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TRENDS OF RESEARCH
Drying TECHNOLOGIES

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The reasons for the growing interest in the drying process, as well as some aspects of the interaction between industry and university research groups in the implementation and application. Study examined trends drying processes that occur at the intersection of different fields using the translational capacity of the technical process.

Drying, intensity, efficiency, energy aspects, and dry foods.

Introduction. Home purpose drying food industry - saving vysushuvanoho product. Reducing the moisture content prevents or significantly hinders the progress of microbial and enzymatic reactions. However drying negatively affects the chemical composition of the product, material and nutritive value of food. In theperfection Technology drying provides:

- Improving the technical and economic performance (reduce energy consumption, increase process performance, reduce the size of equipment, Relief control process);
- Consideration of environmental aspects (minimizing energy consumption, reduce harmful emissions into the atmosphere, increasing the safety of production);
- Improving product quality (homogeneity dryingMinimizing chemical changes of the product, preserving nutritional value).

Drying is one of the most difficult processes processing products and least studied because of the difficulty of establishing a mathematical model of simultaneous transfer of heat flow, solids, moisture.

The increasing interest in recent drying occurs in developing countries against the backdrop of relatively stable in the other

continents. This is evidenced by the analysis of the number of publications on the topic of dry materials in international symposia in the Netherlands and China (2002), Brazil (2004), Hungary (2006). [4, 6, 8,

12, 14] . Publications mainly covers the following fields,% food and agricultural products 30-35; Equipment: design, optimization, control 20-25; basic principles of drying, modeling, production 20-25; other 15-30.

The above analysis shows that the food industry and agriculture remained dominant in the study of the drying process - over 30% of publications devoted to this issue. This trend was observed and symposia on drying in 2008 in India and 2010 in Germany.

The increasing interest in the drying process certifies the amount received in the US in the past two decades patent drying to 240 per year, while the total number of patents crystallization, evaporation, adsorption, distillation and membrane separation is less than 200 [5]. A striking example of successful cooperation between research institutions and industry was a joint activity of 14 major European chemical companies (BASF, Bayer, BP Amoco, DOW, Rhone-Poulenc, DuPont, Elf Atochem, Hoechst AG, ICI, Norsk Hydro, Novo Nordisk, DSM and Astra Zeneca), With more than 20 European universities in areas such as combined drying and granulation, spray drying and pin, mathematical modeling, standardization of test methods and expert systems with dryers choice [13].

By intensive studies of potential energy savings in drying technology [7] encourage global economic crisis and the constant increase in the cost of energy. Attention to problems driven by growing legal requirements on environmental, environment and quality of work as well as the negative impact of the global threat of carbon dioxide and other emissions, given the growing world energy consumption and energy production forecasts (Table. 1).

1. Production of the world's energy resources.

Energy Resources	Production of the year,%			
	2000	2010	2020	2030
Equivalent 1t. oil *	9.179	11.132	13.167	15.267
Oil	39	38	38	38
Coal	26	24	24	24
Natural gas	23	25	27	28
Nuclear energy	7	7	6	5
Renewable energy	3	3	4	4
Hydraulic energy	3	3	3	2

* Billion. T.

Industrial energy consumption for thermal dehydration sometimes reaching over 12% of total industrial consumption [15]. High energy consumption in the drying process, makes the problem of energy-saving technologies in the number of primary drying**.**

Given the agrarian economy of Ukraine and the country's decline in industrial production in the world development drying technology is an attractive and promising. Thus, despite the decline in total milk

production during the economic crisis in Ukraine in recent years produced more than 10 million. Tons of raw milk, which is 26% more internal needs (annual demand for liquid milk is more than 2.1 mln. Tons). Production skimmed and whole milk powder twice bigger than the internal needs of the country [2]. These indicators enable Ukraine to occupy a high enough position in the ranking of the world's major exporters of dairy products (Table. 2).

2. The main countries - manufacturers of powdered milk, thousand tons

Країна	Сухе молоко											
	знежирене						незбиране					
	Виробництво		Імпорт		Експорт		Виробництво		Імпорт		Експорт	
	2010	2011	2010	2011	2010	2011	2010	2011	2010	2011	2010	2011
Австралія	113	109	5	6	160	175	222	230	15	15	137	145
Аргентина	50	55			20	19	38	37			170	200
Бразилія	80	80	10	10	3	5	130	134	37	39	6	10
ЄС	1975	2000	4	5	378	450	980	1010	2	2	444	430
Індія	4325	4325			10	15	375	410				
Китай			91	100			55	56	320	430	3	3
Мексика	175	187	155	155			13	13	15	20	7	7
Нова Зеландія	500	454	3	3	344	375	344	375			948	1000
Росія	252	195	180	185			70	70	55	50		
США	718	800			384	414	824	885	7	5	10	8

An important sector increase production and expand the range of dried products are canning industry. Since Ukraine exported a wide variety of dried products, the issue of domestic production is extremely serious. It is clear that production and reduce imports exotic for our climate dry products economically unfeasible. Imports also dried vegetables, dried mushrooms and requires a substantial reduction. For example, Russia exported to various countries including Ukraine (Table. 3) dried products worth about 2 million. Dollars [1].

Ways to intensify the drying process. Reduced capital and operating costs dryers depends on the feasibility of increasing the speed of drying, subject to the requirements of product quality. High speed drying allow you to reduce the size of both the dryer, so auxiliaries. This, in turn, reduces operating costs. As you know, raw materials for industrial drying characterized surface and internal moisture. The intensity of drying during removal of surface moisture depends on the value of external heat and mass transfer coefficient as mass transfer resistance, is out of dried material. Thus, increasing the convective heat transfer and external mass transfer coefficient, increase speed, temperature drying agent or the relative humidity of the drying agent spent will increase the speed of drying usual convective dryer. Naturally, there are exceptions, such as intensive drying may contribute to the reduction of surface hardening and drying speed. It can also cause

extreme reluctance compression and cracking products. Thus, increasing the turbulence of the drying agent, mechanical vibration or fluctuations lead to higher flow speeds drying. The ultrasonic sound effect or increase the rate of drying, but the mechanisms of intensification complicated.

3. Export Code dehydrated vegetables and fruits in the world in 2007-2011., Th.

Країна	Рік				
	2007	2008	2009	2010	2011
Азербайджан	11,1	13,7	13,1	36,9	26,0
Німеччина	324,2	454,1	764,8	281,1	340,5
Італія	478,3	208,5	270,0	88,7	107,5
Казахстан	381,8	689,8	451,7	343,3	349,2
Монголія	134,2	176,8	84,6	222,7	204,6
США	69,3	13,1	26,4	11,9	8,3
Таджикистан	-	12,2	0,5	119,3	53,4
Україна	**746,1**	**682,8**	**331,4**	**392,2**	**457,5**
Франція	220,3	75,5	66,6	44,3	53,7
Інші країни	1719	2195,9	1760,8	1356,1	1257,5
Всі країни	2754,7	2979,5	2185,7	1923,8	1830,4

When using superheated steam at a temperature inversion as a drying agent drying rate is higher compared to hot air, but at temperatures below the critical opposite - lower. Ultrasound exposure may cause high-frequency pressure pulsations followed by cavitation. Alternate generation regions of high and low pressure causes rapid vaporization and liquid transfer through a material. Using electromagnetic field can warm polar liquid volume to be evaporated. This effectively eliminates the transfer of heat resistance of the material. The transfer of moisture through the material is enhanced to some extent by increasing the mobility of water at higher temperatures. The described mechanism of increased speed drying occurs when superheated steam drying.

Another possible way to enhance the intensity of drying involves increasing the effective area of the interface for heat and mass transfer. For example, in the oncoming collision zone configuration flow generated by the collision of opposing streams of gaseous material point, is a factor of high turbulence intensity. If a pasty or similar to the sludge material dissipates region of turbulence tends to increase the area of the interface drying. The intensity increases further drying is inversely proportional amount of material particles or droplets size ceteris paribus. When allowed, use mechanical stirrer dispersing agents or within the dryer increases speed drying. We also know that heat transfer material from one particle to another more efficient (must provide sufficient surface impact) than between gas and material particles. Mixing hot inert

material particles of wet material points leading to very high intensity drying. It is possible to use such material points adsorbent when coolant effectively enhances the mass transfer capacity, while reducing humidity gas. Most of the options intensification drying proven [9]. However, not all ideas can be applied now, because most of them related to changes in product quality. In addition, the introduction of new technologies leads to complications equipment, requiring pre-feasibility study to industrial use. Application areas using some of the following methods increase intensification drying is shown below.

	Methods intensification drying
Drying period Constant Speed	increasing turbulence free flow; application oscillations, vibrations; use two-phase drying agent; application of acoustic field of high sound pressure level;
incident rate	application of ultrasonic field; high-frequency heating; electrokinetic phenomena; use of synergy effects;
constant and falling velocity	increase the surface area for heat transfer separation and mass transfer; using high heat; superheated dry steam.

Using multistage dryers. If in the material surface and internal moisture to effectively conduct the drying process drying mode and even the type of drying in some cases differ to remove these two different types of water. For economic reasons, preferably selected single drying unit for drying the whole process of changing spatial mode for continuous dryers and temporarily - for dryers periodic operation. Zoning dryers along their lengths typically used in conveyor and tunnel installations to ensure the best mode of drying thermally labile materials at intensifying the drying process [3]. During the falling rate drying regime should take place slowly to ensure that the temperature of the material below the critical temperature, above which the material quality is much worse (changing the color, texture, etc.). But for the great performance and cost-effective for some materials using two different types of dryers.

Removal of surface moisture - even more intensive process that requires shorter holding time in the dryer product, while the removal of internal moisture - a slower process that requires a longer holding time and therefore a larger dryers. To remove surface moisture is mainly intended fluidized bed dryers, roller, spray, etc. For a longer stay raw materials used dryer Circulating tunnel, tape, etc.

To successfully use multi dry starting material must have both types of water in sufficient quantity to two-stage drying process duration was sufficient for industrial implementation. In some cases, the first stage can be used to remove surface moisture to reduce the adhesive properties of the product are sufficient for further drying, such as fluidized bed [10]. For example, in the production of coffee Spray drying is followed by drying in a fluidized bed. According cutting process requires a large mixing chamber and vysushuvanyy fine grinding. Such hybrid dryer rentabelnishi than conventional. Sometimes a long time in the two-stage dryer need for structural changes or of chemical reactions are much slower than the drying process. For example, crystallization of polyethylene terephthalate (PET) - polymerized resin in high column, while the initial moisture is removed in a small fluidized bed dryer.

Table. 4 shows examples of industrial use two-stage drying technology [11]. Note that multi-dryer - it's just smart combination of known technologies.

4. Some examples of two-stage drying.

The degree of drying		Benefits	Using
first	second		
Spray drying (τ 0 ... 10 s)	Drying in a fluidized bed (τ 0 ... 10 min)	Use the full size dryer - zumovlennya best technical and economic characteristics	Spray dryer with flyuyidyzatsiyeyu (Niro)
		If necessary granular product (suitable for quick cooking)	Liquid solutions (coffee, milk and washing)
Spray drying (τ 0 ... 10 s)	Drying in vibrating distributor (τ 0 ... 10 min)	The same	Dry coffee, milk etc.
Spray drying (τ 0 ... 10 s)	Drying in the dryer Conveyor circulation and zoning (τ 0 ... 10 min)	Drying in moderate conditions for thermally labile materials and very sticky solid materials that are high in sugar	Drying juices
Aerofontanne drying (τ 0 ... 10 s)	Drying in a fluidized bed (τ 0 ... 10 min)	Instant removal of surface moisture in aerofontanniy dryer; internal moisture - long stay in the fluidized bed dryer	Wood or cellulose
Drying in a fluidized bed (τ 0 ... 1 min)	Column / filtration dryer (τ 0 ... 10 hours)	Instant removal of surface moisture in the fluidized bed dryer, final drying - in the Column dryer	Polymers
Roller dryer	Impact drying		Drying tiss-term-

(τ 0 ... 0.1 s)	(τ 0 ... 0.1 s)	paper-vynya margin in dvostupin chat dryer; at the same time on each stage of drying

However, it usually offers unique advantages that are not consistent with composite technology (tab. 5).

5. Comparative analysis using multistage dryers in the dairy industry.

Dryer	Energy saving,%	Characteristics powder
Single: spray	-	Neahlomerovanyy (~ 0.2 mm); wide distribution in size; a significant fraction of the fine
Two-stage, fluidized-bed spray	~ 18	Agglomerated with processing for quick cooking; had small fraction; no dust
Three-stage: Cut-onshore fluidized bed and fluidized bed with the outside	~ 30	Agglomerated and granular; good solubility; slight difference in size

New promising technologies, implementing the recently include a combination of traditional methods of drying. In particular, heat pumps, multistage drying methods, production management based on optimal control models used widely.

Conclusions

The article reflects the current state and the growing importance of drying in the world of scientific research highlights the prospects for the production of dry food in Ukraine and abroad.

Trends in the drying technologies are to intensify the drying process by: increasing the surface area for heat transfer division and mass transfer; using high heat; superheated steam drying; increasing turbulence free flow; Application: oscillations and vibrations, two-phase drying agent, the acoustic field of a high sound pressure level, ultrasonic field, high-frequency heating, electrokinetic phenomena, synergy effects multistage drying process.

Using current trends intensify drying requires an integrated system approach to multidimensional and multidisciplinary modeling concurrent processes transfer of momentum, energy and mass. Also, the study will require active collaboration of researchers to achieve effective contribution to fundamental science and industrial projects. Policy development requires attention to environmental safety and energy conservation, given the constant increase in environmental and economic requirements, provided high quality finished products.

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Pryvedenы Causes rastuscheho Interest for the drying process, as well as interaction Some aspects nauchnыh unyversytetskyh industry and collectives in the embodiment and application. Rassmatryvayutsya Trends Studies drying processes, poyavlyayuschyesya on stыke DIFFERENT industry with science Using postupatelnыh of opportunities tehnycheskoho process.

Drying, Intensity, Efficiency, эnerhetycheskye aspects, Dry pyschevыe produkty.

Reasons over of growing interest are brought in processes of drying and also some aspects of co-operation of industry and scientific university collectives in embodiment and application. The tendencies of research of processes of drying that appear on joint of different areas of

science with use of forward possibilities of technical process are examined.

Drying, intensity, efficiency, power aspects, dry food foods.

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OPTIMIZATION RYVKOVOHO motion mode Swing mechanism boom cranes

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In the article the way the fluctuations of cargo during the steering jib cranes. Optimization mode triggers turning the tap is performed using methods of variations. The paper used criterion integrand which serves energy jerks, which is subject to minimization. For the control parameter is selected force acting on the steering on the part of the drive mechanism.

Fluctuations load optimization transitional regime movement.

Problem. It is known [5] That when working jib cranes pendulum oscillations observed cargo that cause uneven movement mechanisms and links provide additional dynamic load, which reduces their reliability and leads to discomfort in their operation and increase the risk of accidents.

Solving the problem of reducing the load fluctuations on flexible suspension provide a more efficient operation of crane equipment.

Analysis of recent research. The problem of the fluctuations of cargo on a flexible suspension for several decades. Recent studies on this issue are based on the use of mathematical theory of optimal processes (maximum principle, variational calculus). Note that modern methods of eliminating vibrations offered to sell the goods through certain steps to control steering during transient states of motion (acceleration, braking).

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In [1,2,8] Option is selected by managing power to the drive mechanism of action: to eliminate the need to manage fluctuations in load torque on the motor shaft rotation mechanism. Management action has a relay character, resulting in increased dynamic loads on the valve.