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## **TECHNIQUE OF APPLICATION OF ADDITIVES FACILITATING SILAGING OF PLANT MATERIALS USED FOR PRODUCTION OF BIOGAS**

*Summary*

*In the study the technique of application of additives to plant materials used for production of biogas is presented. It has been found out that application of additives to materials at the time of their harvesting with collecting straw cutters is the most often used manner. From the conducted studies it results that the elements introducing the additive to fodder (sprayers, nozzles, supply ducts) of the applicator have to be located in front of the crushing rollers' assembly, in the shredding assembly or at the end of the straw cutter's exhaust channel.*

**Key words:** biogas, production, plant materials, forage harvesters, studies

## **TECHNIKA APLIKACJI DODATKÓW UŁATWIAJĄCYCH ZAKISZANIE MATERIAŁÓW ROŚLINNYCH PRZEZNACZONYCH DO PRODUKCJI BIOGAZU**

*Streszczenie*

*W pracy przedstawiono technikę aplikacji dodatków do materiałów roślinnych przeznaczonych do produkcji biogazu. Stwierdzono, że najczęściej stosowanym sposobem jest aplikacja dodatków do materiałów w czasie ich zbioru siewkarniami zbierającymi. Z przeprowadzonych badań wynika, że elementy wprowadzające dodatek do paszy (rozpylacze, dysze, przewody doprowadzające) aplikatora mogą być umieszczone przed zespołem walców zgniatających, w zespole rozdrabniającym lub na końcu kanału wylotowego siewkarni.*

**Słowa kluczowe:** biogaz, produkcja, materiały roślinne, siewkarnie zbierające, badania

### **1. Introduction and purpose of the study**

Silage as a substrate for biogas production is used for the whole year, so it should be characterised by high oxygen stability. So, taking into account the oxygen silage stability and the use of the lactic fermentation products by methane bacteria for biogas production of high content of biomethane, the biochemical transformations within the process of silaging should be oriented at limitation of formation of acetic acid and the increase of acetic acid, propanoic acid and other volatile low molecular fatty acids. Among many additives steering this process, attention should be paid to microbiological formulations (inoculants) which comprise many lactic acid heterofermentative bacteria. These bacteria in the process of silaging of different plant materials and their by-products, apart from acetic acid, produce big volumes of acetic acid, methylacetic acid and other alcohols. The obtained silage is characterised by very good oxygen stability, while the fermentation products are used by methane bacteria for production of bacteria [1, 2, 4, 9, 11, 13, 14].

The technology of production of silages designed for biogas is just the same as the technology of silaging of fodder for cattle. The same rules of procedure, except for the length of chaff, are obligatory here. For cattle the degree of shredding of silaged green fodder is 15-20 mm, while for biogas works the recommended length of chaff is 4-8 mm. Such a big degree of shred ding means also its better mixing with different additives steering the process of fermentation [12, 15, 17].

The purpose of his study is presentation of the manners and techniques of application of plant materials designed for biogas production.

### **2. Technique of application**

The efficiency of different additives' influence depends on uniform arrangement of their specified volume in the plant mass to be silaged [5, 6, 7, 10, 16].

Due to the state of aggregation, we distinguish the following additives:

- liquid (solutions or suspended matters),
- solid (powdered, granulated and other ones).

Additives used for silaging are to influence the process of fermentation only to obtain good and oxygen stable silage ensuring high methane efficiency [9].

Additives to preserved plants may be added [3, 8, 10]:

- at the time of plant's harvesting (fig. 1) – this treatment is much easier to be mechanized and its advantage is that the process of preservation starts already in the harvesting machine.
- at the time of plants' loading to the tank (horizontal tanks, foil sleeves (fig. 2)). There are many solutions as far as horizontal tanks are concerned. Applicators and plants' protection systems are used most commonly. In case of storage of green fodder in horizontal tanks of small capacity, wheel barrow sprayers are used, while in case of tanks of big capacity there are used tractor field sprayers, waste removing carriages.

In practice, different additives are introduced into plants at the time of their harvesting. In order to do that, there are used applicators assembled on harvesting machines (harvesting chaff cutters, harvesting trailers with cutting devices). In practice there are used applicators for liquid additives. These are simple devices, as far as construction is concerned, and they are universal. In practice, different ad-

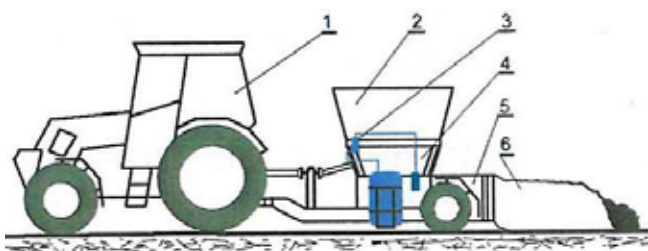
ditives are introduced into plants at the time of their harvesting. In order to do that, there are used applicators assembled on harvesting machines (harvesting chaff cutters, harvesting trailers with cutting devices). In practice there are used applicators for liquid additives. These are simple devices, as far as construction is concerned, and they are universal. Due to the manner of additives' application to the plant material, they may be divided into gravity-operated (gravitational) and pressure ones (fig. 3), which are produced more often. Applicators to solid preparations (powdery, granulated) are applied rarely due to the lesser surety of their operation, that depends most often on chemical and physical properties of an additive.



Author's photo / foto: autor

Fig. 1. Applicator for liquid preparations mounted on the chaff cutter

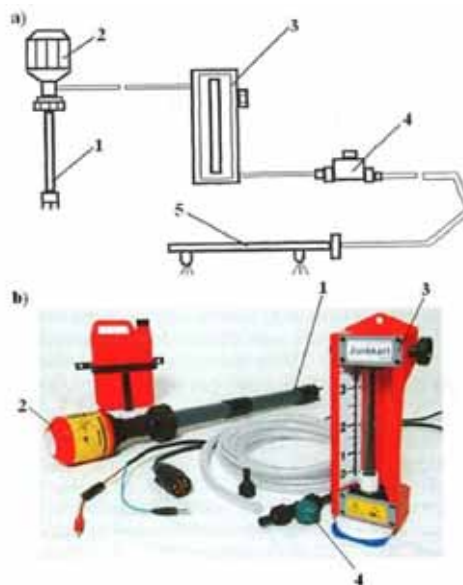
Rys. 1. Aplikator do preparatów ciekłych zamontowany na siewczarni zbierającej



Source: own study / Źródło: opracowanie własne

Fig. 2. The application of additive into moist grain during loading to the plastic tube: 1 – tractor, 2 – hopper, 3 – the system of applicator, 4 – grain crusher, 5 – tunnel adaptor, 6 – plastic tube

Rys. 2. Aplikacja dodatku do wilgotnego ziarna podczas jego załadunku do rękawa foliowego: 1 – ciągnik, 2 – kosz zasypowy, 3 – instalacja aplikatora, 4 – gniotownik, 5 – adapter tunelowy, 6 – rękaw foliowy

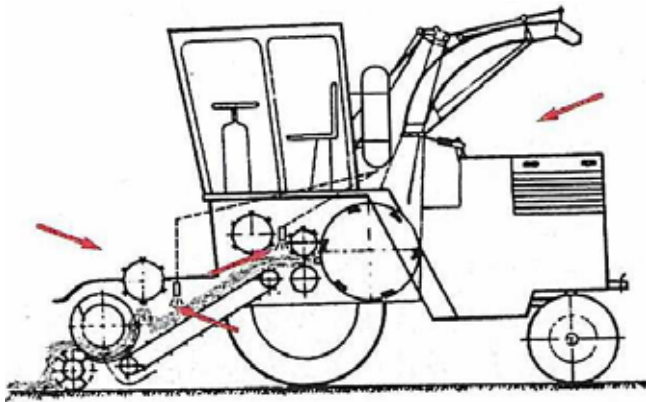


Source: own study / Źródło: opracowanie własne

Fig. 3. Junkkari HP5 applicator: a) construction scheme, b) general view: 1 – centrifugal pump, 2 – electric motor 12V, 3 – flow regulator, 4 – trickling preventing valve  
Rys. 3. Aplikator Junkkari HP5: a) schemat budowy, b) widok ogólny: 1 – pompa odśrodkowa, 2 – silnik elektryczny 12V, 3 – regulator przepływu, 4 – zawór przeciwdziałający kapaniu

### 3. Places of additives' application to plant materials in a harvesting chaff cutter

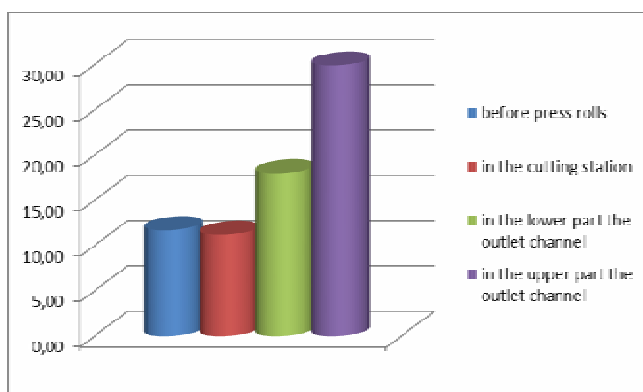
On the basis of the worked out methodology of the studies, there was conducted the assessment of unevenness of a liquid additive's distribution (sodium benzoate) in plant materials harvested with harvesting chaff cutters. Moreover, the volumes of an additive's losses in the process of application have been determined. The methodology of the studies as well as detailed results of the studies have been presented in earlier works [5, 6, 10]. As a result of these works it has been found out, that in case of mounting of an applicator on the harvesting chaff cutter (fig. 4) its elements introducing an additive to the plant material (sprayers, nozzles, supplying ducts) may be located above the feeding drum in front of the crushing drums' assembly or in the shredding assembly. In case of the use of the beater harvesting chaff cutter, these elements should be mounted in the bottom part of the exhaust channel, right above the shredding drum. In practice, the elements introducing liquid preparations are very often assembled in the upper part of the exhaust channel, right in front of the controlling ending. In this case one has to take into account the increased losses of preparations, which may amount even up to 30% (fig. 5). It results from the fact, that liquid formulation addend to green fodder at the end of the exhaust duct is subject to intensive swirling and fragmentation into drops of different diameters. Part of the fragmented formulation, in particular drops of smaller diameter, are entrained by the stream of air and thrown away outside by it.



Source: own study / Źródło: opracowanie własne

Fig. 4. Places of preparation's application to green fodder in the harvesting chaff cutter

Rys. 4. Miejsca aplikacji preparatu do zielonki w sieczkarni zbierającej



Source: own study / Źródło: opracowanie własne

Fig. 5. Volumes of preparation's losses depending on the places of its addition to green fodder in the collecting chaff cutter

Rys. 5. Wielkości strat preparatu w zależności od miejsca dodawania go do zielonki w sieczkarni zbierającej

#### 4. Conclusion

As a result of conducted studies and analyses it has been found out, that application of additives to plant materials at the time of their harvesting with harvesting chaff cutters or, in case of smaller farms – with harvesting trailers with cutting devices, is the most often used manner.

Such a manner ensures good mixing of additives with green fodder, is easier to be mechanized and the process of green fodder's preservation starts already in the harvesting machine (harvesting chaff cutter, harvesting trailer).

Sprayers, nozzles or supplying ducts of applicators are to be assembled in such places of a harvesting machine, in which the plant material is loosened to the maximum (if al-

lowed by the construction of the harvesting machine), what creates big area of its contact with the additive and ensures its low losses.

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