

FIELD ROLLER BRIQUETTING MACHINE – WORK PARAMETERS OF MODYFIED MODELS OF MACHINE ASSEMBLIES

Summary

A Field Roller Briquetting Machine prototype was developed at the Industrial Institute of Agricultural Engineering and PROTECH Sp. z o.o. The machine is the subject of the project, which aims to develop, build and test a mobile machine for harvesting and compaction of plant biomass (straw) and stalk materials by rolling it up for briquette formation. As part of the task, the structure of the main working units of the machine was modified.

Słowa kluczowe: brykieciarka, słoma, brykiety, energia odnawialna, maszyna mobilna

POŁOWA BRYKIECIARKA ZWIJAJĄCA – PARAMETRY PRACY ZMODYFIKOWANYCH MODELI ZESPOŁÓW MASZINY

Streszczenie

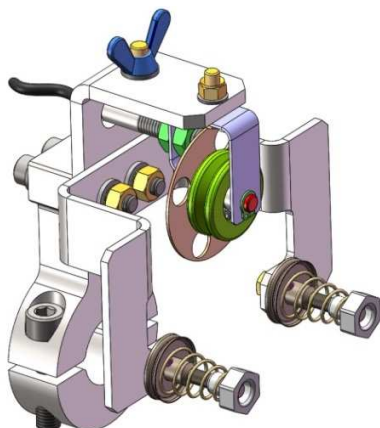
Prototyp brykieciarki polowej powstał we współpracy Przemysłowego Instytutu Maszyn Rolniczych oraz spółki PROTECH Sp. z o.o. Maszyna jest tematem projektu, którego celem jest opracowanie, zbudowanie i przetestowanie mobilnej maszyny do zbioru i zagęszczania biomasy roślinnej (słomy) i materiałów łodygowych przez jej zwijanie w celu formowania brykietów. W ramach zadania zmodyfikowano konstrukcję głównych zespołów roboczych maszyny.

Key words: briquetting machine, straw, briquettes, renewable energy, mobile machine

1. Introduction

Production and use of energy from renewable sources is one of the most important issues of global and European energy policy. One of the biomass sources most often used for heating purposes is renewable energy. It includes, among others, remnants from agricultural and forestry production. The remaining straw is not used for other purposes, it remains after harvesting cereals. The low bulk density causes that the straw also has a lower energy density (calorific value related to the volume unit). Therefore, in order to be economically justified, its use in power engineering should increase its degree of compaction and it is best to directly in the field. Higher density of straw, and therefore higher energy density, is obtained by its briquetting.

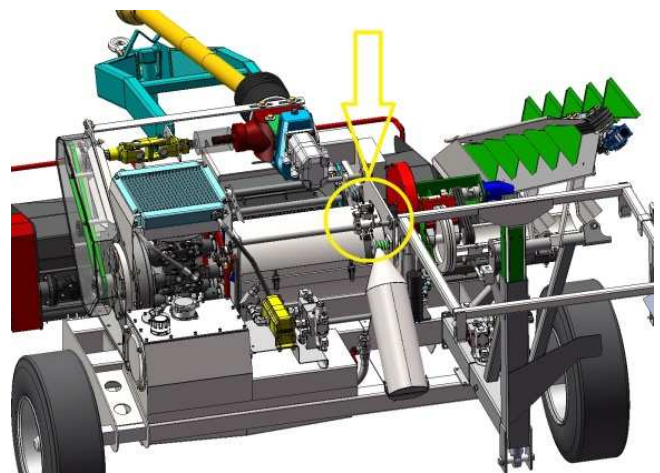
The last stage of the project, which was completed in July 2018 [7], consisted in modifying the existing basic machine components. The modifications were intended to improve the machine's operation, increase its efficiency (throughout) and the ergonomics of the service (replacing parts, access to components). In this article two selected sub-assemblies will be described. It will be a feeding and thread counting unit (Fig. 1 and Fig. 2) wrapped with a briquette to fix its shape and a briquette cutter (Fig. 3 and 4). The introduced changes have already been implemented and the subassemblies have been tested during the harvest in August 2018 [1, 2, 3].



Source: own work / Źródło: opracowanie własne

Fig. 1. Unit feeding and counting thread wrapping the formed briquette

Rys. 1. Zespół podawania i zliczania nici owijającej formowany brykiet



Source: own work / Źródło: opracowanie własne

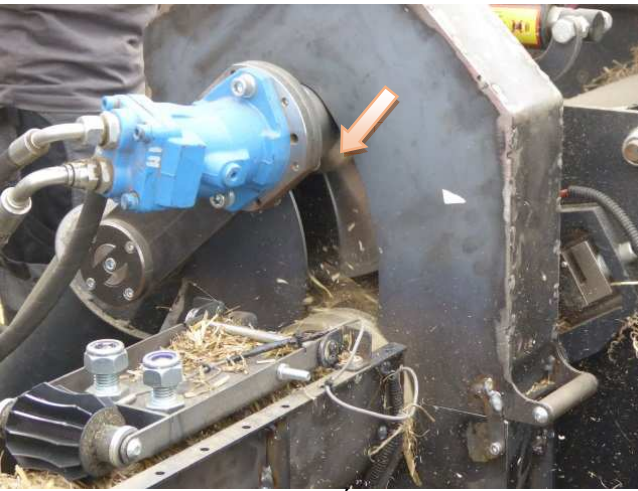
Fig. 2. Feeding and thread counting unit mounted on machine

Rys. 2. Zespół podawania i zliczania nici zamontowany na maszynie



Source: own work / Źródło: opracowanie własne

Fig. 3. Briquette cutter mounted on machine
Rys. 3. Zespół cięcia brykietu zamontowany na maszynie



Source: own work / Źródło: opracowanie własne

Fig. 4. Briquette cutter (saw marked with an arrow)
Rys. 4. Zespół cięcia brykietu (piła zaznaczona strzałką)

2. Modified models description

2.1. Thread introduction

The mechanism of introduction of the thread has been significantly modified from the previous version [4, 5]. In addition, its design has become more compact. The thread, which is fed from the reservoir containing two spools, goes to the counting mechanism shown in Figs. 1 and 2.

The thread feeding mechanism is equipped with two tensioners, between which there is a thread guide roller. Presence of tensioners results in unchanged thread tension on the guide roll. The guide roller is equipped with a steel plate cooperating with an inductive sensor. This sensor measures the roll revolutions and the user receives a message on the display of the amount of thread used (Fig. 5). At the same time, when the thread in the tray is finished, the user is informed by the sound signal about this event. Fig. 5 also shows other parameters:

- amount of produced briquettes (Ilość brykietów),
- machine speed in km/h (Prędkość),
- Rotation speed of PTO shaft in RPM (WOM),
- Twist of briquetting chamber in degrees (Kat),
- Percentage of chamber load (on lower right corner of display).



Source: own work / Źródło: opracowanie własne

Fig. 5. Display shows thread usage in meters (Sznurek)
Rys. 5. Wyświetlacz wskazujący zużycie nici w metrach (Sznurek)

2.2. Cutting mechanism

The cutting mechanism has been constructed and built in a more compact way. The flywheel that accumulated energy was eliminated to ensure higher saw speed during the cutting phase. Also eliminated was the clutch that connected the drive shaft of the saw with the hydraulic motor that drives it and the wedge belts that engaged the saw shaft with the flywheel shaft. The whole has been closed in a closure, a steel casing with a cover. The cover allows to get to the saw blade, for example to replace it, as well as to protect the mechanism and restrict access to it during operation. The whole is equipped with a much shorter shaft mounted on a linear bearing, as a result of which the mechanism does not get into vibrations, like it was observable in the previous version and eliminated the bending of heavy components.

2.3. System of briquettes transportation

System of briquette transportation is formed by following elements:

- transporting chute,
- counting roller,
- chain conveyor,
- turning bend.

In this chapter also Big-Bag hanger is describe. Despite of the fact, it is not a part of transportation system (it is only container), it directly cooperates with described component.

Next to the rolling chamber, and above transporting chute there is a saw which cut product into equal parts.

After briquette being cut, it is transported further through transporting chute (6).

As Fig. 7 presents, above the chute, counting roller was mounted. It is used for counting the length of produced briquette and also as the product holdfast.



Source: own work / Źródło: opracowanie własne

Fig. 6. Briquette transporting chute
Rys. 6. Rynna transportująca brykiet



Source: own work / Źródło: opracowanie własne

Fig. 7. Counting roller
Rys. 7. Rolka zliczająca długość brykietu

Briquettes outcoming from rolling chamber are generating pressure, which is the source of force, which moves cut product along transporting chute to the chain conveyor (Fig. 8). From there, briquettes are transported upwards to the end of the machine, where on the special construction Big-Bag is hung. To prevent product from back falling, on the bottom of chain conveyor steel barrier is mounted, which is also an extension of transporting chute.



Source: own work / Źródło: opracowanie własne

Fig. 8. Product transportation
Rys. 8. Transport produktu

To change a direction of briquettes and allow them to fall into bag, there is a bend, causing turn of the product using its momentum to flow through (Fig. 9).



Source: own work / Źródło: opracowanie własne

Fig. 9. Turning bend (marked with an arrow) and the Big-Bag in the end of the machine
Rys. 9. Kolano kierujące brykiet (zaznaczone strzałką) oraz worek Big-Bag z tyłu maszyny

Design of Big-Bag hanger allows to height steering using hydraulic cylinder connected directly to tractor. In the future it will be necessary to change cylinder from one-sided to two-sided, because it is not always easy to lower the frame down and detach Big-Bag full of product. Frame was also moved closer to the axis of the machine (comparing to the previous versions), which allows the use on public roads without dismantling whole construction. Furthermore, for the same purpose the construction of chain conveyor allows to fold it (Fig. 10, Fig. 11.).



Source: own work / Źródło: opracowanie własne

Fig. 10. Chain conveyor in transport position
Rys. 10. Przenośnik łańcuchowy brykietów w pozycji transportowej



Source: own work / Źródło: opracowanie własne

Fig. 11. Chain conveyor in work position
Rys. 11. Przenośnik łańcuchowy brykietów w pozycji roboczej

3. Work parameters

During operation of the machine, its components were characterized by the following parameters:

Parameter	Value
rotational speed of the saw	4400 rpm
briquette length (adjustable)	115 mm
thread usage (per briquette)	6,5 m
chain briquette conveyor linear speed	0,9 m·s ⁻¹
length of thread in a tray	17 000 m (2 spools)
time between cuts (variable)	4 s
time of one cut	0,8 s

Source: own work / Źródło: opracowanie własne

The most of the given work parameters have no fixed value, and it is variable and depends, among other things, on the working conditions. Rotational speed of the saw has been given as the nominal value, while the cut is reduced as a result of resistance during cutting. The length of briquettes is determined by the machine operator. Together with the length of the briquettes, the amount of thread needed to wrap one briquette changes. The time of a single cut is set in the program by the machine operator, and the time between individual cuts is dependent on the current load of the machine and at the same time on the speed of the briquette from the briquetting chamber [4, 5, 6].

4. Summary

The new features of machine tested in this harvesting season worked with effect predicted during design. It is obvious that some of them need to be improved by strengthening or redesigning. Notwithstanding, this harvesting season

was the most successful compared to the previous years, and machine can work without damage for a long time. It allows user to harvest significant areas of the field without technical breaks. Thanks to that, tests are longer and more efficient.

5. References

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