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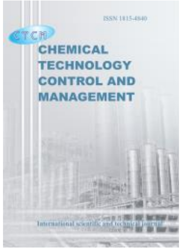

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STRUCTURAL MODEL OF THE TECHNOLOGICAL PROCESS OF STORAGE AND PROCESSING OF OIL RAW MATERIALS

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Abstract: *The technological method of storing and processing oilseed raw materials is structurally modelled in the article. Additionally, it is suggested that the generalized structure be presented as a three-part scheme, consisting of a raw material department, a processing shop, and transportation networks. On the basis of a thorough examination of the characteristics of the constituent parts of the technological complex, a practical model for the problem of the general characteristics of the technological complex is proposed.*
Keywords: *technological process, storage, processing of oilseeds, model, technological complex, block diagram, sets, stochastic.*

Аннотация: *Мақолада мойли хомашёларни сақлаш ва қайта ишлаш технологик жараёнининг структуравий модели келтирилган. Шунингдек, умумлаштирилган структурани уч элементли схемаси − хомашё бўлими, қайта ишлаш цехи, транспорт тармоқлари кўринишида тақдим этиш таклиф этилган. Технологик мажмуани ташкил этувчи элементларнинг хоссаларини батафсил ўрганиш асосида ишланадиган моделни яратиш учун технологик мажмуанинг умумий тавсифлари масаласини ҳал қилиш кўриб чиқилган.*
Таянч сўзлар: *технологик жараён, сақлаш, мойли хомашёларни қайта ишлаш, модель, технологик мажмуа, структуравий схема, тўплам, стохастик жараён.*

Аннотация: *В статье представлена структурная модель технологического процесса хранения и переработки масличного сырья. Предложено представить обобщенную структуру в виде трехэлементной схемы – сырьевое отделение, цех переработки, транспортные сети. Рассмотрено решение задачи общей характеристики технологического комплекса по созданию работоспособной модели на основе детального изучения свойств элементов, образующих технологический комплекс.*
Ключевые слова: *технологический процесс, хранение, переработка масличных культур, модель, технологический комплекс, структурная схема, множества, стохастический, процесс.*

1. Introduction

The technological characteristics of how technological complexes for the processing of oilseed raw materials work have been demonstrated in bibliographical works on the topic, and they support the idea of their presentation as a single class of control objects. The primary responsibility of managing such technical complexes is to ensure that specified volumes of oilseeds are processed with the fewest possible losses while accounting for the alternative operation of their component groups of processes (Fig. 1). According to research [1–14], the difficulties of technological complicated automation for the processing of oilseed raw materials have not yet been taken into account in such a formulation.

In order to solve this issue, a practical model based on a thorough examination of the features of the components (or groups of processes) that make up the technological complex should be developed in addition to the basic characteristics of the technological complex.

According to this perspective, the technological complex can be split into three major categories (based on the types of current processes): (Fig. 2.). We shall refer to the two key components of the technological complex as "raw materials department" and "processing shop" in accordance with the terminology used in technical practice. Intra-factory transport networks, which provide multiple connections between separate components, are the third component of the technological complex. The major issue—the synthesis of the control system for the complete technological complex based on the attributes of its separate elements—can be resolved due to such a structural identification of the technological complex [1-4].

Let us consider in more detail the generalized characteristics of each element.

2. Simulation of the raw material department

The great majority of contemporary businesses that process oilseeds have separate storage areas for raw materials that include equipment for processing raw materials to protect their qualities as well as communication lines between them.

According to Fig. 2, which depicts an expanded technological plan of the raw material department, the model can be meaningfully described as follows.

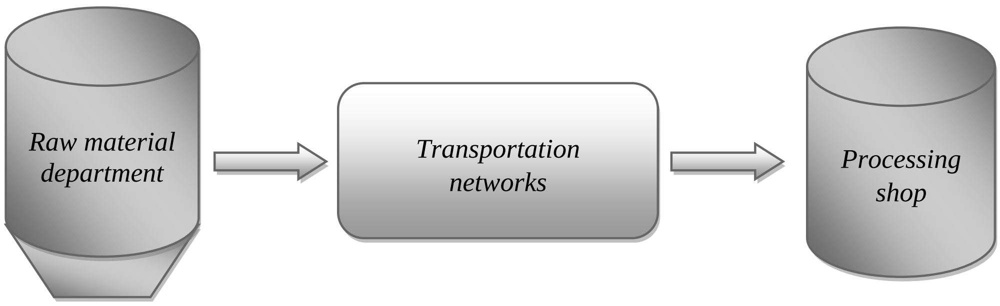

Fig.1. ***Structural diagram of the technological complex for storage and processing of oilseed raw materials.***

Let raw materials enter the raw material department in certain batches.

A finite set

$$N_\alpha = \{n\}. \tag{1}$$

is given.

Quantitative and qualitative features *n* of batch α. Then the state of all incoming raw materials is characterized by the set

$$A_1 = \bigcup_{\alpha=1}^{m} N_\alpha \; ; \tag{2}$$

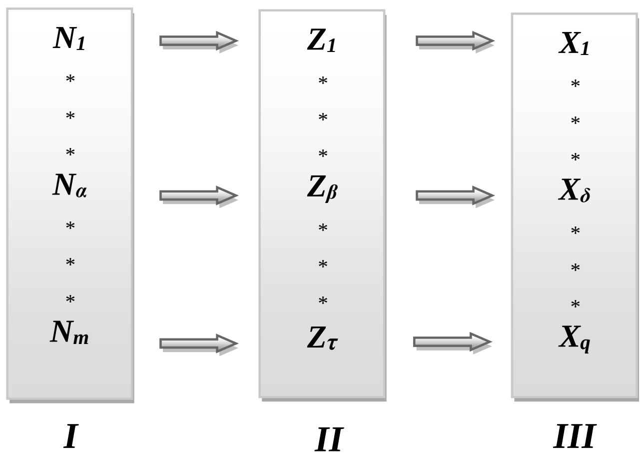

Fig.2. ***The generalized structure of technological operations in the raw material department:***
I- batches of incoming raw materials; II- raw material department with a certain number of separate devices for storage and processing of raw materials; III- batches of raw materials for processing.

In the raw material department, batches of raw materials are placed in apparatuses of various designs. The set of parameters *Z* characterizing the state of batch β will be denoted by

$$Z_\beta = \{Z\}\,. \tag{3}$$

The state of all raw materials in storage is described by the set

$$A_2 = \cup_{\beta=1}^{\tau} Z_\beta \,. \qquad (4)$$

At the same time, the number τ of devices determines the total capacity of the raw material department.

Similarly, we represent a set of qualitative and quantitative features x of a batch r going for processing:

$$X = \{x\}\,. \qquad (5)$$

The state of all raw materials going for industrial processing is determined by the set

$$A_3 = \cup_{j=1}^{q} X_r \,. \qquad (6)$$

where q – is a number of parties.

Mappings

$$\varphi: A_1 \xrightarrow{\varphi} A_2 \qquad (7)$$

$$\psi: A_2 \xrightarrow{\psi} A_3 \qquad (8)$$

are fully describe the raw material department, taking into account input and output streams.

The technological complex's procedures taking place in the raw material department can be seen as a transition from state A_1 to state A_3. There are a variety of states that define this transition, which is influenced by both internal and external forces. The states A_1 (starting properties of raw materials) will be taken into consideration as given in this work, therefore cause-and-effect processes that alter the properties of raw materials in the raw material zone are not taken into consideration.

First of all, the set A_2 is subject to identification with known A_1 and unknown A_3. Oilseed raw material is a sophisticated biochemical system that exhibits a variety of physical processes that are influenced by chance events [3-5]. The study methods are experimental-static due to the lack of precise knowledge regarding the quantitative and qualitative ratios that characterize the transformation of raw materials during storage. Hence, using a probabilistic model and accounting for the stochastic nature of the ongoing processes, the indicated set A_2 will be obtained. In accordance with the mission assigned to this activity, the primary objective is to identify broad trends that describe changes in the loss of raw materials and a valuable component inside of them during storage.

3. Simulation of the processing of raw materials

Oilseed processing facilities today are outfitted with a variety of technological tools that are linked together in a technological chain. There are both single-product and multi-product technical flows, depending on how the technological process is organized, the types of raw materials, and created goods (Fig. 3).

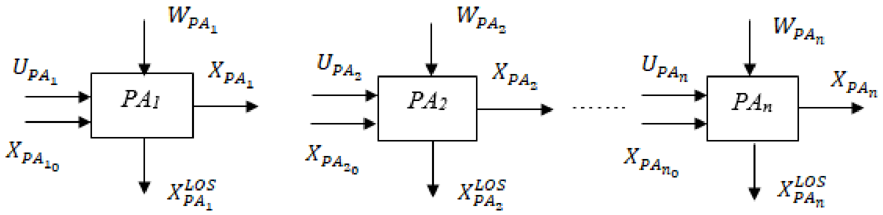

Fig.3. ***The generalized structure of the processing shop of the technological complex:*** *X_{PA_i} – vectors characterizing the qualitative and quantitative characteristics of raw materials and semi-finished products at the inlet and outlet of the i-th apparatus; $X_{PA_i}^{LOS}$ – vectors of losses of raw materials and valuable components in it; U_{PA_i} – vectors that determine the set of technological methods that provide control of the apparatus; W_{PA_i} – vectors of disturbing influences destabilizing the technological process; PA – processing apparatus; n – the number of devices in the production line.*

Each apparatus processes raw materials in different ways to extract valuable components, yet losses always happen at each step. The success of implementing technological processing processes, the kinds of raw materials used, outside influences, etc., determine the quantity and kind of these losses.

In accordance with the goal, the main task of identification is to reveal the functional dependence of the form

$$X_{PA}^{LOS}(0,T) = F\left[U_{PA_i}(0,T), X_{PA_i}(0,T), W_{PA_i}(0,T), T\right], \qquad (9)$$

where (*0, T*) – is the processing interval for a separate batch of raw materials.

Dependence (9) describes the work of the entire processing shop, regardless of the quantity and type of processing machinery or the kinds of raw materials. In accordance with the material balance equations, each batch *r* from the set A_3 (6) of raw materials supplied for processing is determined by the mass M_r and the content of a valuable component in it X_r.

$$J_\beta(r,\beta) = \sum_{\beta=1}^{l}[M_{j\beta}(t), X_{r\beta}(t)], \qquad (10)$$

where β – is the type of raw material, r=1,2,…, l – is the number of product lines.

At the same time, there are certain restrictions on the permissible ranges of change in performance parameters

$$G_{r\beta} \le G_{r\beta_{доп}}, \qquad (11)$$

and in quality

$$X_{r\beta_{min}} \le \mathrm{X}\, r\beta \le X_{r\beta_{max}} \qquad (12)$$

Technological methods of processing raw materials are selected from the area of permissible controls

$$U_{i=m}U = \{U\}. \qquad (13)$$

The loss of a valuable component is also determined by the types of raw materials β and batches *r* by quantitative $M_{\beta_r}^{LOS}$ and qualitative composition $X_{\beta_r}^{LOS}$

$$X_{PA_i}^{LOS} = \sum_1^y\left[M_{\beta_r}^{LOS}(t), X_{\beta_r}^{LOS}(t)\right], \qquad (14)$$

and here y –is a number of types of losses.

Permissible loss values are determined by the technological regulations:

$$\mathrm{M}_{\beta_r}^{\mathrm{LOS}} \le \mathrm{M}_{\beta_{r_{per}}}^{\mathrm{LOS}}; \qquad (15)$$

$$X_{\beta_{r_{min}}}^{LOS} \le X_{\beta_r}^{LOS} \le X_{\beta_{r_{max}}}^{LOS}. \qquad (16)$$

As a result, the set of equations (9) – (16) reflects the processing shop mathematical model in general terms.

While processing processes have been examined in greater detail than storing processes, it is required to utilise analytical and experimental research approaches to identify them.

Conclusion

As a result, the difficulties associated with automating technological complexes have been examined, which has revealed that the study's subject is a complex system that includes a number of physical, chemical, and biological processes that are currently unable to be accurately described analytically.

Raw material storage is the sequential (in time) passage of the material from its starting condition to its ultimate state under the influence of a variety of internal and external influences, the majority of which are random. As a result, it was predetermined that the raw material department would be thought of as a stochastic object, the characteristics of which are defined in the state space.

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