THE ROLE OF DESICCATION TECHNOLOGY IN RAISING THE EFFECTIVENESS OF PRODUCTION

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It was resolved at the 24th Communist Party Congress that the effectiveness of consumer goods production must be raised by implementing the achievements of science and engineering in all sectors of the national economy.

We will discuss here the developments in desiccation technology, of concern to researchers in this field.

Desiccation processes are important to the national economy, having found many applications in all sectors of industry and agriculture. Dried products include such a diversity as cereals, fuels, mineral fertilizers, timber, pharmaceuticals, foodstuffs, grass, paper, rubber, building materials, radioengineering components, ceramic components, textiles, synthetic chemicals, insulation materials, etc. One dries materials for mass consumption produced in millions of tons annually as well as expensive materials produced in quantities below a hundred kilograms annually. The size of dried articles ranges from microcomponents for the radio industry to large aggregates such as work benches, vehicles, agricultural machinery, etc.

Desiccation is one of the most important stages of a manufucturing process in almost every industry, and on its proper management depends not only the preservation but also the better quality of products.

The basic requirements of a desiccation apparatus are that it yield a dry product with specified quality indices (moisture content within given limits, vitamin content as well as other valuable ingredients, structural and mechanical properties, etc.) and that it ensure the best possible characteristics in terms of heat and energy losses, since 10-15% of all fuel in the overall nationwide heat balance is spent on desiccation processes. For this reason, the construction of highly economical and efficient desiccator aggregates according to modern scientific and engineering standards is of utmost importance to the entire national economy.

The development of leading Soviet industries is intimately related to developments in desiccation technology. We will examine here the basic trends of modern high-power desiccation specifically in those industries where desiccation is the crucial treatment stage affecting the product quality. Improvements in the performance and in the economy of desiccation are achieved along the following lines.

1. Increase in the power rating of aggregates and construction of large-capacity composite aggregates (for example: tube desiccators, fluidization-bed desiccators with a 200 tons/h capacity, atomizer-desiccators with up to 50 tons/h evaporated moisture).

2. Increase in the rate of heat and mass transfer processes, through optimization of the heat-carrier parameters and improvement of the hydrodynamic process conditions.

3. Increase in the desiccation rate, by prior dispersion of the material and consequent enlargement of its heat and mass transferring surface: disperse materials are now more often dried in fluidization and suspension beds, where the process can be accelerated considerably and not only the technicoeconomical indices of the desiccation process can thus be improved but also the quality of many heat sensitive materials.

4. Applications of new desiccation techniques and compound heating modes: of considerable practical interest are desiccators where heat sensitive materials undergo drying in a cycled mode.

Institute of Heat and Mass Transfer, Academy of Sciences of the BSSR, Minsk. Translated from Inzhenerno-Fizicheskii Zhurnal, Vol. 26, No. 5, pp. 775-780, May, 1974. Original article submitted January 29, 1974.

Studies made at many scientific-research institutes have shown that cycled desiccation not only helps to preserve the quality of precious foods (cereals and vegetables) but also raises their market value.

Sublimation desiccators are very advantageous to use in the food industry as well as in other industries, inasmuch as the taste of products dried by this method can be retained for long periods of time. Sublimation desiccation may become popular in those regions of the Soviet Union where refrigeration, deep-freeze transportation, and deep-freeze preservation techniques have not yet been properly implemented.

Other modern methods of drying include thin-film desiccation with a radiative heat supply, liquid and paste desiccation in a fluidization bed with sprinkling and with an inert disperse packing, desiccation in an extraneous forcing field (for example, in a field of industrial-frequency or high-frequency electric currents), etc.

5. A rational design of desiccators requires provisions for uninterrupted drying, which would make continuity and complete automation of the entire technological process feasible.

The construction and the installation of automated desiccator aggregates make it possible, in turn, to increase the output, to improve the product quality, and also to improve the working conditions in a factory.

For instance, a conversion to automated continuous desiccation of a product like cereals will reduce the necessary equipment for cleaning and drying, also the necessary electrical equipment, by 50-60%. The expenditure for automated cereal cleaning-drying equipment can be recovered within 2-3 seasons.

Automated desiccation of potatoes and vegetables can reduce the final moisture content from 12 to 6%, thus making it possible to preserve a product approximately 5 times longer.

6. Finally, in the design of desiccators for the food industry, it is very important to make use of secondary energy sources and of all heat otherwise wasted, as this apparatus becomes rationally integrated into the thermal system of the entire processing plant.

Desiccation plays an important role in several other industries as, for example, in the fuel industry where the continually growing demand for solid fuel in this country emphasizes the role of desiccation processes and apparatus in this particular application.

Thus, the fuel industry now uses more equipment capable of handling disperse fuels, namely solid fuel particles suspended in a fluid.

Over a hundred tube desiccators with a capacity of 40-100 tons/h each are used throughout the nationwide system under the management of the USSR Ministerium for the Coal Industry. At the same time, drum desiccators are widely used in electric power plants throughout the country.

In the chemical industry it is necessary to dry lumpy, loose, liquid, and pasty materials. Disperse materials, especially crystalline ones, are encountered here most often. They may be of either organic or inorganic origin.

Disperse materials are dried in drum-type, belt-type, and eddy-type desiccators, as well as fluidization-bed, suspension-bed, and vibrofluidization-bed apparatus.

Thus, in the potash combines Soligor and Bereznik there are in operation fluidization-bed systems designed at the VNIIG and tube desiccators with a capacity of over 100 tons/h designed at the ITMO AN BSSR. The construction of desiccators with a capacity of 150-180 tons/h in a single stage is now underway. According to available data, desiccation carries much weight in the production of such materials.

The fast growing chemical industry requires additional heavy-power equipment, and new techniques of effective desiccation are called for.

The problems of dehydrating bacterial preparates are of overriding significance in the microbiological industry. The desiccation costs amount to about 50% of all expenditures on technological processing here. It is to be noted, however, that the problems of desiccation peculiar to this branch of industry require further research in and utilization of high-performance atomizer-desiccators which have already been developed at the ITTF AN UkrSSR, the ITMO AN BSSR, the NIIKhIMash, the NIIUIF, the MÉI, the MIKhM, etc.

A large number of drugs are now manufactured in large pharmaceutical plants. Such drugs include mainly those mass produced in the form of tablets. Desiccation constitutes a major portion of the

manufacturing process in the production of these drugs or of other preparates as well. The rate and the quality of desiccation of the raw material will determine all subsequent operations.

Among the methods already widely used in industry are the combined gravity-fluidization bed and bubbling fluidization bed.

Desiccation chambers of the Rosstromproekt system with multiple circulation are widely used in the production of ceramics for the building industry. The interaction between incoming and outgoing air streams in such an apparatus has the effect of enhancing the desiccation process.

As the building-ceramics industry grows, existing designs of dessication chambers are improved while new ones are developed in the USSR. Several models of an ejector-type desiccation chamber, which ensure very steady drying, have already been constructed and installed.

Counterflow desiccator tunnels with various extra design features (for instance, with zonal regulation of the operating parameters), designed to accelerate the desiccation of articles, are also widely used and also desiccators with an alternating vertical air stream.

Ejector-type desiccator tunnels are also widely used in building-ceramics factories. The presence of ejectors here ensures an internal circulation of the heat carrier.

Whenever ceramic articles must be dried fast (for example, porcelain-faience items), one uses conveyor desiccators. Structurally, such an apparatus consists of two parallel moving belts with cradles containing the moist pieces.

The ceramic raw material is most often dried in rotating drum desiccators.

For clay one uses now not only drum desiccators but also air-spout desiccators, while atomizer-desiccators are used for a ceramic mass in the form of slag. Such a desiccation yields ready powder, while other methods require additional equipment for comminuting the dry material.

Desiccation is extraordinarily important in the processing of agricultural products. It is to be noted here that, in this case, desiccation serves not only as a means of ensuring long-time preservation but, owing to the strictly scientific choice of apparatus and process mode, it has also become an important means of improving the taste and the market value of these products.

The desiccation of cereal crops (wheat, corn, rye) and of certain crops for industrial use (e.g., sunflower seeds) has been thoroughly analyzed and there are in operation many desiccators of various types, capacities, and degrees of mechanization. The Ministerium of Provisions operates now several hundred heavy-power grain driers of the recirculation type with a capacity of 50 tons/h, which have been designed at the ITMO AN BSSR and subsequently modified at the Kazan Branch of the VNIIZ.

In developing new methods of desiccation, particular attention must be paid to preventing the formation of cancerogenic compounds.

As is well known, artificial desiccation of grass ensures an almost complete preservation of nutrients and vitamins contained therein (during plain natural desiccation 60-80% of these substances get lost) and the feasibility of mechanized harvesting even under unfavorable weather conditions. The use of hay flour allows a reduction in the use of concentrate fodders and, at the same time, an upgrading of the feed given to farm animals.

The production of vitamin flour from grass, in quantities of many million tons annually, is contemplated in the near future. Considering that 3-4 tons of water must be evaporated per ton of flour, one can estimate the heat expended on the desiccation of grass to be commensurate with that needed for the desiccation of cereal, for example.

Desiccator aggregates of the drum type are at present manufactured serially. Although they have performed well in the desiccation of various grades of grass, their capacity of 500 kg (dry material) per hour does not appear adequate. There is a definite need for higher-capacity apparatus operating by the most advanced techniques.

The cellulose-paper industry ranks among the basic and most important branches of the national economy, its share of production (in terms of worth) since 1961 being larger than that of all other timber processing industries.

Desiccation constitutes one of the basic technological processes in the manufacture of paper and cardboard. Contact-drying is now the principal method used for paper. The desiccator part of modern paper-making machinery is a huge aggregate, rather inconvenient to operate and difficult to automate.

For this reason, any measures designed to accelerate the desiccation of paper and to reduce the metal mass and thus also the energy consumption will benefit the national economy on the whole, especially in view of the ever growing industrial and consumer demand for the variety of cellulose-paper products.

In order to improve the effectiveness of the process, one uses today compound modes of heat supply to the material surface which have been developed at the Engineering Institute of the Food Industry in Moscow.

The sawmill and timber processing industries in this country have grown vigorously during the Soviet era. Such a drastic increase in lumber production and the expanding use of lumber products in various sectors of the national economy have made it necessary to develop timber desiccation techniques, namely to design special types of chambers and processes, to improve the performance, and to use more effective heat carriers.

The desiccation of wood is a technological process which requires large quantities of energy. Many types of desiccation chambers for this special purpose are in operation today throughout the timber industry; they have been designed at the NIIMOD, the VTI, the UkrNIIMOD, the Moscow Timber Engineering Institute, and the TsNIIFM.

The major part of desiccation is done in large-scale lumber mills, where continuous-duty chambers are used for reducing the moisture content prior to shipment. Water vapor, water, or flue gases serve here as heat carriers. Most widely used are continuous-duty chambers with a convective heat supply.

The great variety of desiccator models used in different plants does not reflect on the nature of any particular production process but, rather, stems from a lack of selection guides applicable to either new or modernized old installations.

In view of the tremendous increases in electric power generation and the construction of heavy-power energy systems, it has become feasible to utilize electric energy for the desiccation of wood.

Among the desiccation chambers used for wood and operated on electric power at industrial frequency, one ought to mention the electrical radiator-convection chambers which have been designed at the UkrNIIMOD and the electromagnetic chambers which have been designed at the Institute of Heat and Mass Transfer (BSSR Academy of Sciences) according to the modern method of desiccation with cycling.

During the past decade there has occurred a rapid development in radio engineering instruments with relatively few metallic components and in related industries. An outstanding feature of these industries is that the technological processes here are highly mechanized and automated. In connection with it, one had to develop heating—drying apparatus and methods based on entirely new fundamental principles and capable of accelerating the heat treatment of materials as well as articles, i.e., of reducing the process time to a fraction of the time (in some cases to one order of magnitude less or even shorter) than required in conventional systems. Such new methods have been developed at the ITMO AN BSSR and they include, for instance, various modes of continuous or intermittent radiative-convective heating of polymer coatings or thin layers of a material. These methods have brought about a great improvement in the heat treatment of heat sensitive materials and products, in their quality and preservability.

In consideration of all this, several new technologies have been introduced for the heat treatment of articles and prototype radiative-heating pilot desiccators have been installed with luminous or dark radiation sources, serving as a sound basis for a subsequent setup of various series of automated process-and-assembly lines.