APPLICATION OF MICROWAVE ENERGY IN DIFFERENT TYPES OF AGRICULTURE

Применение СВЧ энергии в различных областях сельского хозяйства

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Abstract: The main issues are considered in this topic. In this article discusses the using of microwave technology in various fields of agriculture production. We have presented the results of improving the quality of agricultural products using microwave processing.

KEYWORDS: MICROWAVE ENERGY, TECHNOLOGY, EQUIPMENT, PROCESS, DRYING, DISINFECTING, MICRONIZATION, GRAIN, ENERGY.

1. Introduction

The introduction in the agro-industrial complex of the new low-power electro technologies, based on last researches of the electrical effects in the last decades, is one of the most important challenges of the new century.

2. Preconditions and means for resolving the problem

In first we should attention to such technologies that using biophysical characteristics of the impact energy of the electromagnetic field (EMF) ultra-high frequency (UHF) on agricultural materials, which provides a significant reduction in energy and receive high quality new products.

Table 1

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<tr>
<th>Technologies</th>
<th>Sphere of application</th>
<th>Benefits of technology</th>
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<tbody>
<tr>
<td>Combined drying of grains and seeds with the use of microwave energy</td>
<td>Postharvest seed and grain of agricultural crops in order to further their long-term storage and further</td>
<td>Intensification of the moisture removal, 5-13,2%, reduction in micro-defection due to more grain &quot;soft&quot; mode of drying on 2,6-6,2%, increase properties in crop seed for 5-6%, reduction in specific energy consumption for 29,4-32,3%</td>
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<tr>
<td>Pre-sowing stimulation and disinfection of the seeds</td>
<td>Improving sowing properties crop seeds and theirs the decontamination from pathogens</td>
<td>Increase seed germination in 10-12%, increase prolificness up to 20-30%, reduction in energy and materials in 3-5 times</td>
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<tr>
<td>Improvement of baking properties of bread and flour</td>
<td>Heating of food grain and flour to improve its baking properties</td>
<td>Improvement gluten in the grain in 1,3 times, increasing the desiccant capacity test at 5%, reduction the degree of dilution of the test at 10 EF, improvement in overall valoriparameter estimation on the 19% increase in the volume of grain</td>
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We dedicated fragmentary different areas of applied technologies.

3. Solution of this problem

Combined drying of grains and seeds, using microwave energy.

Drying of grains and seeds in agriculture is one of the most critical and complex energy-intensive operations. Improve the efficiency of grain drying is possible, intensifying the internal mass transfer. It can do by using the features of microwave energy.

Analytically and experimentally, found that thermodynamic equilibrium between liquid and vapor, located inside the material disturbed by the action of EMF UHF. In this process overpressure formed at temperatures below the boiling point of water. Under the impact of overpressure we see filtration moisture transfer from the inner grains layers to the outer grains layers, in the evaporation zone.

Filtration moisture transfer speed at high operating parameters of the microwave treatment is 10-100 times higher than the speed of diffusive transfer in conventional convection drying. Thus, the treatment on a material by microwave energy leads to an intense transfer of moisture to the surface almost up to its secretion in the liquid droplet condition.

In first stage, wet grain for drying is processed convective method. This accompanied by removal of surface moisture. When the outer layers of the grain dewatered and moisture supplied to the surface quickly enough inner layers of the, the rate of convective drying begins to fall.

At this time, the grain treated with microwave energy of electromagnetic field, which provides an intense transfers of moisture from the inner layers to the outer layers of dehydrated in the evaporation zone.

Table 2

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<td>Production of high-nutrient and quickly cooked cereal products, improving nutritional value of feed grain</td>
<td>High-intensity heating of cereal and feed grains, grain products for improving their nutritional properties</td>
<td>Improve quality of native starch to 50% and higher, increasing the digestibility of grain and grain products by 30-40%, simmering cereals by 5-10 times, reduction cost of energy in the 1.5-1.8 times</td>
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Processing costs do not exceed 7-10% of the cost of raw material.
After microwave treatment, moisture evaporation proceed again with sufficiently high intensity convectively until drying of the surface layers and falling drying speed.

This progression of convection and microwave treatment repeated a number of times, until the grain moisture reaches conditioned mode.

We have conducted a special studies of changes biological and biochemical properties of grain and seeds in different modes of its microwave processing.

These studies allowed defining rational process parameters that providing reduce energy intensity and increasing high quality. The technological process of the combined grain drying with using microwave energy has been implemented in two installations of conveyor and silo-type through enhancements to existing standard designs. As a source of microwave energy in the dryer we used industrial sources of microwave energy "Khazar-2R" with adjustable output power and operating frequency of microwave EMF 2375 ± 50 MHz. Removal of moisture in a conveyor installation was carried out by warm air, heated by electric heaters system with regulation to 50 kW power.

We made comparative tests of the installation in condition farm "Experimental" and other farms of Rostov region in comparison with the known convective dryer of conveyor type T-685 (Germany) with the productivity - 0.98 - 1.12 t / h providing the reduction of specific energy consumption up to 4200 - 4380 kJ or 29.4 - 32.3%.

Fig 1. General view of the conveyor system for combined drying grain using microwave energy

Complex analysis of the tests results shows that, with compared with the traditional convective drying process developed by the combined drying process using microwave energy provides:

- moisture removal intensification of 5.3 - 13.2% reduction in unit energy consumption for 9.1-32.3 % decrease micro damage grain due to a "soft" mode of drying by 2.6 - 6.2% increase crop seeds characteristics of by 5-6%.

- Pre-sowing seed stimulation and disinfection.

Nowadays problem of seeds quality is quite acute in agriculture. Chemical methods, like dressing of seeds before sowing by pesticides, are preferred in the system of protective sowing by peptides, are preferred in the system of protective measures against pests and diseases. However, their systematic application has led to the development of resistant species of pests and diseases, environmental pollution, food and feedstuffs.

Researching characteristics of the impact by the EMF microwave energy to crops seeds allowed developing a combined process of the stimulation and disinfection. It includes special wetting the seeds surface by the special aqueous solution and subsequent their microwave treatment. For the period of the rest microorganisms commonly found in surface microcracks seeds absorb a special solution, while only the surface of the seed is moistened. When the microwave treatment we have a local heating of the wetted surface of seeds due to its high dielectric properties and loss of microorganisms found there. In this case, there are simultaneous drying of seeds and electromagnetic activation their preplant properties due to the influence of microwave energy on the activity of amylolytic enzymes.

The preliminary laboratory evaluation of the germination, as compared with the control and depending on the original, can be increased by an average of 10-12%, the number of surviving plants for harvesting more than a 15-20% increase yield to 20-30%.

This energy and materials in the proposed technology in comparison with known can be reduced by 3-5 times.

Improving the baking properties of food grains.

The main condition for obtaining high-quality white bread flour is the content of a large amount of gluten proteins of certain physical properties. It was established experimentally that the energy of the microwave electromagnetic fields affect on the activity of amylolytic grain enzymes and crops seed. Activity of this enzyme plays a role in the preparation of bakery products it together with other factors (temperature, moisture, oxidizing processes, etc.). With this we proposed combined method moisture-heat processing of food grains using EMF microwave energy to strengthen the gluten and improve other baking properties.

In particular, it was observed increase strength level to DCO -90-95 au because of the combined processing of wheat with gluten- 24-26 %, and with DCO 105-120 ea. During preparation flour from this grain and bread it was observed increase the desiccant ability of pastry from 55.4 to 60.4%, reducing the degree of dilution of the pastry from 50 to 40 EF and a general improvement in the overall valorimetric assessment from 58 to 77%.

The volumetric yield of 100 grams of bread flour, baked from processed grains increased from 575 cm³ to 790 cm³, while the total score increased from 4 to 4.6 points.

Thus, as a result of the combined treatment it was obtained cereal product of higher quality and correspondingly higher (25-40%) value. Energy costs and processing costs are thus no more than 7-10% of the initial output value that provides high economic effect.

4. Results and Discussion

The use of new combined technologies of the processing of agricultural materials with using positive treatment effects of microwave energy allows to: significantly reduce the specific energy consumption, to get better quality performance of products, increase the shelf life and safety of products, obtain a qualitatively new positive properties of the products.

5. Conclusion

The basis of effective use of microwave energy in these processes is the principle of combined processing of agricultural materials, according to which it used only in a limited range to achieve the qualitatively new effects that are unattainable or difficult to reach by other known methods.

6. Literature