

# **CALS software tool system for marketing research results of phosphoric industry waste utilisation**

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A comprehensive information CALS-system (Continuous Acquisition and Life cycle Support – continuous information support of the product life cycle) module of marketing research of a phosphoric industry waste utilisation of large-capacity productions has been developed. The marketing research carried out has been structured in following categories: analysis of the raw material and processing market; analysis of waste processing technologies; analysis of the markets of waste utilisation products. The CALS-system proven to be successfully applicable in the phosphoric industry.

## **1. Introduction**

Prediction of competitiveness at the initial stage of development is the extremely complex and expensive task. Application of information CALS-technologies allows to considerably facilitate this task (Bessarabov, 2008). Complex of uniform information models, standardization of access ways to the information and its correct interpretation under the international standards lays in a basis of CALS concept. CALS provides uniform ways of process control and interactions between all process design participants.. The task of CALS is conversion of product life cycle (LC) to the highly automated process by re-structuring (reengineering) of business processes included into it. It has been shown that during the development of perspective chemical productions the CALS-technologies and main CALS-standard ISO 10303 STEP offer a handy solution of a problem of computer supported representation of all LC stages: marketing, design, production, maintenance and sales.

Implementation of CALS-technologies in the chemical industry enables use of modern quality control technologies for production support which contributes significantly to sustainable development of a company. Another important factor for developing competitive production is marketing research. With the appearance and strengthening of

marketing as the basis of market activity, market studies are included in its framework and become its integral part. The marketing is crucial to determine the cost value for development of technology, experimental research, hardware manufacture, etc. There are a number of publications about application of CALS-technologies at stages “Design” and “Production”, however ‘Marketing’ stage aspects are just about non-existent.

## 2. Structure of marketing research of a phosphoric industry waste utilisation

This works covers the development of the standard information CALS-system for marketing research of a phosphoric industry waste utilisation (Fig. 1).

The importance of waste utilisation products by their processing is ever increasing. Storage and stacking of waste containing phosphorus is dangerous for the environment. There is a necessity for processing the accumulated waste and creation of waste-free productions (Stehlik, 2009). Processing tasks are further complicated by the requirement that final utilisation products should have strong demand at the market. The attention has been paid to the main production waste of a phosphoric industry – phosphoric sludge, phosphoric plaster, and phosphoric slag (Klemeš, 2006).

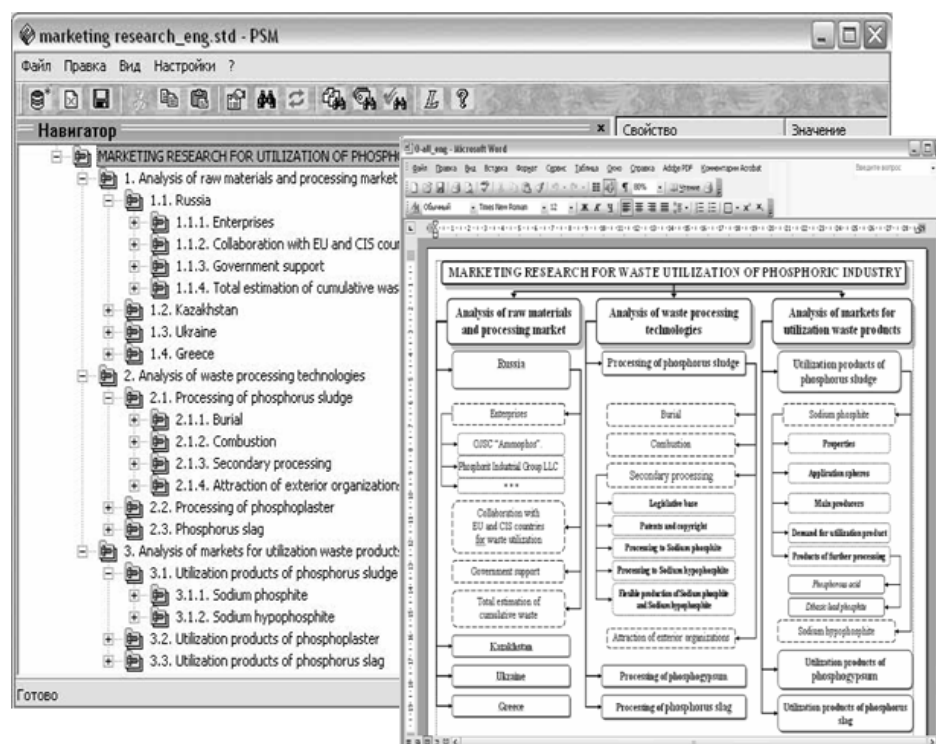


Fig. 1. A screenshot of the CALS-project based software tool “Structure of marketing research of a phosphoric industry waste utilisation”

The key parameters of the market, which had been dealt with: volumes, prices, forecasts as well as detailed aspects of applied technologies of existing waste processing. The main components of activity and development of the market in Russia, Kazakhstan, Ukraine and Greece had been analyzed while developing this module. The marketing research carried out has been structured in following categories: (i) Analysis of the raw material and processing market; (ii) Analysis of waste processing technologies; (iii) Analysis of markets of waste utilisation products (Bessarabov, 2009). All the above categories have been included in the developed CALS-Software tool (Fig. 1).

### 3. Analysis of the raw material and processing market

In the first category, “Analysis of the raw material and processing market” (Fig. 2), for each of the countries considered (Russia, Kazakhstan, Ukraine and Greece) the following four main subcategories had been analyzed: producers of substances containing phosphorus (for example, in Russia); total waste accumulated within this or that country; existing government support of firms producing a phosphoric production; cooperation with other countries. In a subcategory of enterprises the leaders of the phosphoric industry of Russia were included: OJSC "Ammophos" (Cherepovets), "PG "Phosphorit Ltd." (Kingisepp), "Minudobreniya Ltd." (Balakovo), "Minudobreniya Ltd." (Belorechensk), OJSC "Minudobreniya" (Voskresensk), OJSC "Minudobreniya" (Meleuz), OJSC "Minudobreniya" (Rossosh), OJSC "Azot" (Cherepovets), etc.

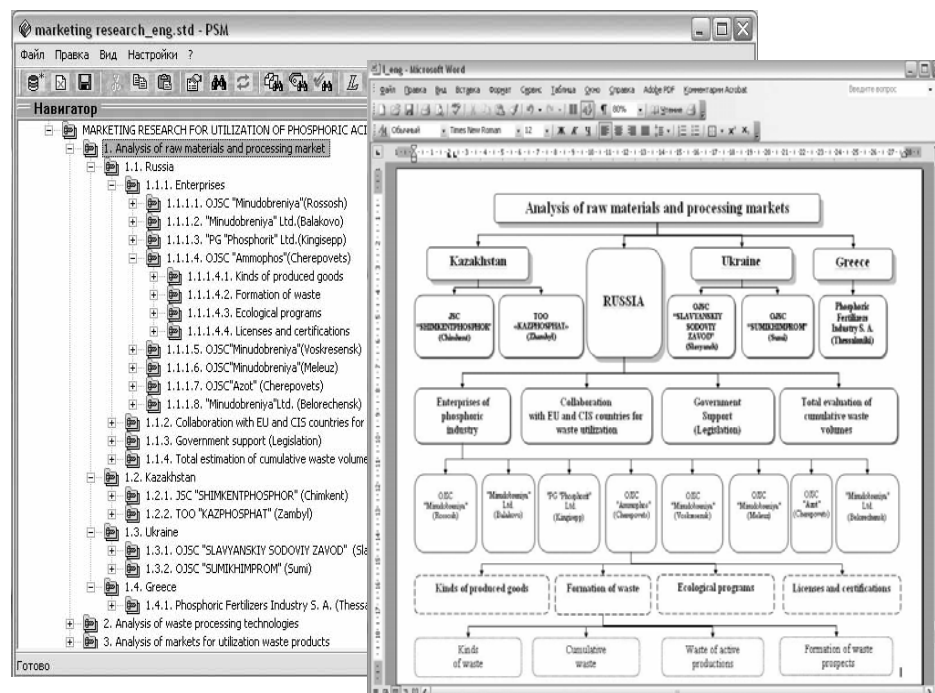


Fig. 2. Element of the CALS. The first category: “Analysis of the raw material and processing market”

For each plant, the following components are considered: sorts of product manufactured; derivation of waste (sorts of the waste, accumulated waste, waste of acting productions and prospects of the new waste derivation); environmental programs of enterprise; licenses and certificates available at the given enterprise.

In the category “Analysis of the raw material and processing market”, the information on the government support for accumulated waste utilisation of phosphoric industry enterprises, including the information on general estimation of the accumulated waste in a territory of the above mentioned countries (beginning of 2008) has been given. In the last subcategory of the given section, the following information is accumulated: international cooperation between the countries considered in the CALS system, teamwork and projects in the field of improvement of the phosphoric production technologies, existing methods of waste utilisation and creation of joint ventures of the phosphoric industry.

#### 4. Analysis of waste utilisation technologies

For the categories “Analysis of waste processing technologies” data on applied technologies of phosphoric sludge, phosphoric plaster and phosphoric slag processing are included. Subcategory «Phosphoric sludge processing» contains four sorts of utilisation: burial, combustion, secondary processing and there is also a list of companies rendering services in the sphere of utilisation is given. For each technology of utilisation the information contains: characteristics of technology; advantages and disadvantages; cost and ecological aspects (Fig. 3).

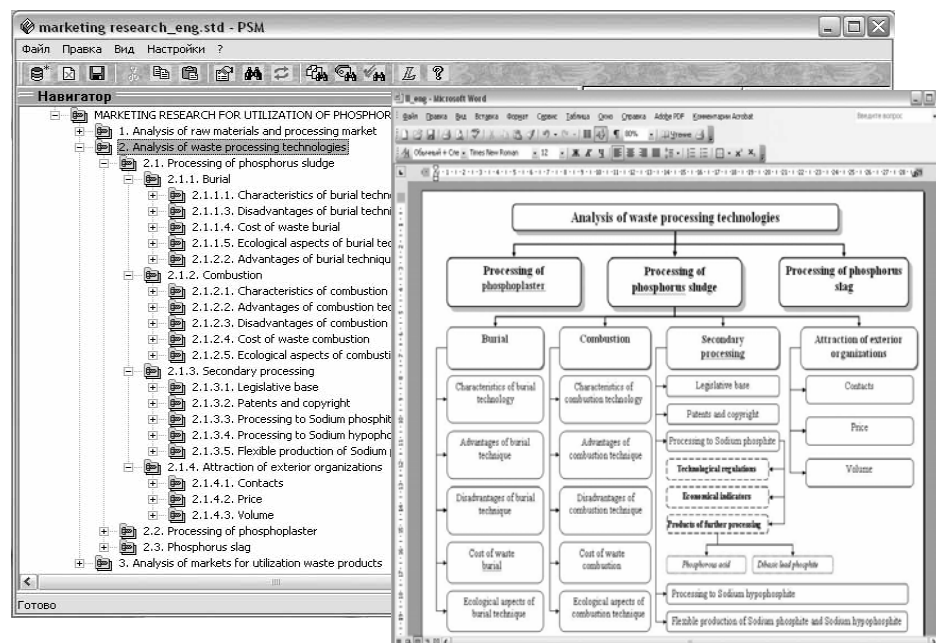


Fig. 3. Element of the CALS: The second category of the top level: «Analysis of waste utilisation technologies».

Within the limits of the second category of marketing model the technology of secondary processing of phosphoric sludge waste to the sodium hypophosphite and phosphate has been developed. Further analysis of two productions (sodium hypophosphite and phosphite) showed that they both have the features of flexible production processes. That means that they have technological and chemical similarity. This enables to carry out synthesis of the flexible biproduct flowsheet. Such flowsheet has been imported to the CALS system, in the category “Flexible production of sodium hypophosphite and phosphit”. The optimal flowsheet developed includes 23 process units: 9 combined units in which operations production of sodium phosphite as well as hypophosphite (solid line) are carried out; 3 units only for production of sodium phosphite (dot line); 11 units only for production of sodium hypophosphite (dashed line). For transition from the one product to another 2 flexible sites of switching (FSS-1 and FSS-2) are included into the scheme. Flexible sites of switching allow enabling the release of target products at the minimum control actions. This reduces the number of units which leads to cost reductions.

## 5. Analysis of the markets of waste utilisation products

Information about the products of utilisation is brought to the third category of marketing research “Analysis of the markets of waste utilisation products” (Fig. 4). Waste utilisation products (phosphoric sludge, phosphoric plaster and phosphoric slag) were included into it, and, the most important, possible application of utilisation products.

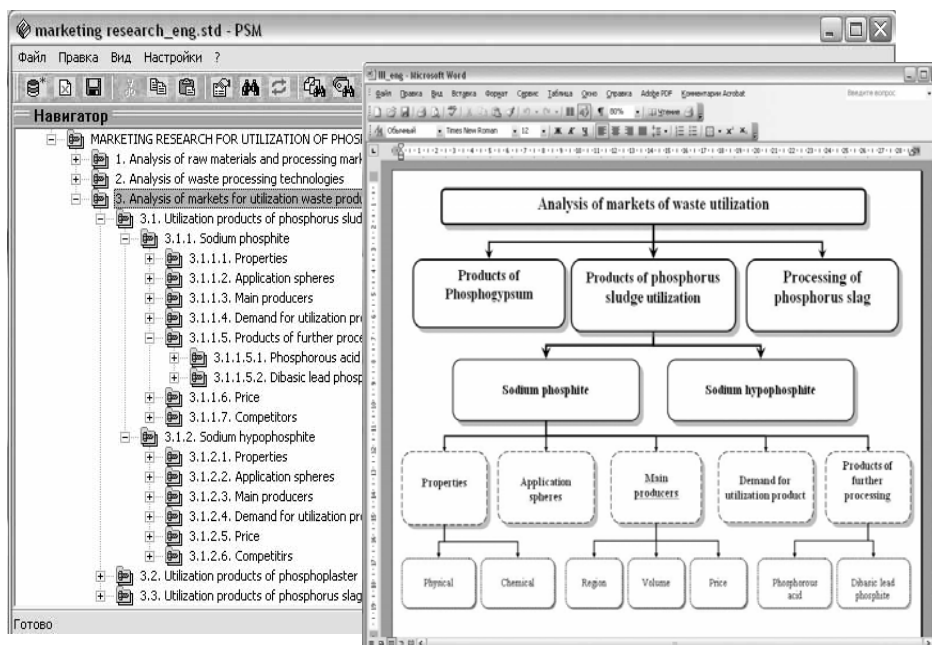


Fig. 4. Element of the CALS-project. The third category of a top level: «Analysis of the markets of waste utilisation products».

For example, when recycling the phosphoric sludge it is possible to produce: Sodium hypophosphite, applied as a component for an anticorrosive and decorative coating of various surfaces that allows it to be the target commodity product which is in demand in the market; sodium phosphite: the restorer in inorganic synthesis; in galvanics – reagent for synthesis of the dibasic lead phosphite; the initial reagent for obtaining of phosphorous acid; dibasic lead phosphite: excellent thermo stabilizer, working at high temperatures; phosphorous acid is the dibasic acid of average force and applied as the restorer in chemical reactions.

## **6. Conclusion**

Simplicity and efficiency of the user access to the available information when CALS-standards (ISO-10303 STEP) are applied enables to expand qualitatively commodity markets of products and technologies, and also to capture a greater share of the market. This can promote active implementation of the latest computer supported marketing in practice that will lead to greater competitiveness of waste utilisation technologies of large-capacity chemical productions.

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## **References**

- Bessarabov A., Klemeš J., Bulatov I. and Ogorodnikova T., 2008, Development of an analytical quality control system of high-purity phosphoric acid on the CALS concept basis PRES 2008 / CHISA 2008 conference, August 24-28, 2008, Prague, Czech Republic, Summaries 4:, 1457-1458.
- Bessarabov A., Bulatov I., Kochetygov A. and Kvasyuk A., 2009, The system analysis of phosphoric industry waste utilisation based on CALS-technologies Chemical Engineering Transactions, vol. 18:, 327-332.
- Klemeš J., Bulatov I., Seferlis P., Koltsova E., Kapustenko P. and Zhekyev M., 2006, Waste Minimisation and Utilisation in Phosphoric Acid Industry Chemical Engineering Transactions, vol. 9:, 263-268.
- Stehlik P, Contribution to advances in waste-to-energy technologies 2009, Journal of Cleaner Production, 17 (10), 919-931