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PROSPECTS OF ESTABLISHING ECOLOGICAL CENTERS FOR INDUSTRIAL PROCESSING OF ORGANIC ANIMAL WASTE*VLADIMIR D. POPOV, Full Member of the Russian Academy of Sciences, DSc (Eng), Professor*¹

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The intensification of animal husbandry leads to an increase in the anthropogenic impact on the environment, which requires the development of new technological and management solutions. The research purpose was to study conceptual approaches to creating environmental centers for industrial processing of organic waste from livestock, to determine their goals and objectives, and to search for implemented practical examples. The authors have analyzed the best available technologies and world trends in the development of intelligent machine technologies in agricultural production. The analysis of basic and promising technologies for utilization of organic waste from animal husbandry, including six main directions, has been carried out, and their main advantages and disadvantages have been identified. The specific capital costs for the introduction of technologies based on the annual manure output range between 1,600 and 12,600 rubles per ton, and the specific operating costs are in the range between 300 and 10,000 rubles per ton. The obtained data indicate the complexity of choosing a single recycling technology, since the effectiveness of each technological solution depends on a number of factors. To solve the problem, a conceptual scheme for building centers for industrial processing of organic animal waste has been proposed. The main goal of the centers is to involve additional resources in the economic turnover in the form of organic matter, nutrients, bioenergy and new afterproducts. The main task of the centers is to design technical systems optimized by the composition and performance of individual technological units, ensuring the most efficient production of highly sought-after types of final products and energy resources. As an analog, the Italian complex Biogas Wipptal is considered, which processes 70 thousand tons of manure per year, produces 45 thousand tons of organic fertilizers annually, 18 thousand tons of purified liquid and generates 2 MW·h of electrical and thermal energy. A preliminary assessment based on the example of the Leningrad region shows that the establishing of centers will allow producing high-quality organic fertilizers for export in the amount of at least 1 billion rubles per year.

Key words: environmental safety, processing technologies, organic waste, manure, litter.

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IMPROVING THE COMBINED ASPIRATING CHANNEL OF FRACTIONAL PNEUMATIC SEPARATOR OF SEEDS*ANDREY L. GLUSHKOV, PhD (Eng)*

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The paper presents the results of experimental studies of the combined aspirating channel of a fractional pneumatic separator, designed for secondary and final cleaning of grain and leguminous crops, as well as of cereal seeds and legume grasses from hard-separable impurities. The studies were carried out according to conventional techniques. Using a laboratory unit of a fractional pneumatic separator, spring wheat seeds were cleaned from light impurities at a specific feed

of grain material into the aspirating channel of 1.74 ± 0.1 kg/(s·m) and equal losses of full-value grain into waste of $5.7 \pm 0.2\%$. In the experiments, the authors artificially prepared grain mixture with a moisture content of 14%. The grain mixture consisted of spring wheat seeds of the Irgina variety (95%) and light impurities (5%). The latter constituent was represented by a fraction of small-size oats grain. Specifically, light impurities were screening through the oblong sieve holes 1.7 mm wide. The results of studying the combined aspirating channel with a side air supply pipe showed that its use is impractical, since it has an effect of cleaning from light impurities of 74.9%, which is 4.4% lower than that of the combined aspirating channel without an air supply pipe. Studies of the effectiveness of the combined aspirating channel with an inclined suction channel have found that the maximum effect of cleaning from light impurities, equal to 83.0%, is achieved when the inclination angle of the suction channel is 67° . In this case, specific energy consumption of separation is 0.064 kW·h/t. The study has found that the use of an inclined suction channel in the combined aspirating channel allows improves the quality of cleaning the grain material by 3.7% as compared to the vertical suction channel.

Key words: seeds, secondary cleaning, pneumatic separator, aspirating channel, cleaning effect, specific energy consumption.

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DETERMINING THE EFFORT OF BARLEY STRIPPING

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The determination of the effort of grain crop stripping will make it possible to estimate the power required for the stripping process and correctly select the energy parameters of the rippler and also assess the probability of ear separation during stripping. A series of experiments were carried out to determine the effort of stripping barley varieties Vladimir and Jaromir as well as a promising variety of bare-grain barley Nudum-95. The studies were conducted in the Kaluga region on the fields of Kaluga Research Institute of Agriculture. The measuring device is a load frame formed by a double-toothed stripping fingers and brackets and a strain gauge. The measurements were made with stripping fingers having a gap width of 3.3 and 3.6 mm. It was determined that stripping the ears of barley with stripping fingers with a slit width of 3 mm is impractical since there is a significant proportion of ear clipping. The authors determined the values of the stripping forces of the barley ears of the considered varieties and constructed stress diagrams. The greatest efforts were observed when stripping barley ears of the Nudum 95 variety with a comb of 3.6 mm. The range of efforts was 8.7...12.8 N. The smallest efforts were observed when stripping the "Vladimir" barley variety with a comb of 3.6 mm - they amounted to 6.9...9.1 N. The research results were statistically processed to determine the standard deviations and coefficients of variation of the stripping forces. The greatest coefficient of effort variation was obtained when stripping barley ears of the Nudum-95 variety with stripping fingers having a gap of 3.6 mm. The smallest coefficient of effort variation was obtained when combing the barley ears of the Vladimir variety with stripping fingers having a gap of 3.6 mm. The calculation results have proved the uniformity of statistical aggregates.

Key words: grain harvesting, rippler, rippling drum, stripping fingers, stripping force, ear of barley, ear separation.

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BENCH DESIGN AND STUDY OF PHYSICAL AND MECHANICAL CHARACTERISTICS OF A TEAT CUP LINER WITH ANTIBACTERIAL FILLER

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The research purpose is to develop test benches and study the change in the physico-mechanical properties of a teat cup liner depending on the content of antibacterial filler powder in it. The developed test bench includes a teat cup with a teat cup liner, a vacuum level setter, a vacuum meter and a multimeter. The milk tube plug of the teat cup liner contains a light-emitting diode, and its head plug – a photoresistor. A vacuum increase in the internal cavity of the teat cup liner caused a compression of its walls and decrease of light flux supplied from the light-emitting diode to the photoresistor, readings of which are recorded by the multimeter. The elongation of the teat cup liner was determined on a separate bench with a load of 6 kg. The tests were carried out for three sets of DD 00.041 A1 RB teat cup lines, with four samples per a milking machine. The 1st set contained 0%, the 2nd – 3% and in the 3rd one – 5% of silver-based filler developed by the

ECOS company. Measurements were carried out after 20, 60 and 110 hours of operation of milking machines with studied teat cup liners connected to a laboratory milking plant. It has been found that adding the filler to a teat cup liner increases its rigidity. In the initial state, the closing vacuum at 0% amounted to 24 kPa, at 3% – 26 kPa, at 5% – 30 kPa. After 110 hours of operation, the closing vacuum was reduced at 0% by 6 kPa, at 3% – by 6 kPa, at 5% – by 8 kPa. In the initial state, the extension of the teat cup liner sleeve at 0% was 25 mm, at 3% – 22.5 mm, at 5% – 20.5 mm. After 110 hours of operation, the elongation increased at 0% by 12 mm, at 3% – by 11mm, at 5% – by 10.3 mm. After 110 hours of operation, no changes were observed on the surface of the liner with no filler, in the 3% samples there appeared rough strips 40...50 mm long, while in the 5% samples there appeared through cracks 20...35 mm long. Thus the best characteristics have been found with a 3% filler.

Key words: test bench, milking unit, teat cup liner, antibacterial powder filler, physical and mechanical properties.

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STUDIES ON COMPRESSIVE AND TENSILE STRENGTH OF THE SOD-PODZOLIC SOIL

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The most important element in the design of tillage machines is the assessment of the strength characteristics of undisturbed soils in the field. The aim of the reported study was to analyze the features of forming the strength limits of sod-podzolic soil of different granulometric composition for compression and stretching, depending on the absolute moisture content and the amount of plant residues. Complex research was carried out on the basis of Tver State Agricultural Academy using the author's experimental equipment (Patent No 46361 of the Russian Federation). It was found that the greatest resistance to compression in all categories of farmland was characterized by sandy loam soils, where the value of the applied force was on average higher than that on relatively light loamy soils by 4.0...4.5 kPa (4.7...6.4%). At the same time, the tensile strength, on the contrary, was higher in light loamy soils-by 0.4...0.7 kPa (5.6...11.9%). The ranges of absolute moisture content that provide the maximum destructive compressing forces amounted to 17...21% for light loamy soil for arable land; 20...22% for perennial grasses; 18...22% for hayfields; while for sandy loams these figures accounted for 17...19, 19...20, and 18...21%. The range of absolute moisture content, providing maximum tensile forces on loamy soil, amounted to 15...17% for arable land, 17...18% for perennial grasses, 18...20% for hayfields; in sandy loam soil, respectively, 14...16, 17...19, 18...20%, respectively. The increase in tensile forces for light loamy soils as compared to arable land was 1.3 kPa (21.5%) for perennial grass, 2.0 kPa (32.9%) for hayfield, 8.2 kPa (12.2%), 15.9 kPa (23.6%) for compressive forces, 1.4 kPa (26.5%), 2.2 kPa (40.3%) and 8.4 kPa (11.8%), 15.5 kPa (21.8%) for sandy loam, respectively. The identification of these patterns aims at expanding the original data on soil shear deformations necessary for the effective designing of working tools of tillage machines and units.

Key words: compressive and tensile strength of the soil, root residues, soil moisture, arable land, perennial grasses, hayfield, development of tillage machines.

TECHNICAL SERVICE IN AGRICULTURE

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RESOURCE-SAVING CLEANING TECHNOLOGY OF ENGINE LUBRICATION SYSTEM

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The refusal to clean the lubrication system from contaminants before replacing the used oil with the fresh one is caused by the high price and insufficient cleaning properties of the flushing oils used to clean the lubrication systems of diesel engines. As a result of the conducted studies, it was found that the cleaning of the lubrication system and the removal of contaminants from the oil ducts can be carried out with used motor oil without draining it from the crankcase. It was determined that the introduction of ammonium hydroxide into the used engine oil in a mixture with carbamide and the subsequent engine operation at 1500...1600 rpm allows removing almost all types of contaminants from the oil. The oil cleaned in the engine according to the basic physicochemical characteristics complies with the requirements for the base oils used in the production of flushing oils. In the process of applying the used oil, the engine oil channels are partially cleaned. At the next stage, additives of dimethyl sulfoxide, potassium isopropylate and diesel fuel are added to the cleaned oil in the engine crankcase. It was determined that the subsequent start of the engine and its idling at a variable speed for 30-40 minutes allows increasing compression in the cylinders, reducing fuel consumption, and increasing the oil pressure in the lubrication system. As a result of the subsequent engine operation after it has been cleaned with the proposed technology, the service life of freshly refilled oil is increased by 15...20%, the costs of washing operations are reduced by 30...40% due to a refuse to use expensive washing oils.

Key words: engine, lubrication system, cleaning, pollution, used engine oil, flushing oil, additives.

ECONOMY AND ORGANIZATION OF AGRICULTURAL ENGINEERING SYSTEMS

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COMPARATIVE TECHNICAL AND ECONOMIC ASSESSMENT OF AUTOMATED AND ROBOTIZED MILKING PLANTS

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In this work, a feasibility study was carried out taking into account the capitalization of two milking systems: a milking robot and a UDA-16A milking unit as exemplified by a holding with 240 heads of dairy cows. The authors have outlined advantages and disadvantages of these milking systems. As a result of a comparative assessment, it has been found that when milking with UDA-16A, lost profits will amount to 2.16 million rubles as compared to the robotic system due to the improved milk quality, the cost of treating mastitis is 63 thousand rubles, production losses in recovered animals - 0.81 million rubles. But with all its merits, including high-quality preparation of animals for milking and the quarterly milking method increasing the quality of milk, milking robots do not pay back their investments during their lifetime as contracted to a milking parlor. The authors propose an alternative milking system in milking parlors for "herringbone"-type plants, including automated milking modules with quarterly control of the milking process, which ensures an additional profit of about 7.95 million rubles as compared to a milking parlor without quarterly milking, or more than halving the investment as compared to robotic milking.

Key words: technical and economic assessment, automated milking systems, robotic milking, milking robot, capitalization, payback, "herringbone" milking plant.

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ASSESSMENT OF AGRICULTURAL MACHINERY QUALITY UNDER ITS FULL AND PARTIAL REUSE

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The author has analyzed processes of full and partial reuse of agricultural machinery and determined the patterns of changing the machine quality taking into account the peculiarities of reuse in agriculture, which are caused by the circulation and turnover of production assets. It has been revealed that the supplied tractors and combine harvesters are not sufficient for conducting extended and simple reuse. Extended reuse of the machine and tractor fleet can be maintained only due to the qualitative technological improvement. For an economic assessment of the quality of equipment, it is proposed to use a comprehensive indicator - the optimal quality criterion for the work performed by the unit in appropriate conditions of use based on the calculation of compensating costs and leveling charges in relation to the operating time of a machine.

Key words: agricultural machinery, reuse, machinery quality, offsetting costs, leveling charges.

POWER SUPPLY AND AUTOMATION OF AGRICULTURAL PRODUCTION

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STUDY OF OPTIONS AND OPERATING MODES OF AN OZONATOR-IONIZER USED ON DAIRY FARMS

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The authors claim that the existing methods of disinfecting milk are associated with high energy costs. A method for treating milk with ozone and negative ions seems to be promising. The paper presents an experimental unit for determining the parameters and operating modes of an ozonizer-ionizer to be used on dairy farms, including an air compressor, a high-voltage transformer, an ozone-ion mixture generation chamber, an ozonizer, an ozone concentration meter, a voltmeter, and an ammeter. Based on the relationship between the ozone concentration and the operating time of the ozonizer for different dielectric plate areas as well as the ozone capacity of the unit and its electric capacity and operating voltage on the plates, optimization criteria that have a greater effect on the ionizer efficiency were determined. As a result, regression equations were obtained that made it possible to determine the parameters of the ozonizer-ionizer and its operating modes for dairy farms: the total ionizer capacity is 1.5 μF ; discharge current – 75 mA; temperature +283 K, and humidity 67%. It was found that an increase in ozone concentration from 50 to 600 mg/m^3 depends on the applied voltage. The maximum concentration of ozone in the chamber is reached 30 seconds after turning on the ozonizer. Six minutes after its turning off, the ozone concentration is reduced to almost zero. The total area of ozonator plates has a nonlinear effect on ozone concentration.

Key words: ozonation, ionization, antibacterial treatment, ozonizer-ionizer, microflora, pasteurization, milk separation.

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THERMOGRAM ANALYSIS OF PULSE-TYPE IR DRYER

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In the course of the study, the authors analysed the thermograms of plant raw materials that were dried in the pulse-

type IR dryer at a constant surface temperature using a relay controller. Therefore, they identified the relationship between the changes in the frequency of the regulator functioning and the kinetics of moisture removal from raw materials. Thermograms, in the considered case, are arrays of numerical values of time points and temperature variations at those points of the dried raw materials where thermocouples are located. These thermograms were digitally filtered using the Fourier transform (FT) using the Cooley-Tukey algorithm. This analysis showed that the frequency of the regulator functioning during the drying process can be described as a dynamic model of a bi-capacity inertial link that characterizes the process of dehumidification as a general decrease in moisture content in the raw materials in the presence of a time-varying gradient of moisture content over the depth of the raw materials. The end of the drying process is characterized by a decrease in the frequency of the relay controller operation. The timely finishing of the drying process allows reducing the waste of energy for drying and saving a larger amount of biologically active substances in the dried products.

Keywords: plant raw material, pulse infrared dryer, relay control, kinetics of moisture removal.