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Methods cock of lowering heat losses in techniques of drying corn

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The purpose. To analyze the known receptions of lowering heat losses and to develop basic new ones which would substitute traditional types of fuel at drying seeds and ensure their choice quality. **Methods.** Analysis of literary data, experimental, laboratory and field tests. **Results.** Receptions of lowering heat losses during drying seeds of corn in chamber corn drying machines are specified. Trials of power saving complex which included drying machines SKP-10, SKPM-15 are conducted. They determined influence of the technique upon sowing qualities and yielding ability of seeds of hybrids of corn. **Conclusions**. To lower heat losses in standard drying machines it is recommended to apply reversing and recycling of heat-transfer agent. That reduces fuel rate for 20 — 26%, and completely preserves quality of seeds. Other direction of saving electric power is implementation of combustion of biomass and use of new types of heat generators.

Key words*: drying seeds, drying chamber, power saving technology, sowing qualities, yielding ability.*

Drying seed corn requires much greater heat loss compared to other cereals. Therefore there is a need to promote new energy-efficient drying methods.

Are known by various technical and technological methods to reduce heat loss. These techniques should include two-stage drying with drying cobs in the grain, pulse drying mode with alternating heating and cooling, drying at the maximum temperature [1-5]. The level of heat loss is also affected by the design and technical condition of the furnace, download the chambers and sealing. However, not all methods of reducing energy consumption provide high quality seeds.

The method of drying seed corn in chamber dryers, in which the normalized current regulations, is also quite energy intensive [6]. Its technical and technological parameters are as follows: the temperature regime of 35-50 °C depending on moisture of grain, consistent inclusion of cameras in the work bascicly the drying schedule, the change in direction of purge chambers. With these parameters, the energy consumption for evaporation of 1 kg of moisture is of 8.56 MJ, and thermal efficiency of dryer — 35-40 % of the theoretically possible.

The problem of energy saving in the drying of seed corn is becoming more urgent due to the constant increase in the cost of all types of energy sources — diesel fuel, and liquefied gas, electricity. The problem is compounded by the fact that the production of maize seeds has gradually moved to the Northern part of Ukraine — the forest-Steppe zone and Polesie, where they the best hydrothermal conditions of growing, but the grain is harvested too wet and require drying. With an eye on this, current studies are aimed at finding effective ways to reduce heat loss in the technology of drying of corn seeds [7-9].

The purpose of the research is to analyze the known methods of reducing heat loss and to develop a fundamentally new that would replace traditional fuels during drying and have provided high quality seeds.

Methodology and methods of research. Analyzed well-known methods, reducing heat loss and researched new through the use of alternative fuels. Energy saving methods of drying were studied in the chamber dryers of the type of UPC-10 and SKPM-15, equipped with heat generators operating on solid fuel (rods of corn). In the drying process and collected samples of seed to determine sowing qualities on the methods of national standards and further recommended by the Institute [10, 11]. Drying was started at a moisture content of 25-28 % depending on hybrids of maize were done with humidity of 10-13 %. Individual

seed samples sown in the field to determine field germination and productivity according to the methodology of field experiments with corn [12].

The results of the study. The analysis of literary sources shows that the most significant research in the areas of design techniques to reduce heat loss during drying of seed corn was carried out at the Institute of grain crops NAAS of Ukraine and Odessa national Academy of food technologies [3-5]. However, the vast majority of the development has been aimed at technological modernization of the chamber corn, without replacing fuel.

To such known methods of energy conservation include: two-stage drying, preheating cobs before the main drying, return the waste fluid into the drying zone (recovery) application maximum permissible temperature differential heat mode, reversal (change of direction of the coolant). They all have a different impact on energy consumption and the quality of drying.

Pre-heating was based on the use of increased temperature of the coolant at the beginning of drying. Experiments found that heating at 50 °C for 6 hours reduces the drying time of 7 hours, increases the rate of drying grain by 10.9 %, increases the dryer capacity by 22.5 % compared to the control is a typical technology in regular mode with gradual increase of temperature.

The study also showed that the temperature of the cobs in the mound during warm-up, did not exceed 39 °C, and heating the grain to 35 °C. Therefore, the seed quality remained — the performance of laboratory and field germination, yield was equivalent to the ordinary mode of drying according to standard techniques.

Another method of drying included differentiated regimes depending on the moisture content of the seeds, namely, gradually increasing speed. The essence of the growing mode is that the rate of temperature rise must comply with the water yielding capacity of grain. For step-mode the temperature is set depending on grain moisture content of cobs in the outermost layers of the mound — top or bottom. The temperature change after every 5 to 6 % reduction in grain moisture.

Studies have shown that using differential treatment can increase the average drying temperature at 2-3 ° C, without degrading the quality of the seeds. As a result, the performance of the dryer increases to 18-20 % and more than the typical permanent regimes recommended for the chamber dryer.

For intensification of drying and to reduce heat is also recommended that the maximum allowable temperature of the coolant, together with its reversal. Due to this, the temperature of the coolant in the chamber dryer can be increased to 50-55 ° C, but subject to reversal every 30 min [4].

In General, the use of intense temperature increases average speed the drying of seed corn by 20-27 %, the performance of the drying chambers at 15-21 %, provided high yielding and sowing properties of the seeds compared to a typical regime. However, the mode of intensification can only be applied to seed more resistant hybrids of corn with harvest moisture of grain up to 30— 32 %.

A significant reserve to reduce heat loss is also recirculating the exhaust of the drying agent, that is, its re-entry into the drying zone. When this recirculation is performed depending on the operation mode of the dryer — cyclic (with simultaneous drying and stop all cameras) and batcycle (in the mode of continuous operation of the dryer).

Drying recirculation significantly reduced the consumption energy by 26% and will not degrade the quality of seeds — their germination rate and the yield remained at a high level.

Significant reduction in energy consumption was achieved in the two-stage drying of seed corn, which is first dried on the cob, and then after threshing, the grain. Due to the two-stage drying was significantly improved technical and economic indicators of the chamber dryer: the total duration of drying was reduced almost in 2 times; the fuel consumption was reduced by 40 %. However, decreased germination energy and germination of seeds, due to the considerable mechanical injuries, of sperm in the process of threshing and final drying of grain.

Fundamentally another area of saving is drying, using the heat generators operating on plant fuels. Recently invited to a lot of heat plant fuels with the capacity of 0,5—5,0 mW, but not all are suitable for drying seed corn in the cob [7, 8].

The analysis shows that all the generators on the principle of heat should be divided into pyrolysis (with a closed system biomass combustion) and direct action (open system). The latter have an open flow combustion system, so their efficiency is increased to 90-95 %.

Based on the analysis of various heat sources, we have determined the basic requirements for their design, drying of seed corn: fuel; heat capacity; stable temperature control; sanitary and ecological norms, the purity of products; fire safety; efficiency; logistics characteristics (grade of metal, heat resistance, lining); the control mode of drying; the cost in relation to its thermal capacity; a mechanism for loading, ash removal and slag.

The calculated ability of different materials to form the heat, that can be applied in the technologies of energy saving drying (tab. 1). The combustion of biomass (corn cobs, straw, sunflower husk) of their number to produce thermal energy should increase by 3-4 times compared to conventional fuels. The conversion factor of biomass to conventional fuels is 0,35—0,52. For conventional fuels should be considered as one which, when burned, emits 29,2 MJ of heat. We have set the conversion indicators is recommended to be considered in energy-saving technologies of drying and the design of solid-fuel heat generators direct action.

1. The specific heat generation in saluvan different materials

Fuels	**Heat generation, MJ/kg**	**The Conversion factor to conventional fuel**
Diesel	40-42	1,37-1,44
Gas	33-36	1,13-1,24
Coal (Donets basin)	26-28	0,89-0,96
Fuel plant materials:		
- Corn on the cob	10-12	0,35-0,41
- Straw	12-14	0,41-0,48
- Sunflower husk	13-15	0,45-0,52

Also a study of the work chamber dryer which is equipped with solid-fuel heat generator TPG—1/25. The basic model of the heat source has an original design and works in the mode of direct combustion of the fuel — rods of corn. Thermal power of the prototype generators was 2.0—2.5 mW depending on the volume of fluid and container chamber dryer. Technical and technological characteristics of chamber dryer, which is equipped with such heat generators are shown in table 2. Drying speed at this energy saving complex was 0.25 to 0.29 %/h, the performance of one camera was 1.2 - 3.1 t-%/h.

2. Technical and technological characteristics of kukuruzari UPC-10 with a solid fuel heat generator TPG-1/25, 2015-2016

Hybrid	**Weight of the cobs, t**	**Moisture content, %**				**Drying Rate, %/h**	**The performance of the camera, t-%/h**
		Grain		**Corn on the cob**			
		Before drying	**After drying**	**Before drying**	**After drying**		
Cross 254 M	4,2	24,7	11,0	30,8	10,2	0,25	1,2
Cross 251 MST т	9,6	26,8	11,4	34,3	10,0	0,29	3,1
Cross 255 MST	9,5	25,2	11,6	32,7	11,0	0,25	2,7
Cross 222 C	3,9	25,8	10,2	31,4	9,5	0,29	1,3
Dn Zoryana	18,4	25,1	11,4	32,1	10,5	0,25	1,8

Seeds corn hybrids harvested with a moisture content of 25-28 % and dried by a dryer equipped with a heat source, a little high laboratory and field germination and yield (tab. 3). It was determined the influence of drying, it was revealed that drying of seeds of hybrids of the Cross 267 SST and Cross 307 MST to a moisture content of 6-9 % reduced germination in 2-7 % depending on hybrid. Seed yield of hybrid Cross 267 SST was significantly decreased only at a humidity of 6 %. Energy saving drying is in all cases provided the highest germination and yield.

3. Sowing qualities and fruitful properties of seeds of corn hybrids after different methods of drying, 2015-2016

Hybrid	Method of drying	Germination, %			Grain yield, t/ha
		The standard method	Cold test	Field	
Cross 267 SST	Control (natural)	99	98	86	3,49
	The Thermal W-9%	99	94	79	3,53
	The Thermal W-6%	97	95	79	3,50
	Energy-saving	97	96	85	3,54
HIP_{05}					0,16
Cross 307 MST	Control (natural)	100	98	89	3,86
	The Thermal W-9%	98	98	86	4,27
	The Thermal W-6%	98	90	87	3,66
	Energy-saving	99	97	92	4,67
HIP_{05}					0,24

Conclusions

Identified techniques of energy saving drying of seed corn in the chamber dryers of the type CSP, which should include a differentiated heating mode, maximum allowed temperature, reversal and recirculation of a coolant, two-stage method of drying. Of these methods of greatest practical importance is the reversal and recirculation of the coolant, which reduce fuel consumption by 20-26%, fully preserve the quality of seeds that do not require significant technical and technological re-equipment of the chamber dryer.

Discovered fundamentally different direction of saving electricity based on biomass and new heat generators formed the basic requirements for their design. When drying on a new energy-saving complex obtained certified seeds of hybrids and lines of corn with a high field germination and productivity.

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