

## DEVELOPMENT OF HIGH ACCURACY OF THE COPY SOIL SYSTEM

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**Data actuality.** Ukraine is the largest agricultural country in Europe and all over the world. Foreground job of nation is guarantee of grocery safety – has accomplished in our country today. For this reason nowadays it goes increasing export of grains. For stable entrance to international market it's planning to grow crops every year from 70 till 100 mil. ton. Due to reach this result that desirables applying innovational equipment and technologies in agricultural manufacturing.

At the same time, Ukraine is situated in risk area of crop farming with lack of moisture quantity. It's known, that in the steppe region of Ukraine at the certain temperature conditions on the field after cultivation, prepared for seeding, daily lacks of ground moisture consist from 20 till 60 ton per ha [1]. That's why now technologies are extending to the growing agricultural crops widespread, focused on freeze of moisture in the ground. Accordingly agricultural requirements to operation «seeding» start ridiculous. So, for example, seeding should be accomplished during one or two days on a field; deviation from selected depth of seeding placement at the Mini-till technology - 17%, at No-till technology - 25%; pre-planting fertilizing is obligatory and so on. To the construction of the sowing machines' tools, working in energy-saving conditions, making demands to moisture-holding functions and providing additional cutting of crop residues.

Analysis of mechanical facilities, employed at the growing early grain crops and technologies has shown, that one of prohibitive and little-investigated factor in increasing of productivity and grains' quality is existence of mixed-age cultures in the field (Picture 1). The reason of getting such crop stands is neither non-appropriative agricultural technologies, nor modern sowing complexes of machines' perfection. Unevenness seedlings - is consequence of imperfect work of sowing machines' copying mechanisms. As can be seen from the above, creating of high accuracy of copy soil system is actual and it's a new direction in modernizing the sowing machines.

**Problem statement.** High evenness of the depth of seeding placement is one of uninvestigated and unused source of feasibility constructions of the sowing machines. The copy of soil systems were created to control this index, identified as pantograph or parallelogram systems (Picture 2). They are required in constant monitoring of their technical conditions and service. As follows, the sowing machines have 10 % of downtime at the planned maintenance.

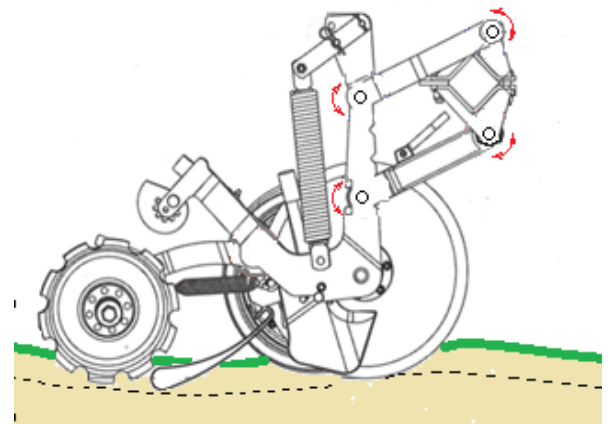
Analyze of constructions showed, that at the present technological developments no one domestic (such as, PJSC «Elvorti Group», LLC «Beltec-Arpo») and foreign suppliers of high technological agricultural machines (John Deere, Gaspardo, Kinze ect.) isn't applicable the building principle of the copy soil system, which don't need in maintenance. (Table 1).

As can be seen from performed data in the Table 1 we can assume, that proposed maintenance systems to modern sowing machines are labor-intensive. The main reason of applying in the joint connections of parallelograms the rubbing-mates type of "shaft-bushing". The constructions are able to withstand huge loads, but in case of intensive greasing with plastic materials. Default of the requirement leads to fast wear of details, locking and fail-

ure of the movable connections of parallelogram systems (Picture 2), making it impossible to conduct in order to growing-on requirements. .



*Picture 1. Example of unevenness sun flower's seedlings at the violation of the depth of seeding placement.*



*Picture 2. Principle work of the copy soil system.*

Due to this the main aim of the project is development of high accuracy of the copy soil systems (СІПКІІІІ). Mistake of the depth of the seeding placement aren't be exceed  $\pm 0,5$  cm.

**Solving the issue.** Above said one of the most effective solution of the issue is creating tribosystem, that corresponds to the maintenance or much more service time, center around the application of composite materials for structural purpose [2, 3]. Problem of developing and involving new engineering plastics in agricultural machinery has been researched by many scientists, in several, like of Abramov L.M., Burya A.I., Kreydlin L.M., Klimchuk J.F., Tsurpal I.A., Murgas M. [4-8] and ect. Ageing process of plastics [9] and their methods of heat treatment were investigated [10].

**Table 1**  
Quantity of movable connections in the sowing machines' constructions that required maintenance at the using and its periodicity

Production plant	Mark of machine	Working width, m	Quantity of servicing point with the frequency (service hours)		
			8-12 hours	15-25 hours	40-50 hours
Great Plains	3S-4010 HD (HDF)	12	94 (115)	9	7
	3S-4000 HD	12	22	6	14
	Yield-Pro YP2425A-2470	16,8	82	48	68
	Centurion CDA600	6	-	-	68
Horsch	Pronto 7/8/9 DC (8 DC PPF)	7,5/8/9(8)	24	-	29 (27)
	Maestro 12/24SW	8,4/16,8	-	-	79/127
Agro-Souz	Agro-Souz Turbosem II 19-60	11,4			183
John Deere	Deere Bauer 44/58/60	16,8/22,4/25,2	72/96/108	72/96/108	48/64/72
	JD 1710/1740	8,4	36	36	24
Amity Technology	Till Drill 4010	12,2	68	-	18
	Till Drill 6015	18,3	100	-	36
Vaderstad	Rapid RDA 600J(800J)	6(8)	-	-	85 (101)
	Spirit ST 600C(800C)	6(8)	-	-	66 (500ha)

For resolving the tasks, connected with development and tests of new composites' facilities (CM) in sowing machines' movable connections, required to conduct full spectrum of the works, such as: theoretical calculations, benchmark (laboratory) trials, composite materials' property corrections (if applicable), and production tests.

Based on the conducted calculations [11, 12] definitive reactions and loadings, that appeared in the friction assembly of the copy soil mechanism of the sowing complex «Agro-Soyuz Turbosem II 19-60».

**Equipment and methods of investigation.** Machine CMIQ- 2 was being used for tribological tests of materials by scheme of friction «disk-shoe». Temperature in contact area is counted by electronic thermocouple «Termometer 301 Type K».

The testing of samples on the fractional tabor abrasion were conducted in accordance with ГОСТ 23.208-79 on the special prepared laboratory equipment based on the friction machine CMIQ- 2.

Investigation of water absorption was accomplished in accordance with ГОСТ 4650-80.

Heat treatment of completed details based on the carbon fibers, due to reducing the water absorption, accomplished by own methodology [14].

**Some results of laboratory investigations.** In Problematic research laboratory of maintenance Dnipropetrovsk State Agrarian and Economic University (DSAEU) ga-

thered valuable experience related to creating and widespread investigation of new composite materials from non-metallic source [13].

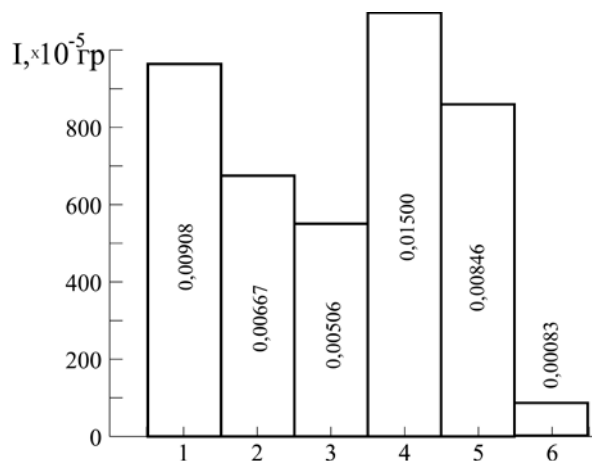
For laboratory tests took materials, extended on the EU market:

- sample № 1 – Nylon 66;
- sample № 2 – ПА-6-210KC;
- sample № 3 – PA6/6.6 R196-GF30 (rain forced 30% glass fiber, Black 91410), factory «Almaak»;
- samples № 4 and 5 accordingly – Kocetal GF705 and Kocetal K300, factory «Kolon Plastics»;
- sample № 6 – CCMM-30M, the Republic of Belarus production and modified in DSAEU.

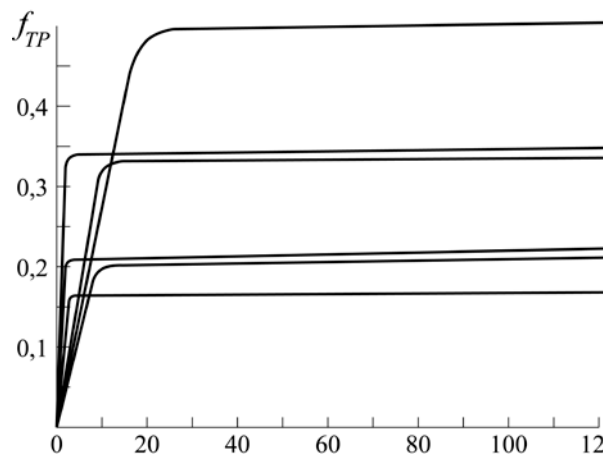
Having determined, that at the friction mode without greasing at the minimal tear of polymeric unit provides in case of using the sample № 6 (Picture 3). It explains by presence the carbon fiber materials, graphite and modifications, showed as low values of this index, as temperature rejection from friction area.

Coefficient of friction  $f_{TP}$  among tested samples characterized by stability. Thus, samples № 1, 4, 3 can be related to frictional materials, because of they have  $f_{TP} \geq 0,3$ . Such materials are not satisfied work conditions of tribosystem in the sowing machines.

In addition, material CCMM-30M (sample № 6) is water- absorbing (to 2 %) it was developed method of heat treatment of finished parts [14], can reduce moisture on composite materials to 40% compared with the standard.



**Picture 3.** Value of the weight wear of the samples at the temperature without greasing on steel 45; pressure  $P=0,5$  MPa, velocity  $V = 0,785$  m/s.



**Picture 4.** Impact of service time  $t$  to coefficient of friction  $f_{TP}$  in tribosystem «metal-polymer».

**Results of field tests.** Field tests were made in the township Mayskoe, Dnipropetrovsk region on the territory of CJSC «Agro-Soyuz». By sowing complex «Agro-Soyuz Turbosem II 19-60» modernized with experimental ploughshares for period from April 2014 till October 2016 has fulfilled in amount of 17 521 ha. Among this period regulation works with experimental details were conducted only one. Greasing and other works for maintenance of units weren't accomplished.

Modernization technology of movable connections was developed and involved to the sowing complex «Agro-Soyuz Turbosem II 19-60» provided reducing labourship at the maintenances to 25 %, increasing of work speed to 10 %, although accurate shooting of seeds took raised harvest for winter wheat from 0,3 to 0,6 ton/ha [15] and Table 2.

Positive results of the tests of sowing complex «Agro-Soyuz Turbosem II 19-60» made in Ukraine let to modernize СПККПП in sowing machines and complexes John Deere 1895, John Deere 7000, and some other models Gaspardo, Kinze ect.

**Table 2**

*Counted indexes of the lacks of harvest based on the evenness of the depth of winter wheat seeding placements*

Counted biological harvest *, t/ha	Parentage of mixed-age groups, %	Fact harvest, t/ha	Lacks of biological harvest, t/ha
5,4	5	5,27	0,13
5,4	10	5,15	0,25
5,4	15	5,02	0,38
5,4	20	4,89	0,51

\*at the sowing norm of seeding 5 ml. grain/ha, considered in mass of grains in ear.

**Conclusion.** Modified (improved and adopted to operating environment) polymeric composite materials furnish high-wearing feature and low coefficient of friction 0,16...0,26.

Provided stable work of movable connections of the machines and mechanisms, which work in the friction conditions without greasing and at a few quantity of abrasive work with implementation the polymeric composites, modified in DSAEU, which at the loading  $P = 0,5$  MPa and velocity  $V = 0,785$  m/c provide minimal coefficient of friction ( $f_{TP} = 0,16$ ) and temperature in the friction area ( $T = 44^\circ$  C).

Implementation the modified polymeric composites to СПККПП constructions increased the work rate to 10%, provided the depth of seeding placement with accuracy  $\pm 0,5$  cm from determined depth, reduced the cost of labor for the maintenance to 25%. As follows, quantity of even-aged plants increased in average from 73...85 % to 88...92%. It provides stable increasing of the harvest, for example, for winter wheat to 0,3...0,6 t/ha at the different agricultural backgrounds and crop rotations.

Developed measures, methodologies and technologies might be adapted to any type of agricultural machines with the copy of soil system type "pantograph" or "parallelogram".

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