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Development of the CALS-Technology of Drying-Agglomeration Process in Production of Biologically Active Additives of the New Generation

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At the present time, as a promising information technology, methods of the Continuous Acquisition and Life Cycle Support (CALS) concept are widely implemented (Bessarabov et al., 2012). The CALS concept is based on the complex of the unified information models and the standardization of methods for information access and correct information interpretation according to the international standard ISO 10303 (STEP). A series of CALS projects were developed for a number of technologies for producing special-purity substances (Bessarabov et al., 2007) and waste utilization (Kvasyuk et al., 2012); however, in all the cases, CALS methods were used only to create the project documentation.

1. Application of the CALS concept in development of the information systems

The essence of the concept of CALS is the application of the principles and technologies of information support at all stages of the lifecycle of products based on the use of an integrated information system. It provides a uniform way of managing processes and interaction of all participants in this cycle: customers (including government agencies and departments), suppliers (producers) of goods, maintenance and repair personnel (Saaksvuori, Immonen, 2010). These principles and techniques are implemented in accordance with the requirements of the international standards governing rules of governance and interaction mainly through the electronic data interchange.

The life cycle of products includes a number of stages, starting from the origins of the new product idea prior to its disposal at end of useful life. These include the stages of marketing research, design, technological preparation of production, actual production, after-sales service and maintenance products, and safe environmentally friendly recycling (Lam et al., 2011).

There are own targets at all stages of the life cycle. The participants of the life cycle strive to achieve goals with maximum efficiency. At the stages of design, technological preparation of production and manufacturing it is necessary to ensure compliance with the requirements of the manufactured product at a given degree of reliability of the product and minimize the time and money that is necessary for success in the competitive struggle in the conditions of market economy. The concept of efficiency covers not only the reduction of production costs and shorten design and production, but also the provision of facilities development and cost reductions on future products. The operation requirements are of particular importance for complex products, for example, in industries such as organic or inorganic chemistry.

Integrated information environment is the basis, the core of CALS is a distributed data repository that exists in a networked computer system, covering (ideally) all services and departments, related to the processes of the life cycle of products. A single system of rules of representation, storage and exchange of information operates in an integrated information environment. Information processes that accompany and support of the product life cycle at all stages flow in an integrated information environment in accordance with these rules. There is the main principle of CALS concept: information, once incurred at any stage of the life cycle, is stored

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in an integrated information environment and becomes available to all participants in this and other phases (in accordance with their existing rights to the use of this information). This avoids duplication, conversion and unauthorized modification of data, and errors associated with these procedures, and to reduce labor costs, time and financial resources.
In an integrated information environment information is created, converted, stored and transmitted from one participant in the life cycle to another with the help of application software, which include systems CAE/CAD/CAM, PDM, MRP/ERP (Atkinson, 2013), SCM (Jacobs et al., 2011) and other.
The main content of CALS, fundamentally distinguishes this concept from others, constitutes basic principles and technologies that are implemented (fully or partially) during the lifecycle of any product, regardless of its purpose and the physical incarnation.
Different kinds of management can be classified to the underlying technologies: management of projects, product configuration, integrated information environment, quality, work streams, changes in industrial and organizational structures.
Within the problem of CALS it is extremely urgent task for real enterprises to make a transition to a truly paperless technologies for the design, manufacture and operation of products. For this transition, an appropriate legal framework that defines the use of electronic documents and electronic digital signature should be employed. An important direction is to develop methods and software solutions in the field of integrated logistics support of high technology products.
Subject of CALS are methods and means as between the different automated systems and their subsystems and automated systems, taking into account all their support. Almost synonymous with CALS in this sense is PLM (Product Lifecycle Management), widely used in recent times by manufacturers of automated systems (Stark, 2011).
In the narrow sense CALS is a technology of integration of various automated systems with their linguistic, information, software, mathematical, methodological, technical and organizational support.
The linguistic support of CALS includes languages and data formats of industrial products and processes used for the representation and exchange of information between automated systems and their subsystems at different stages of the product life cycle.
Information support consists of a database including information about industrial products, used by different systems in the process of design, production, operation and recycling. Part of the information security also includes a series of international and national CALS standards and specifications.
CALS software systems (Bessarabov et al., 2010) are designed to support a single information space of the lifecycle stages of a product. This is primarily a document management system and document management, PDM system, development tools, interactive electronic technical manuals, and some others.
Mathematical support of CALS includes methods and algorithms to create and use models of interaction between different systems of CALS-technologies. Among these methods, first and foremost, you should call the methods of simulation of complex systems, methods, process planning and resource allocation.
Methodical maintenance of CALS presents methods of processes, such as parallel (combined) design and production, structuring of complex objects, their functional and information modeling, object-oriented design, the creation of ontology applications.
Technical maintenance of CALS includes hardware for receiving, storing, processing, data visualization with information support of the products. The interaction of different parts of virtual enterprises and systems that support different stages of the lifecycle occurs via the data link and network switching equipment. It is widely used features of the Internet and Web technologies. However, the techniques employed are not specific for the CALS-technologies.
Organizational maintenance of CALS presents various types of documents, a set of agreements and regulations governing the roles and responsibilities of participants in the life cycle of industrial products.
The use of information CALS-technologies allows you to reduce: direct costs for design (10% to 30%); time of product development (40% to 60%); time for introduction of new products to the market (25% to 75%); proportion of defects and the amount of design changes (23% to 73%); expenses for the preparation of technical documentation (up to 40%); costs for development of the operational documentation (up to 30%).
The mentioned advantages of CALS-technologies have necessitated their use in this work.

2. Information CALS-model of drying-agglomeration process in production of biologically active additives

In this work, using CALS methods, an information model was elaborated which includes all the steps (marketing, design, production, service and repair, and realization and sale) of the technology of producing biologically active additives of a new generation from an extract of medicinal herbs and gelatin-starch

complex. In recent years, biologically active food additives - therapeutic and prophylactic preparations produced from herbal raw material - have successfully competed with the synthetic drugs.
Let us sequentially consider elements of the information model that correspond to various steps of the technology of biologically active additives (Bessarabov et al., 2004).
On the basis of marketing research results, at the marketing step, two information-analytical blocks were formed: consumer characteristics and risk factors. Each of the blocks included lower-level parameters, whose analysis gives a complete pattern of the entire analytical block. For convenience of using the system, the parameters were inputted in text and table formats, as well as in graphic form. As basic consumer characteristics, the income, age, and sex distributions of consumers were analyzed.
In this block, the reasons for buying biologically active additives and the main factors affecting the purchase decision were also studied. In the block of risk factors, an analysis was undertaken regarding the possibility of a change in tax laws and concerning inflation and competition, market capacity, degree of import substitution, and prices for similar products. At the marketing step, a conclusion was drawn about the expedience and prospects of developing technology and equipment for producing biologically active additives of new generation.
At the design step (Figure 1), the initial data for design were analyzed, which contain information on six basic stages: grinding of medicinal raw material, extraction, concentration, mixing, drying--agglomeration, and packing. Particular attention was given to the limiting stage-drying-agglomeration.
The main methods for drying (Chen and Putranto, 2013) of biologically active additives were analyzed; these are spray drying, fluidized-bed drying, infrared drying, and drying in a vacuum dryer equipped with a rake agitator.
It was shown that the equipment considered is inefficient if the product contains astringent substances (fructose, lactose, gelatin-starch complex, and others), which, during drying-agglomeration, form clots, stick to moving parts and the housing of the apparatus, and can render the apparatus inoperative.

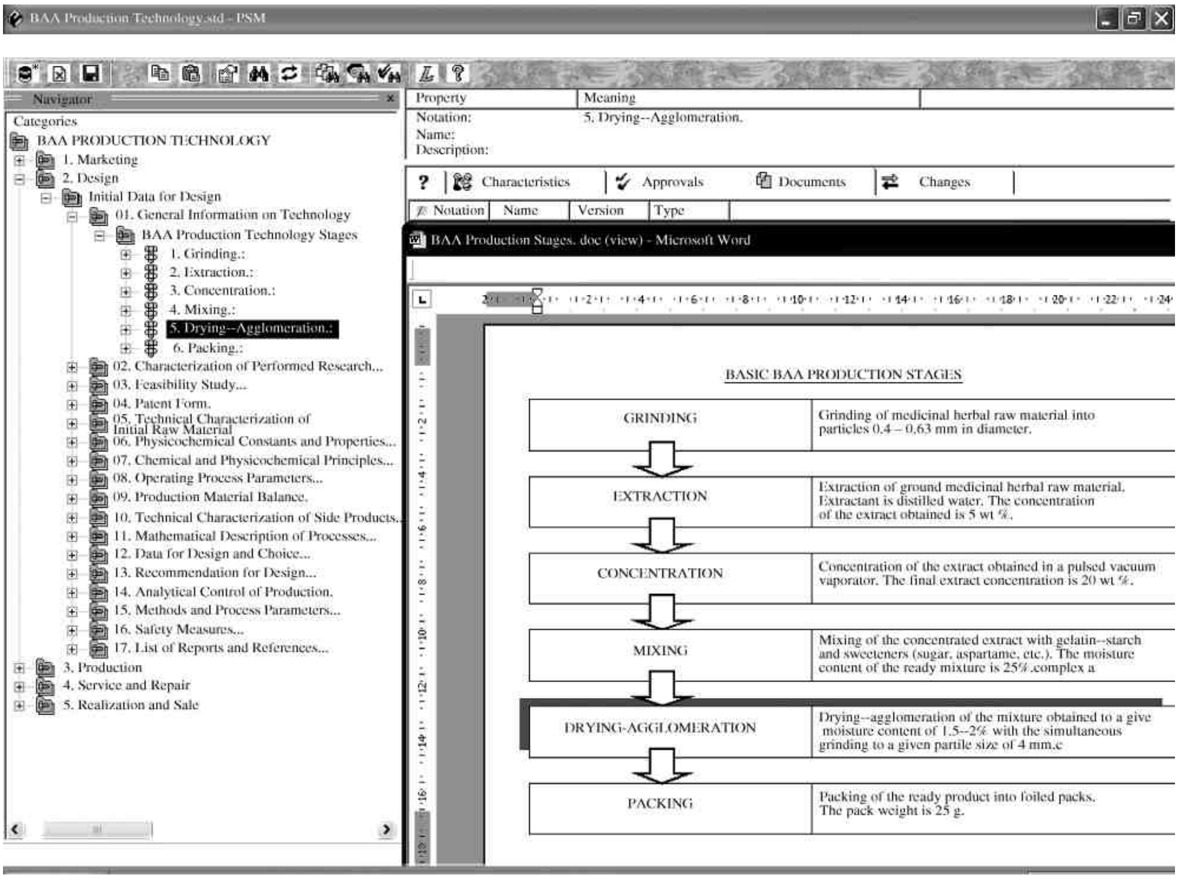

Figure 1: CALS Project element at the design step (basic stages of the technology of biologically active additives).

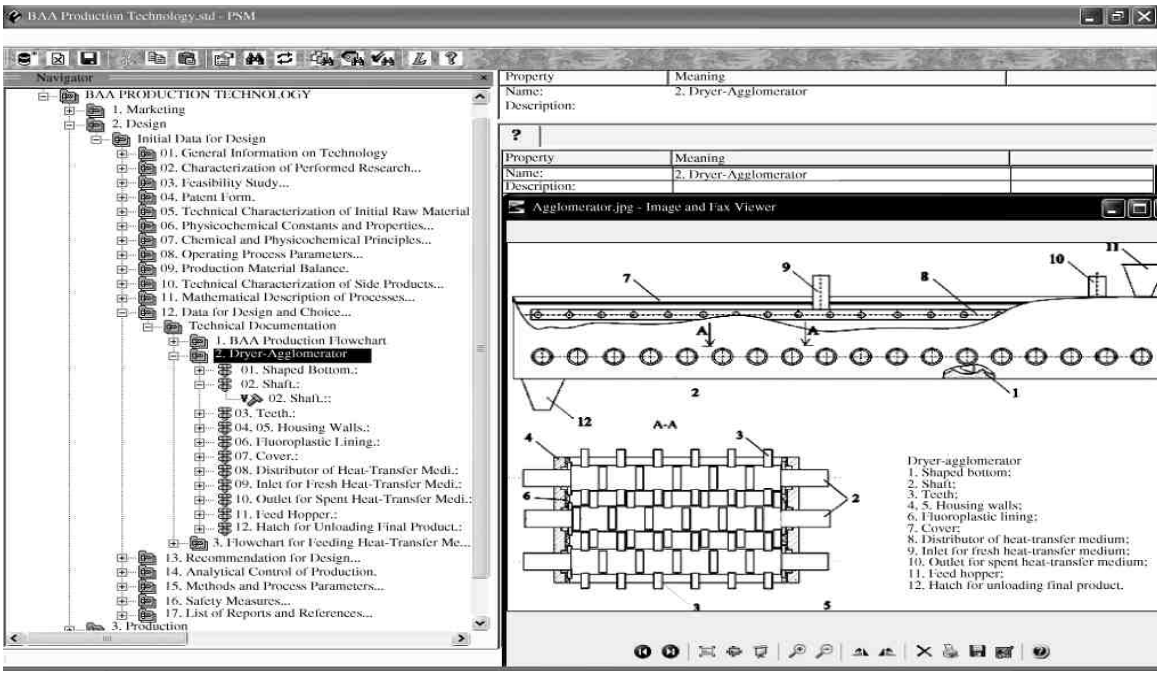

Figure 2: CALS Project element at the design step (dryer-agglomerator design).

Therefore, a continuous convective agitator dryer was proposed, which gives a product of required quality and given particle size distribution (Figure 2). At the design step, four variants of agitator design were considered (Figure 3). The ultimately chosen variant was the design that ensured required product quality at minimal energy consumption, with the agitator of this design being constructed at minimal material and labor expenditures. Three methods for introducing a heat-transfer medium were analyzed, and the optimal variant ensuring the maximal uniformity and efficiency of heat transfer was chosen. Intermediate and final variants described in text and graphic files were included into the CALS project.

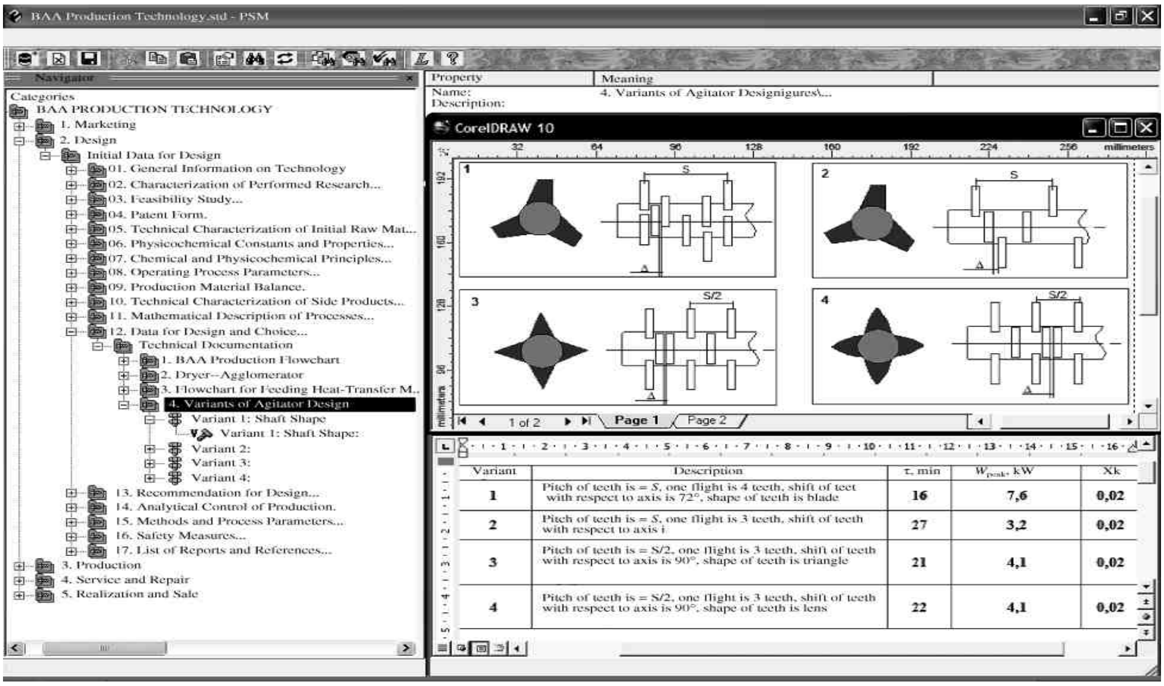

Figure 3: CALS Project element at the design step (agitator design).

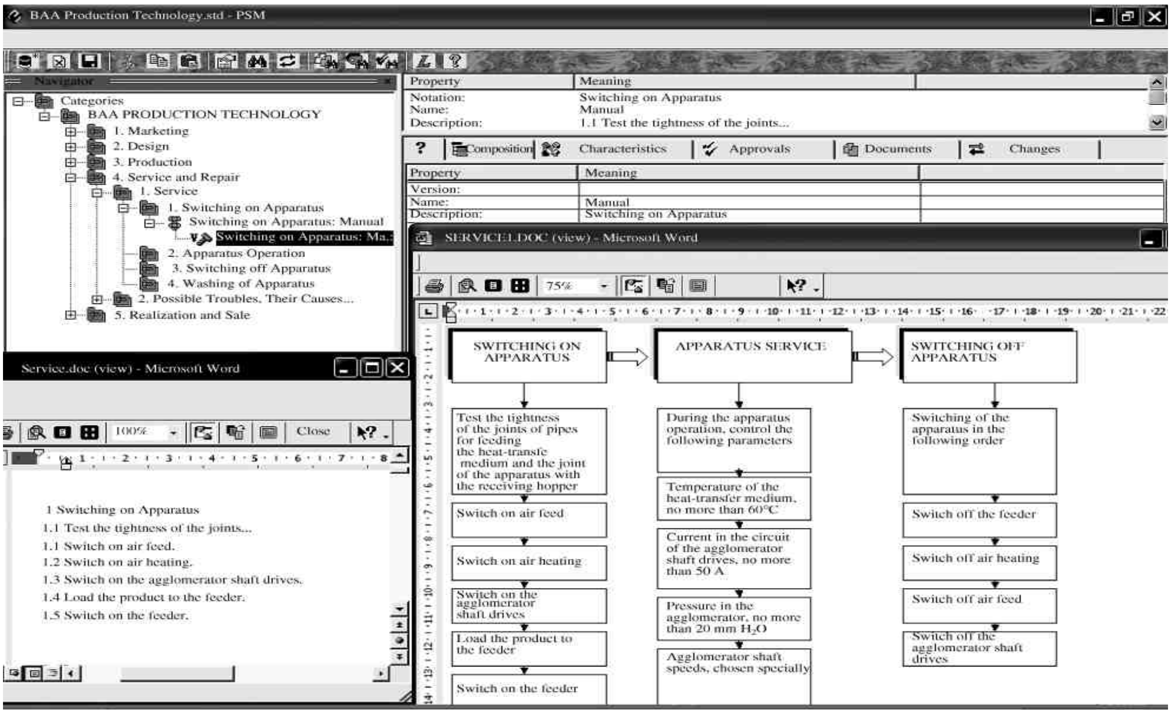

Figure 4: CALS Project element at the step of service of the dryer-agglomerator.

At the production step, technical documentation of extractors, dryers-agglomerators, and other equipment was analyzed by industrial equipment manufacturing plants.
At the service step, technical information on the main stages (switching on, operation, switching off, washing) of service of extractors, dryers-agglomerators (Figure 4), and other equipment was introduced.
Information at the repair step (Figure 5) was structured at three levels: trouble-cause-troubleshooting. The developed module enables one to promptly, in dialog mode, select the optimal variant of troubleshooting.

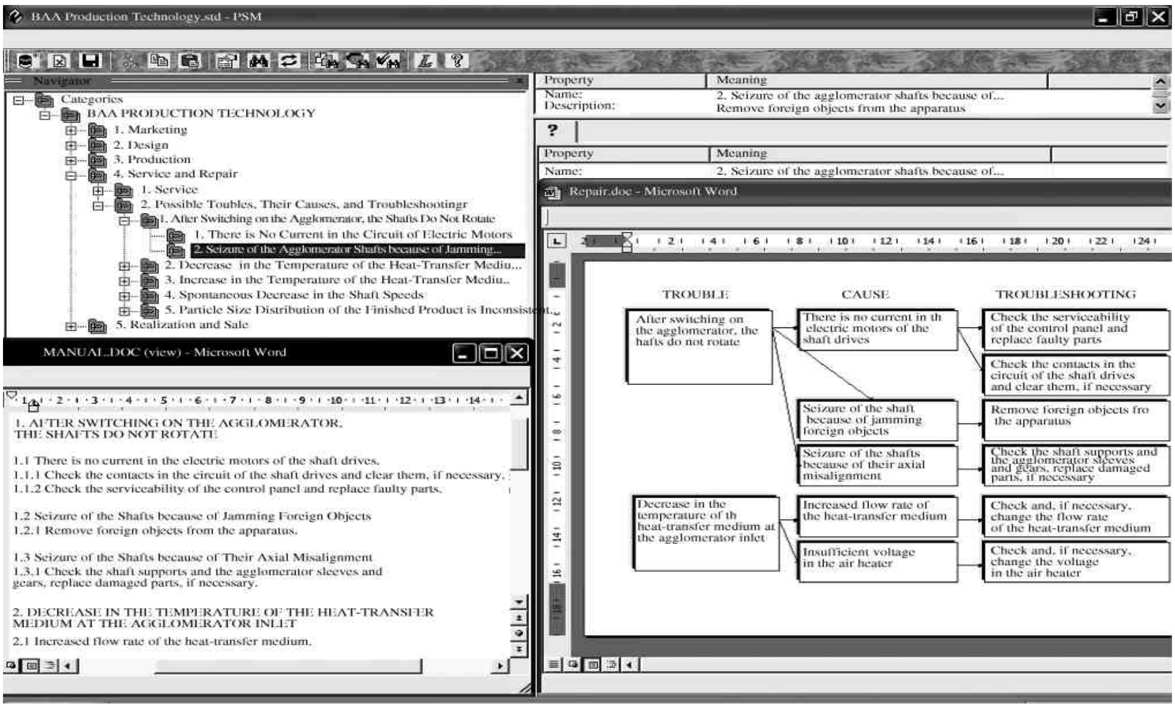

Figure 5: CALS Project element at the step of repair of the dryer-agglomerator.

The step of realization and sale included product promotion to market (advertising in printed and electronic mass media; participation in exhibitions, contests, tenders, etc.) and also analysis of information on the use of the developed equipment not only in the technology of biologically active additives but also in the chemical and pharmaceutical industries.

Under the conditions of the rapid development of the Internet with allowance for its potentialities, one of the elements of this step was the development of the information web site of OOO Ob’edinenie IREA-PENZMASh, the parent organization in the production of the biologically active additives considered in this work and promising equipment for drying highly viscous extracts of medicinal raw material. On the basis of the accumulated information, the optimal structure of the web site was developed, necessary information contents were analyzed, and a system for rapidly surfing the site was implemented. The site combined two main Internet systems: ftp (file transfer protocol) and http (hypertext transfer protocol). The http system was used to illustratively and conveniently store information, to structure information, and to easily move between sections. The ftp service was used for the data (file) storage and exchange.

Basic elements of the CALS project for the technology of biologically active additives were placed on the Internet on the CALS-khimiya (CALS Chemistry) web site in the Pilot Projects section. Also here are links to CALS files containing data in STEP exchange format. The files themselves are located on an ftp server and are accessed via ftp protocol with an ordinary web-browser. This scheme (in which information is place in ftp rather than http) was chosen for new files to be conveniently uploaded to the website by various developers, rather than solely by the server administrator. This web site is one of the promising elements for training scientists and specialists of industrial plants in implementing CALS methods to the chemical industry.

3. Conclusions

The results of this work were implemented at plants of the OOO Ob’edinenie IREA-PENZMASh. The developed CALS documentation significantly reduces the service, maintenance, and repair costs. According to predictions of specialists soon it will be impossible to sell high-tech products in the international market without electronic documentation created in compliance with CALS standards (ISO 10303 STEP). Therefore, one can believe that the electronic description of the technology of biologically active additives in accordance with the international CALS standard ISO 10303 (STEP) enables one to increase sales of the new equipment.

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