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COLLECTING BIOGAS AND LIQUID BIO-FERTILIZERS DURING BIOMASS PROCESSING AT MOBILE MACHINE

This article describes possibilities of using mobile machine for producing biogas and collecting rare bio-fertilizers. Collected biogas could be used to increase quality of fuel or could be used as independent source of energy. Process of biogas producing will create opportunity not just to have a new type of fuel but it will utilize of use organic left overs and will have an ecological impact as well. Designed machine for biogas production also could be used for feeding row-planted crops with rare bio-fertilizers. During equipment testing, the best suitable equipment for applying bio-fertilizers was flat-cutting blades. Those blades provided very good location of bio-fertilizers under sphere of soil and required low level of power.

Key words: *biomass, biogas, liquid bio-fertilizers, applying fertilizers into the soil, mobile machine, dividing fertilizers, feeding equipment.*

Introduction. Waste accumulation from human activity (animal manure, food left overs, sewer water and other) became a serious problem for our environment which soon or later has to be addressed. One of the ways to address this issue is to use alternative source of energy, specifically by processing biomass by using methane fret and collecting biogas which contains about 70 % of methane and some organic fertilizers. It is very critical to utilize biomass in agricultural production specifically in the area where production is required to obtain high volume of fuel and also requires high quality fertilizers [1]. It is very important to emphasize that during processing of biomass left overs will have dramatically less amount of

microorganisms that cause diseases and infections in humans compare to the original raw material.

Biogas production technology is allowing producing in the short period of time by using anaerobic fermentation of original bio-fertilizers which contains bio active ferments [1].

Producing of biogas has high economic impact by utilizing of use constant source of raw material such as manure from livestock farms, leftovers from plant processing and etc. Economic impact could be achieved by utilizing and managing all sources of waste produced by human activities. Processing of different sources of waste on biogas machine will produce biogas, electrical energy, heat, bio fertilizers and positively impact on environment.

Analysis of recent research and publications. Research of domestic and foreign scientists [1; 2; 3] indicated that biogas could be used as a replacement of natural gas and after cleaning process has the same quality. Biogas could be used as fuel and also can be utilize for producing of electrical energy [4]. Also, during process of biogas production will decrease of methane release into environment. Methane has high impact on greenhouse effect and reducing level of releasing methane into environment can positively impact on global warming [1]. Besides that, it is important to indicate positive impact on environment by utilizing all human activity waste and turning them into rare bio fertilizers that indicated higher quality compare to regular organic or chemical fertilizers [5].

Biogas is produced in stationary reactors and requires separate storage facility for the left overs [4]. This factor will draw back biogas production due to expending of necessary area for storage of left overs and will increase [5] cost of bio fertilizers. Also process of applying bio fertilizers will require additional research due to current methods of applying fertilizers cannot be used because of high level of evaporation of bio fertilizers [6;7].

Objectives. Current article objective is to research biomass processing at mobile machine with receiving biogas and rare bio fertilizers and explore of applying method for received bio-fertilizers into the soil from the same machine.

Description of major material. Based on yearly mentioned problems, proposed design of necessary machine has been developed which can resolve necessary problems related to regular methods of producing biogas. Bases for this machine design included next targets: producing biogas with collecting bio fertilizers, transporting bio fertilizers into the filed, applying bio fertilizers for the agricultural crops.

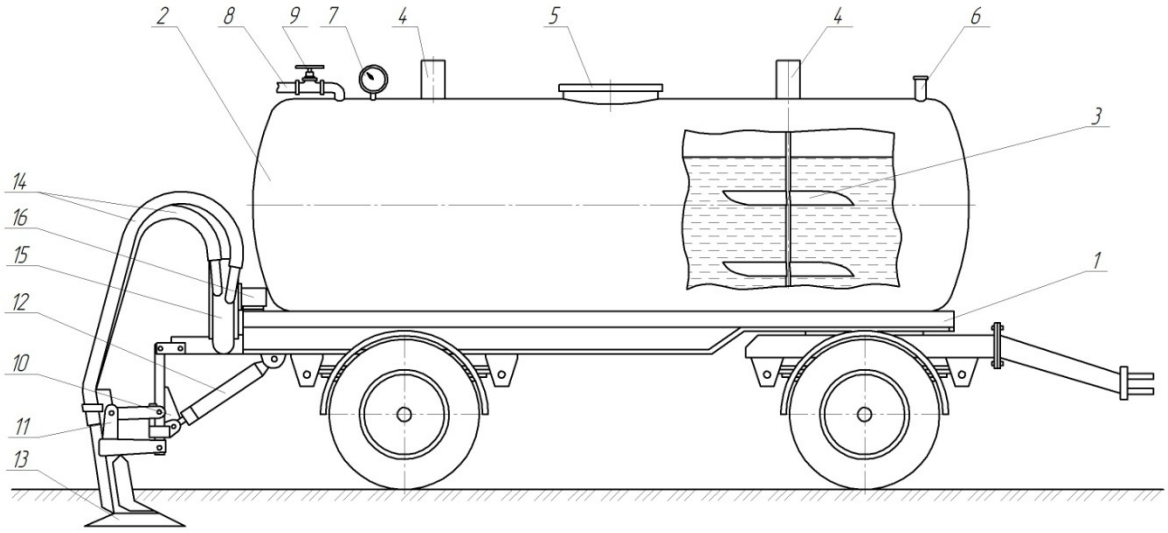

Fig. 1. Mobile machine for producing biogas and applying bio-fertilizers into the soil.

Therefore, mobile machine for biogas and applying bio fertilizers into the soil (fig. 1.) includes moveable chassis 1, attached reservoir to this chassis 2 (reactor). Inside of reservoir 2 installed two blade type mixers 3, that powered by hydro motors 4, that installed on outside surface of reservoir. Loading channel is located on the top part of reservoir 5. Also, on the surface of reservoir safety valve has been installed 6, manometer 7 and gas line 8 with tap 9. Machine has additional equipment for applying fertilizers into the soil. This equipment includes transmission 10, four sections 11 that connected to the transmission via hydro-cylinder 12. On each section have flat blades 13 with connectors 14. At the rear part of reservoir has been installed pump 15 which powered by hydro motor 16. Hydro motors 4 and 16 receive their power from tractor hydro system.

To control process of bio gas production, it is important to emphasize that raw material for biogas production has to have level of moisture not less than 85 % [4]. In case if biomass that will be used for production of biogas is less than 85 %, water could be added to bring moisture for the necessary level. After preparation of biomass for production, raw material will be transferred into reservoir of machine 2 but not more than 2/3 of full volume. Rest of the volume will be used for biogas production [4]. For best results of biogas producing, raw material has to be mixed with the mixtures 3 that powered by hydro motors 4 as well. Raw material has to be mix each 12 hours. After specific time under influence of methane bacteria, gas will be produced and trap at the top of the machine reservoir. When pressure inside of reservoir will reach 5 atm and will be displayed on manometer 7, tap 9 will be open and transported via lines 8 into the biogas trap where could be distributed to the customers. Safe valve 6, will prevent pressure to reach maximum level. After production of biogas will be exhausted, gas lines will be detached from reservoir 2 and tap 9 will be open for pressure balance between reservoir and atmosphere. After that, machine will be transported possibly by tractor to the field area for applying of leftovers from biomass into the soil for the crop fertilizing purposes which is ecologically friendly fertilizer [1]. At the filed hydro cylinder 12, will move transmission 10 into production mode and flat blades will be lowered into the soil for fertilizing purposes. Hydro motor 16 will start pump 15 and process biomass into small particles and transport bio fertilizer by using lines 14. Pump 15 will process all big particles into much smaller ones which will increase transporting level of fertilizers via lines. During of machine movement, flat blade 13 will lift up of top level of soil and fertilizer will be applied under flat blade into the soil. After that, machine will be transported back into biogas production location where new biomass could be loaded for additional production.

For biomass raw material can be used any organic waste: manure, grain and molasses bard, brewer's grain, beet pulp, sewage sludge, fish waste and slaughter plants (blood, fat, intestine), grass, waste, waste from dairy (lactose, whey), waste biodiesel production (technical glycerol from biodiesel production from rapeseed),

waste from the production of juices (fruit pulp , berry), algae, waste starch and molasses (pulp and syrup), waste processing potato chips production (cleaning, red, rotten potatoes) [3].

The biggest advantage of using received bio fertilizer compare with the regular fertilizer is good balanced level of all necessary elements for crop grow improvement. Produced bio fertilizer will impact on environment in soil for microorganisms [5]. After applying bio fertilizer, soil nitrogen will be dramatically improved.

Listed above factors positively impact on quality of the soiland improve texture and level of microorganisms at the soil which dramatically increase crop productivity approximately by 30-50 % [1]. However, incorrect applying method could reduce positive effect into the minimum level and make this process ineffective.

Traditional method of applying regular fertilizers on top of the soil is one of the biggest problems of farming in agriculture due to the high level of reducing important level of necessary grow stimulating components, specifically evaporating of nitrogen, bad smell after applying organic fertilizer. Land application of fertilizer itself contributes to about 46% of the total ammonia emission [7]. In addition, over application of fertilizer can lead to phosphorous accumulation and nutrient imbalances within the soil system. Therefore, many efforts have been focused on reducing ammonia losses, resulting from land application of fertilizer. This has lead to the adoption of liquid fertilizer incorporation techniques, including manure injection, which can reduce odour and ammonia emissions up to 95% [6]. Injection may be defined as the application of liquid fertilizer by method, which incorporate the fertilizer into the soil by some physical means. In “direct incorporation”, fertilizer is directly incorporated into the soil by the injection tool itself without a separate tillage operation [7].

The most common injection tools used include the chisel, sweep and discs (fig. 2). Chisels (fig. 2a) often cannot create sufficient fertilizer holding capacity for the fertilizer application rates required by crops. The chisel-type injector cuts a slot into soil and allows the fertilizer to flow down the slot. As a result, they leave fertilizer

stripes in vertical bands (fig. 3b). In addition, they penetrate deep into soil, therefore requiring more energy.

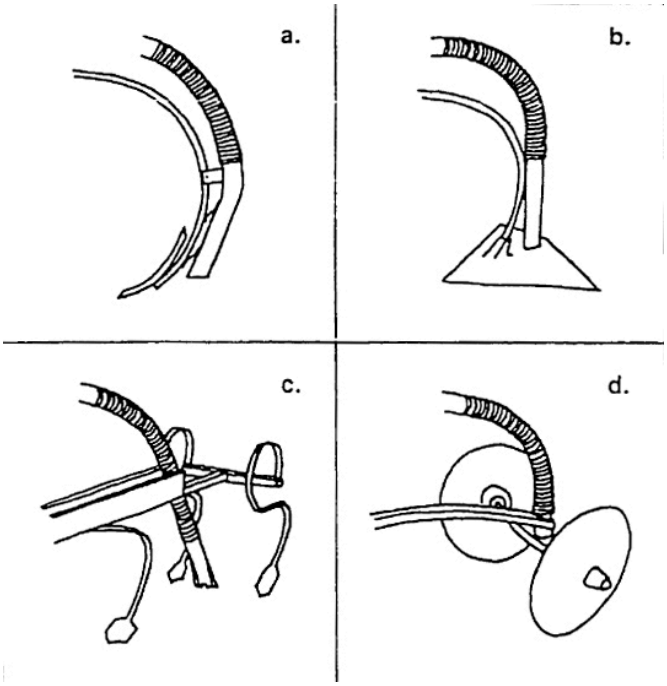

Fig. 2. Tool types for injection of liquid fertilizer into the soil: a) chisel injector; b) sweep injector; c) s-tine cultivator; d) disc injection tool

Sweep type injectors (fig. 2b) lift the soil and allow the fertilizer to flow in a wide horizontal band (fig. 3a) at a shallower depth, and allows the soil surface to come back down over the liquid fertilizer. Sweeps can be used for apply higher application rates in one pass than a chisel injector can apply in several passes. Sweep-type (winged) injection tool demonstrate the best performance for fertilizer injection in terms of mixing soil with fertilizer. Under certain application rates, sweep injectors can work at shallower depths and significantly reduce draft force compared to a chisel tool. However, crop root damage may be a concern for sweep type tools due to their wide cutting widths.

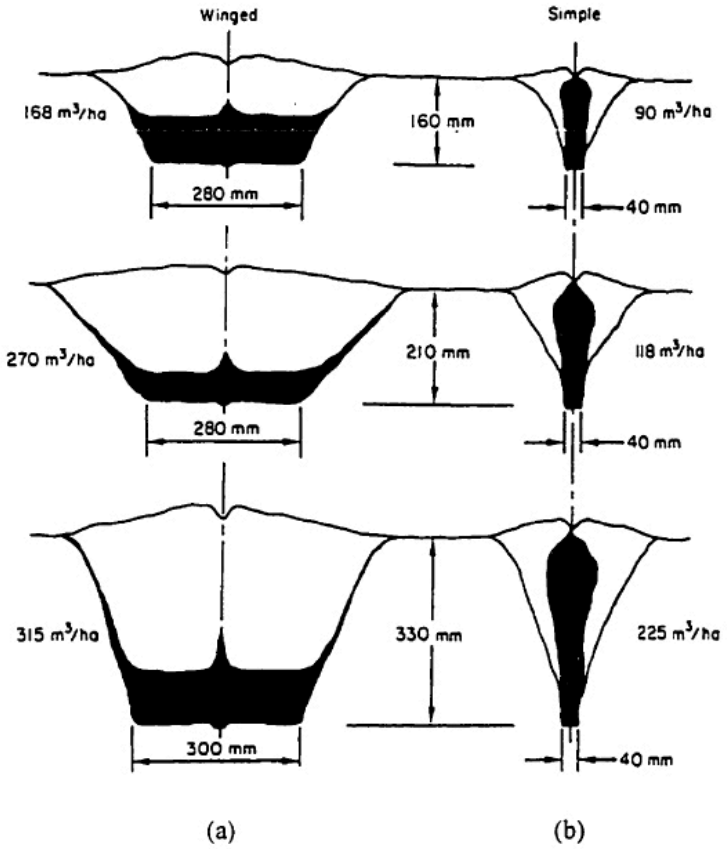

Fig. 3. Distribution of liquid fertilizer in the soil depending of tool type, depth and application rate: a) sweep-type injection tool; b) chisel type injection tool.

Discs have also been used for liquid fertilizer injection (fig. 2d). However, discs do not actually inject the fertilizer, but mix and cover the injected fertilizer with the surface soil layer. The rolling motion of a disc helps to cut through the soil surface at the same time tend to compact the soil and reduce pore size, thus decreasing infiltration rate.

Conclusions. Thus, by successfully designed machine can produce biogas and in addition receive valuable organic bio-fertilizers. On the machine working means as sweep tools allow inter-row plant nutrition. Research of existing tools for injection of liquid fertilizer into the soil showed that the most effective among them is sweep tools, because they provide an optimal balance between application rate, soil depth and draft force. However, they require detailed study because there is a risk of damage to plant roots through a large cutting width.

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Анотація

Середа Л.П., Чернявський М.М.

Переробка біомаси у мобільній машині з отриманням біогазу та рідких біодобрив

У статті розглянуто можливість використання мобільної машини для виробництва біогазу з отриманням цінних біодобрив. Отриманий біогаз може бути використаний в якості пального або джерела енергії. Виробництво біогазу дає можливість перш за все утилізувати всі можливі види органічних відходів, цим самим вирішуючи екологічну проблему. Спроектована машина для виробництва біогазу може використовуватись в якості пристосування для

міжрядного підживлення рослин за рахунок внесення рідких біодобрив у ґрунт. Серед досліджених робочих органів для здійснення внутрішньоґрунтового внесення рідких добрив найкращі експлуатаційні показники проявили плоскоріжучі лапи, позаяк вони забезпечують вигідне розміщення добрив під шаром ґрунту і потребують малого тягового зусилля.

Ключові слова: *біомаса, біогаз, рідкі біодобрива, внесення у ґрунт, мобільна машина, розподілення добрив, знаряддя внесення.*

Аннотация

Середа Л.П., Чернявский М.М.

Переработка биомассы в мобильной машине с получением биогаза и жидких биоудобрений

В статье рассмотрена возможность использования мобильной машины для производства биогаза с получением ценных биоудобрений. Полученный биогаз может быть использован в качестве топлива или источника энергии. Производство биогаза позволяет, прежде всего, утилизировать все возможные виды органических отходов, тем самым решая экологическую проблему. Спроектированная машина для производства биогаза может использоваться в качестве приспособления для междурядной подкормки растений за счет внесения жидких биоудобрений в почву. Среди исследованных рабочих органов для осуществления внутрипочвенного внесения жидких удобрений лучшие эксплуатационные показатели проявили плоскорежущие лапы, поскольку они обеспечивают выгодное размещение удобрений под слоем почвы и требуют малого тягового усилия.

Ключевые слова: *биомасса, биогаз, жидкие биоудобрения, внесение в почву, мобильная машина, распределения удобрений, орудия внесения.*