UDC 331.45
DOI 10.23947/2541-9129-2019-2-18-22

DIGITAL TECHNOLOGIES PROSPECTS IN PRODUCTION CONTROL OF ELEVATORS, FLOUR, CEREALS AND FEED PRODUCTION

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The reasons of overuse of production capacities at storage and processing of vegetable raw materials are determined. The growth rates of gross output of grain and leguminous crops are considered. Elevators, objects of flour, cereals and feed production are considered as important structural elements of micro and macroeconomics. The paper predicts the application of digital technologies in production control and online monitoring of dangerous and harmful production factors. Ways of implementation of this approach on real production processes, which are, controlled both by the operating organization and by the Supervisory authorities are considered. Accidents and fatal injuries at hazardous production facilities of storage and processing of plant raw materials are considered.

Keywords: production control, digital technology, risk-based approach, explosion, accident, fatal accident, hazardous production facilities, safety, human factor, production.

УДК 331.45
DOI 10.23947/2541-9129-2019-2-18-22

ПЕРСПЕКТИВЫ ПРИМЕНЕНИЯ ЦИФРОВЫХ ТЕХНОЛОГИЙ В ПРОИЗВОДСТВЕННОМ КОНТРОЛЕ ЭЛЕВАТОРОВ, МУКОМОЛЬНЫХ, КРУПЯНЫХ И КОМБИКОРМОВЫХ ПРОИЗВОДСТВ

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Определены причины перегрузки производственных мощностей при хранении и переработке растительного сырья. Рассмотрены темпы роста валового сбора урожая зерновых и зернобобовых культур. Элеваторы, объекты мукомольного, крупяного и комбикормового производства рассмотрены как важные структурные элементы микро- и макроэкономики. Спрогнозировано развитие цифровых технологий в производственном контроле и онлайн мониторинге опасных и вредных факторов. Определены методы реализации данного подхода на примере производственных процессов, контролируемых эксплуатирующей организацией и надзорными органами. Рассмотрены ситуации аварийности и смертельного травматизма на опасных производственных объектах хранения и переработки растительного сырья.

Ключевые слова: производственный контроль, цифровые технологи, риск-ориентированный подход, взрыв, авария, несчастный случай со смертельным исходом, опасные производсвтенные объекты, обеспечение безопасности, человеческий фактор, производство.

Introduction. Elevators, flour, cereals and feed production facilities are an important part of economic activity of many regions of the Russian Federation. These regions satisfy the needs of the state in certain types of plant raw materials, allow storing strategic reserves, creating stability in the market of food products. They provide feed to certain areas of livestock, as well as the sale of raw materials and products for export. At the same time, during the operation of hazardous production facilities for storage and processing of plant raw materials, there are certain problems associated with the risk of fire and industrial injuries with fatal outcome [1].

In accordance with the Federal law "On industrial safety of hazardous production facilities" No. 116-FZ of 21.07.1997 [2] these facilities are classified as hazardous production facilities (HPF) hazard class III (medium hazard). According to the accident analysis [3], from 2013 to 2017, 6 accidents and 21 fatal accidents occurred at the facilities of storage and processing of plant raw materials. 50% of accidents and 70% of fatal accident of the total number occurred at the facilities of hazard class III.

Main part. Recently, despite the increase in the gross yield of plant raw materials of grain and leguminous crops in the Russian Federation, the relative amount of storage and processing of such raw materials is reduced [3]. So, in 2017 134.1 million tons of processed cereals and legumes were harvested. At the same time, 14.9 million tons of harvested crop are accounted for 1,000 HPF for storage and processing of plant raw materials, which is 4.3 million tons more compared to 2013 [3]. Table 1 illustrates a stable increase in the specific number of units of plant raw materials per unit of storage and processing. This increase contribute to the requirements of the modern market, which sets certain criteria in production volumes, timing of sales, etc. The load on HPF for storage and processing of plant raw materials increases. This has a negative impact on the operation of these facilities and the organization of production control.

Table 1

Ratio of gross yield to the number of HPF for storage and processing of plant raw materials

No.	Indicators	Time period				
		2013	2014	2015	2016	2017
1	Number of organizations operating HPF for storage and processing of plant raw materials	4132	3750	3789	4621	4017
2	Number of HPF for storage and processing of plant raw materials	10579	9838	9448	9286	8961
3	Gross yield of grain and leguminous crops in the Russian Federation, mln t	91.3	110.8	104.3	119.1	134.1
4	Gross yield of grain and leguminous crops in the Russian Federation, per 1,000 of HPF for storage and processing of plant raw materials, mln t	8.6	11.2	11	12.8	14.9

From the obtained data [5] it follows that the unfavorable load on hazardous production facilities for storage and processing of plant raw materials is not due to the large amount of the harvested crop, but to the increase in the specific amount of harvested plant raw materials per unit of the object for its processing. For this period, most accidents occurred in the Republic of Tatarstan, the second place takes the Rostov region [3]. As table 2 shows, the load has increased over the entire analyzed period.

Table 2

Gross yield in agricultural regions, million tons

No.	Regions of the Russian Federation	2013	2014	2015	2016	2017
1	Republic of Tatarstan	2.6	3.36	3.4	4.3	5.01
2	Rostov region	6.7	9.5	9.8	11.7	13.5
3	Krasnodar Krai	12.03	12.87	13.9	14.3	14.3

The increase in the load on HPF has the corresponding consequences, which are reflected in the deviation from the safety requirements, the established technological regulations, the deviation from the performance characteristics of the technological equipment established in the passport data and, importantly, in the increase in labor of workers operating and servicing these facilities.

As it was mentioned earlier, storage and processing facilities for plant raw materials are important economic agents, whose destabilization can significantly undermine the economic stability not only of a company's owner, but also of the entire region (Fig.1, 2). The main safety problems today are not so much technical as organizational problems, which determines the human factor as one of the leading causes of accidents [6].

Fig. 1. Explosion of dust-air mixture in elevator grain storage sections

Fig. 2. Fire of one of the elevator grain storage sections

Today, the question of the degree of safety in production of is raised. The current level of technology allows changing the emphasis of production from increasing productivity to improving the feasibility and safety [7]. In order to produce safer and more socially justified, it is necessary to integrate modern technological solutions with the existing practices and established requirements in industrial safety. It is expressed in the Decree of the President of the Russian Federation of 06.05.2018 No. 198 "On the fundamentals of the Russian Federation state policy in the field of industrial safety up to 2025 and beyond" [8].

The implementation of such ideas is possible with the help of remote monitoring in production control from the position of digital technologies in a risk-based approach. Remote monitoring should be used for all technological operations associated with the operation of a hazardous production facility. These operations are acceptance of plant raw materials, cleaning, drying, production, transportation, storage of plant raw materials and products, as well as shipment of products. All of these technological operations should be controlled in real time, both by man and by monitoring systems, which allows realization of the existing level of digital technologies development. At this level of control, the information will be analyzed in real time. This will enable organizations operating hazardous production facilities to have advantages in data processing and decision-making speed. A certain prospect opens up for supervisory authorities, which will be able to access the information of the supervised objects remotely, without the in-

spector going to the objects under their supervision. In the future, it should be a dynamic system of continuous monitoring, which will continuously provide information to owners, supervisory authorities and the public on the levels of danger of the production facility at any given time. [10]. The related works should also controlled, such as ensuring cleanliness in buildings and structures of the facility, cleaning of bunkers and silos, work at height, fire works and other works of increased danger.

Conclusion. Production control should not be aimed at the fulfillment or non-fulfillment of certain safety requirements and related consequences, as this creates a large information "gap" between the events and the consequence. A static system cannot respond quickly to changes in technological operations, human errors or failures in the operation of technological equipment. The main goals that should be pursued in the modernization of production control methods are dynamism, speed of reaction to changes in the production environment and the ability to adapt to all technological operations and existing types of work at the facilities. It is these qualities that can significantly reduce the list of existing problems in ensuring production control and bring the concept of safety to a completely new qualitative level.

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Received 05.03.2019
Submitted 06.03.2019
Scheduled in the issue 15.02.2019

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