UDC 697.92

RESEARCH OF PNEUMATIC CONVEYOR FOR OVERLOADING OF FUEL PELLETS

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Abstract. *The constant development of the country's agricultural sector allows the production of biofuels, such as fuel pellets, from agricultural waste - straw, corn and sunflower husks. However, the transportation of fuel pellets is quite energy consuming. The process of loading and unloading, transportation over long distances requires complex mechanized equipment. The use of a pneumatic conveyor for grain reloading will allow to provide high-quality transportation of fuel pellets.*

The aim of the article was to investigate the operation of the pneumatic conveyor for overloading fuel pellets, to determine the optimal indicators that affect the productivity of the pneumatic conveyor.

Since fuel pellets, as raw materials, are structurally similar to cereals, a study of the pneumatic grain conveyor PTZ-25 was conducted. The dependence of the productivity of the pneumatic conveyor on the lifting height h, m and the length of the pipelines L, m was obtained.

The obtained results showed that by reducing the length of the pipelines by four times and the lifting height by half, the productivity of the pneumatic conveyor will increase by 1.15 times.

Key words: ***fuel pellets, pneumatic conveyor, productivity***

Actuality. The constant rise in the price of traditional energy resources is contributing to the growing proliferation of biofuels as alternatives to traditional fuels in particular natural gas and coal. Ukraine has a strong raw material base for biofuels, in particular peat, wood processing waste, and the logging industry. Also, the constant development of the country's agricultural sector allows the production of biofuels, including fuel pellets, from agricultural waste - straw, corn and sunflower husks [1, 2].

However, the transportation of fuel pellets is quite energy consuming. The process of loading and unloading, transportation over long distances needs sophisticated mechanized equipment. The use of a pneumatic conveyor for grain overloading will allow to provide high-quality transportation of fuel pellets, as some of them can work with any type of grain, which is close to the pellets in terms of fraction size and characteristics [3, 4].

Analysis of recent research and publications. Pneumatic conveyors can be used for transportation of various loose non-abrasive products with the size of fraction from 1 to 15 mm and bulk density from 0.2 to 1.0 t / m^3 (pellets, meal, granules). However, they are not intended for overloading of fine, abrasive and aggressive products (flour, sand, cement, chemicals, etc.) [5, 6].

The process of transporting products takes place in the air stream. The use of this method of transportation minimizes injury to the overloaded product. During overload, the material does not contact moving parts (except for the rubberized blades of the rotor of the sluice gate) of the conveyor and is not subject to mechanical impact. The use of additional blocks of cyclones allows making a rough primary cleaning of the material from dust and light mixtures (chaff, leaves, weeds). In addition, when determining the weather conditions, in the process of transportation, the humidity of the products is reduced by 1 - 1.5% when the length of the pipelines is more than 20 meters, which is very important when overloading fuel pellets [7, 8].

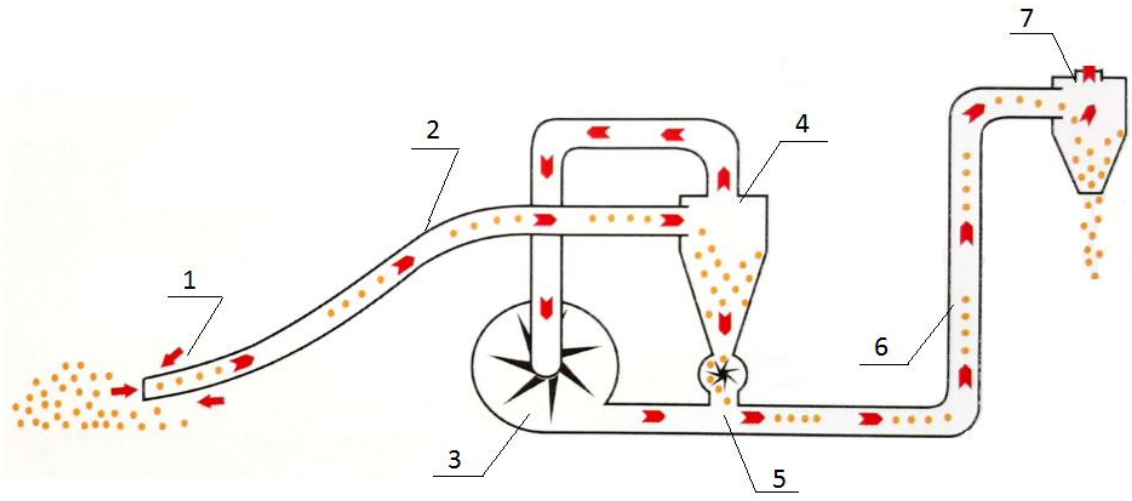

Fig. 1. Scheme of the pneumatic conveyor:

1 - nozzles; 2 - the suction side; 3 - fan; 4 - the main cyclone; 5 - rotary valve; 6 - transport side; 7 - unloading cyclone

Pneumatic conveyors for transporting pellets are a mobile installation with light pipelines that allow the use of conveyors to move material through the area of floor storage, maintenance of granaries, fuel storage facilities, as well as loading - unloading of cars and rail transport.

The basis of the pneumatic conveyor is a high pressure fan, which creates a vacuum (low pressure area) in the main cyclone, which is combined with the suction line and simultaneously injects air (creates high pressure) in the transport line (Fig. 1). The ambient air pressure is higher than in the cyclone, as a result of which the air moves into the cyclone. The intake nozzle at the beginning of the suction pipe mixes the material with air. Next on the deep hose, the air-pellet mixture enters the main cyclone, where the pellets are deposited down under the action of gravity, and the air passing through the filter enters the fan inlet. A rotary valve (sluice gate) is placed under the main cyclone. The rotating valve rotor moves the material from the main cyclone (low pressure area) to the lower box (high pressure area). At the same time, the fan injects air into the receiving box, the pellets are picked up by the air flow and move along the discharge pipe to the unloading cyclone, which is located at the end of the pipeline. In the unloading cyclone, the pellets reduce their speed and pour through the lower hole, and the exhaust air is returned to the atmosphere.

Both an electric motor and a tractor power take-off shaft can drive pneumatic conveyors [9]. Nominal productivity of pneumatic conveyors is determined by wheat grain under the following conditions: bulk grain density 780 kg / m^3, grain moisture 14%, clogging - up to 3%, air temperature 20ºC, atmospheric pressure 760 mm Hg, relative humidity up to 70 %, loading of the intake nozzle 100% (Table 1).

Since the productivity of the pneumatic conveyor depends on the type of material, the table shows a comparison of grain material in terms of productivity, which was based on wheat grain.

Pneumatic conveyors have become widely used for overloading fuel pellets, as their fraction size is close to grain. The speed of transportation of pellets is within acceptable limits.

1. Decreased productivity of pneumatic conveyors, depending on the type of grain

Decrease in productivity from a grain type,%	
Wheat	100%
Soy	-20%
Corn	-25%
Rapeseed	-30%
Barley	-35%
Sunflower	-50%

2. Grain and fuel pellet transport speed [1]

No	Material	Material transport speed, m / s
1	Wheat	12 - 27
2	Rye	22 - 26
3	Corn	14.5 - 27
4	Soy	18.6 - 27
5	Fuel pellets	14.5

The actual performance of pneumatic conveyors depends on many factors: atmospheric parameters, type and characteristics of the transport product, length and configuration of transport pipelines, use of different nozzles, as well as the type of work performed and the load factor of the intake nozzle.

The purpose of this publication is to study the work of the pneumatic conveyor for overloading fuel pellets, to determine the optimal indicators that affect the productivity of the pneumatic conveyor.

Materials and methods of research. A study of the productivity of pneumatic conveyors for unloading fuel pellets was conducted. The basis was a pneumatic grain conveyor PTZ-25, which is characterized by high productivity and can work with any type

of grain and oilseeds, including pellets. Also when using a centrifugal filter, it has the ability to overload raw materials with a high content of dust.

The productivity of the pneumatic conveyor depends on the length of the pipelines *L*, m and on the lifting height *h*, m. These factors were decisive for experimental studies (Fig. 2).

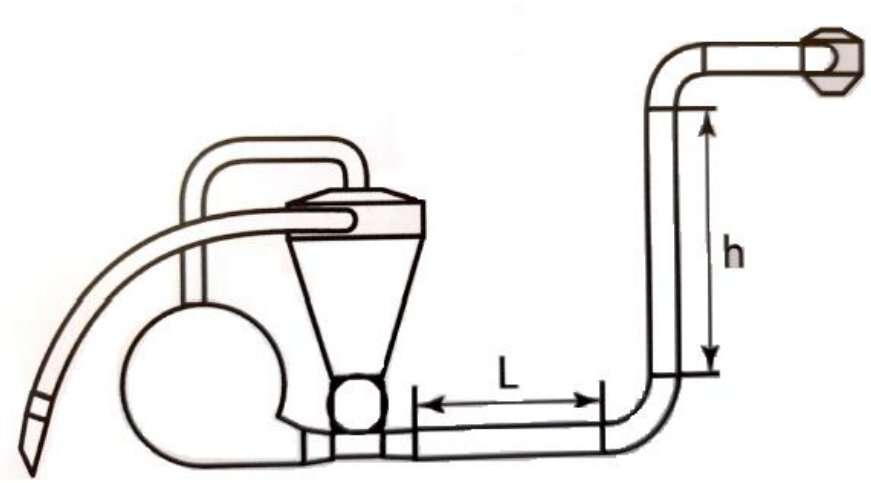

Fig. 2. Input factors to determine the performance of the pneumatic conveyor

To process the measured values, the group of factors was presented in tabular form (Table 3).

3. Factors and levels of planning

The name of the factor	Code designation	Levels of factors		Interval of variation
		Lower -1	Upper +1	
Lifting height *h*, m	x_1	6	12	2
Length of pipelines *L*, m	x_2	10	40	10

The response function is the productivity *G* of the PTZ-25 pneumatic conveyor, tons/hour. For each of the experiments, the performance of the pneumatic conveyor was determined as the arithmetic mean of the sum of local values:

$$G = \frac{1}{N}\sum_{i=1}^{N} G_i, \text{ tons / year,} \quad (1)$$

where N - is the number of certain local values of the performance of the pneumatic conveyor G.

Research results and their discussion. The results of the research can be represented graphically. The productivity of the pneumatic conveyor is determined depending on the lifting height of the pneumatic conveyor h, m and the length of the pipelines L, m.

A graphical representation of the results of experimental studies is shown in Fig. 3.

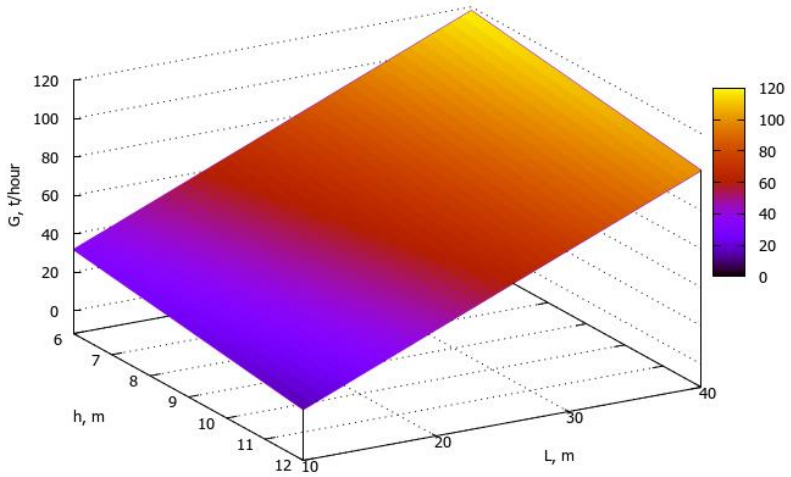

Fig. 3. Dependence of productivity of the pneumatic conveyor on height of rise *h*, m and length of pipelines *L*, m

Graphic results of experimental studies can be represented by an approximate dependence:

$$G = 20{,}2 - 2{,}88\frac{h-9}{2} - 2{,}88\frac{L-25}{10} \quad (2)$$

In this dependence, the intervals of variation used for the input factors: G, tons/h, at 6 m $h \leq$12 m; 10 m $L \leq$ 40 m.

Conclusions and prospects. Since fuel pellets, as raw materials, are structurally similar to cereals, a study of the pneumatic grain conveyor PTZ-25, which can be used to transport fuel pellets, was conducted. The dependence of the pneumatic conveyor productivity on the lifting height h, m and the length of the pipelines L, m was obtained.

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ДОСЛІДЖЕННЯ ПНЕВМОТРАНСПОРТЕРА ДЛЯ ПЕРЕВАНТАЖЕННЯ ПАЛИВНИХ ПЕЛЕТ

Н. А. Сподинюк, Л. П. Горбаченко

Анотація. *Постійний розвиток аграрного сектору країни дозволяє виготовляти біопаливо, таке як паливні пелети, з відходів сільського господарства – соломи, кукурудзи та лушпиння соняшника. Проте транспортування паливних пелет є досить енергозатратним. Процес їх завантаження і розвантаження, перевезення на великі відстані потребує складного механізованого обладнання. Застосування пневматичного транспортера для перевантаження зернових дозволить якісно забезпечити транспортування паливних пелет.*

Метою статті було дослідити роботу пневматичного транспортера для перевантаження паливних пелет, визначити оптимальні показники, які впливають на підвищення продуктивності пневмотранспортера.

Оскільки паливні пелети, як сировина, за структурою подібні до зернових культур, то було проведено дослідження пневматичного транспортера зернових ПТЗ-25. Було отримано залежність продуктивності пневмотранспортера від висоти підйому h, м та довжини трубопроводів L, м.

Отримані результати показали, що при зменшенні довжини трубопроводів в чотири рази та висоти підйому в два рази продуктивність пневмотранспортера збільшиться в 1,15 рази.

Ключові слова: ***паливні пелети, пневматичний транспортер, продуктивність***

ИССЛЕДОВАНИЕ ПНЕВМОТРАНСПОРТЕРА ДЛЯ ПЕРЕГРУЗКИ ТОПЛИВНЫХ ПЕЛЛЕТ

Н. А. Сподинюк, Л. П. Горбаченко

Аннотация. *Постоянное развитие аграрного сектора страны позволяет производить биотопливо, такое как топливные пеллеты, из отходов сельского хозяйства - соломы, кукурузы и шелухи подсолнечника. Однако транспортировки топливных пеллет достаточно энергозатратные. Процесс их загрузки и разгрузки, перевозки на большие расстояния требует сложного механизированного оборудования. Применение пневматического транспортера для перегрузки зерновых позволит качественно обеспечить транспортировку топливных пеллет.*

Целью статьи было исследовать работу пневматического транспортера для перегрузки топливных пеллет, определить оптимальные показатели, которые влияют на повышение производительности пневмотранспортера.

Поскольку топливные пеллеты, как сырье, по структуре подобные зерновым культурам, то было проведено исследование пневматического транспортера зерновых ПТС-25. Была получена зависимость производительности пневмотранспортера от высоты подъема h, м и длины трубопроводов L, м.

Полученные результаты показали, что при уменьшении длины трубопроводов в четыре раза и высоты подъема в два раза, производительность пневмотранспортера увеличится в 1,15 раз.

Ключевые слова: ***топливные пеллеты, пневматический транспортер, производительность***