems (7.5...12.5 m/s). For the separation of small stones, it is proposed to use grid separators with combined air purge. For the complete separation of mineral impurities from corn rods, it is recommended to use hydro-separators.

**REFERENCES**
ВІДДІЛЕННЯ МІНЕРАЛЬНИХ ДОМІШОК З ПІСЛЯЖНИВНИХ РЕШТОК КУКУРУЗИ

Анотація
У зв'язку з енергетичною кризою особливої уваги набуває висвітлення та застосування біопалива. Перспективнім джерелом енергії для зерносушарок можуть стати післяжнивні рештки зернових, які складають 55…60% загальної маси рослини. Це дає змогу отримувати полезну продукцію, яка може бути використана як паливо, а також для виготовлення гранул. Основними її перевагами є: її недорогость, якість та збалансованість амінокислот. Отже, використання зернових сировин для виготовлення палива зосереджено на вивченні варіантів висушування, післячпілючування та гранулювання. Для цього доцільно використовувати пневматичні сепаратори, так як вони мають нижчу вартість та енергоефективність порівняно з іншими типами машин. Однак, їх використання може бути обмеженою, оскільки вони потребують високих швидкостей для ефективного розрізання. Основна причина цього закладається у тому, що швидкість відділення мінеральних домішок від стрижнів зерна визначається виключно швидкістю повітря, що проходить через сепаратор. Відповідно до дослідів, проведених російськими та українськими науковцями, використання пневмосепараторів дозволяє досягти припусків на висушування до 10…15%, а при гранулюванні до 3…5%. Тому, для ефективного використання зернових сировин для висушування та застосування їх як палива, ці проблеми зосереджено на вивченні варіантів висушування та гранулювання.

ЛІТЕРАТУРА

Г.М. СТАНКЕВИЧ, д-р техн. наук, професор
Г.А. ГОНИЧАРУК, канд. техн. наук, доцент
И.М. ШПИКО, канд. техн. наук, доцент
А.Л. ЛИПНІН, канд. техн. наук, доцент
Одеська національна академія харчових технологій, м. Одеса