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Computer Analysis of Waste Utilization at the Leading Enterprises of Phosphoric Industry of Russia and Kazakhstan

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Wastes from the phosphoric industry are in the center of a problem of environment preservation on the manufacturers in Russia and other countries. According to the grant of European Union ECOPHOS INCO-CT-2005-013359 we carried out the development of innovative strategy for phosphoric industry enterprises waste utilization.
Program complex based on the information CALS-technologies was developed for the waste utilization at the leading enterprises of phosphoric industry. Analysis was carried out for two leading enterprises of Kazakhstan and for all of 15 enterprises of phosphoric industry of Russia. Innovative work for these enterprises was analyzed for 1995-2008, and level of innovative activity was determined. Based on obtained data there was carried out an analysis for newly formed waste for period of 1991-2008.

1. Information CALS-project of waste utilization strategy on example of phosphoric industry

The problems of utilization strategy of phosphorus industry wastes are complicated by the requirement that final products of utilization should be in demand at the market. This research considers key parameters of the market: 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 and Kazakhstan have been analyzed. The choice of those countries is due to the fact that they are facing serious environmental problems caused by their phosphorus sectors and that industrial and academic partners from those countries took part in an EC INCO-Copernicus ECOPHOS project.
Development of utilization strategy of phosphorus industry wastes was conducted within the framework of the state-of-the-art computer support system, CALS-

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technologies (Continuous Acquisition and Life cycle Support - continuous information support of life cycle of a product) - Molina et al (1998). The CALS concept is based on the complex of uniform information models, standardization of ways of access to the information and its correct interpretation in accordance with international standards. Thus uniform ways of process control and interaction of all participants of development are provided. A key idea of CALS concept is increasing of product life cycle due to increase of efficiency of control of the information on a product. CALS task is transformation of a product life cycle into highly automated process through re-structuring of its component business-processes.

The developed strategy was structured in following categories: analysis of the raw material and processing market (Fig. 1); analysis of waste processing technologies; analysis of the markets of waste utilization products.

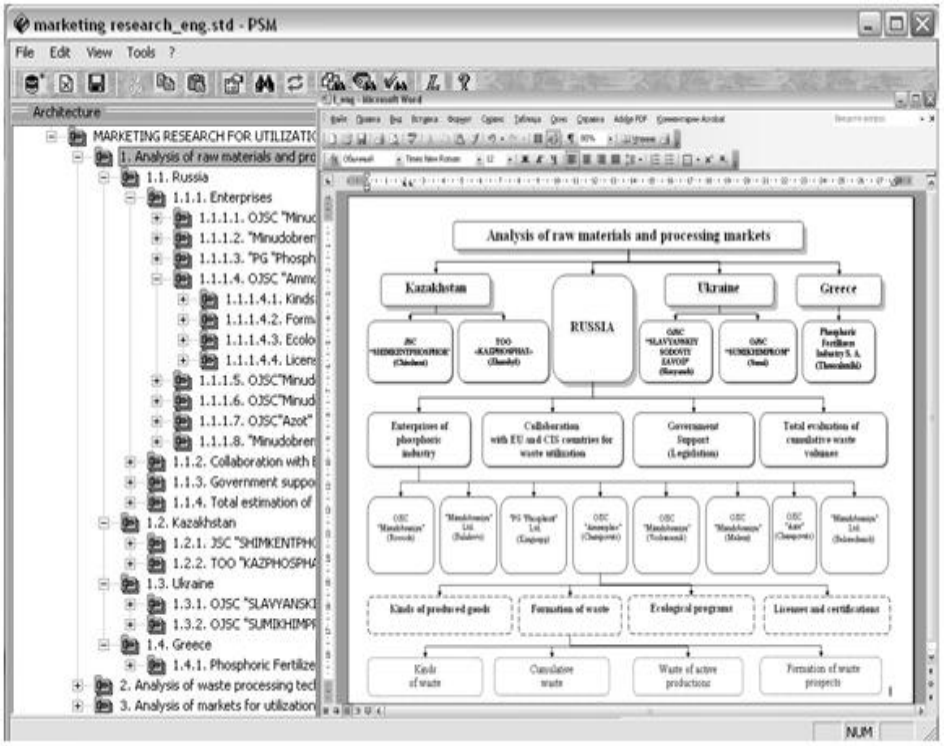

Fig. 1. CALS-project "Analysis of the raw materials and processing market"

In the first section, 'Analysis of the raw materials and processing market' for each of the countries considered (Russian Federation, Kazakhstan, etc.) the following four main subcategories are considered: producers of substances containing phosphorus (eg, in Russia); total waste accumulated within a particular country; existing government support for companies manufacturing phosphorus-containing products; cooperation with other countries. All the above categories have been included in the CALS-project (module) developed see Fig. 1.

2. Information CALS-project for waste utilization of Kazakhstan phosphoric industry

Analysis of waste utilization of Kazakhstan phosphoric industry was carried out for two leading enterprises of Kazakhstan - "Shymkentphosphor" (Chimkent), "Kazphosphat" (Dzhambul). Element of information CALS-project for waste utilization for "Shymkentphosphor" is shown in the Fig. 2.

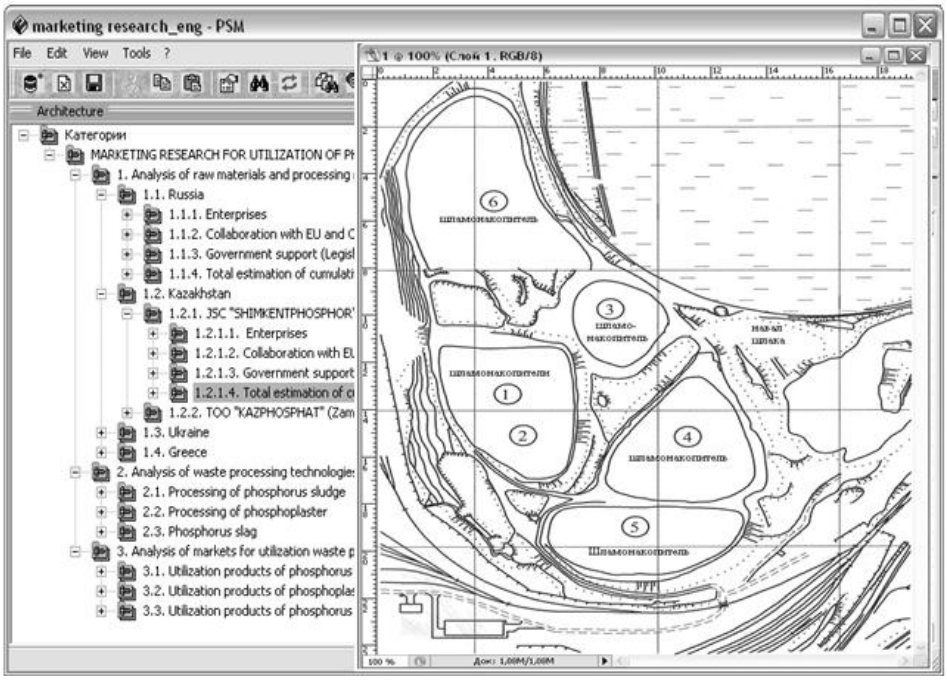

Fig. 2. Element of CALS-project of phosphoric industry waste utilization: Kazakhstan - "Shymkentphosphor" – scheme of sludge storages

Scheme of sludge storages of "Shymkentphosphor" is shown on the element of information CALS-project. More detailed information about enterprise waste is presented in Table 1. It should be noted that real volumes of 1 and 2 sludge storages are higher than projected ones due to increase of dam comb.

Table 1 Estimation of phosphosludge volumes of «Shymkentphosphor»

Sludge storage	Designed by	Breaking-in year	Phosphosludge volumes, thousand m^3		Real sludge volume, 10^3 m^3
			Project	For ”Shymkent-phosphor”	
1	«Phosphor»	1966	18.0	21.0	18.0
2	«Phosphor»	1970	12.0	14.0	12.0
3	LenNIIGiprokhim	1972	17.0	17.0	17.0
4	LenNIIGiprokhim	1975	90.0	90.0	90.0
5	LenNIIGiprokhim	1979	37.0	35.0	35.0
6	KazNIIGiprophosphor	1982	193.2	190.0	190.0

For each of the six sludge storages the next information is included to the CALS-project: number of sludge storage, general designer, breaking-in year, phosphoric sludge volumes (project and for "Shymkentphosphor") and real sludge volumes. As it is seen in the table, from 1982 problem of plant waste utilization is still to be completely resolved.

3. Complex analysis of waste utilization for phosphoric industry of Russia

Analysis of Russian phosphoric industry was carried out for the three directions: analysis of production capacities (extraction phosphoric acid, mineral phosphoric fertilizers), analysis of innovative resources of the leading enterprises of phosphoric industry and analysis of waste.

3.1 Analysis of production capacities of phosphoric industry

Analysis was carried out for all of 15 enterprises of phosphoric industry of Russia. Total capacity of Russian enterprises was ~ 2.5 and 2.0 Mt of phosphoric fertilizers and phosphoric acid, respectively. It is shown that the main volume of production (more than 80 %) is focused at the next four enterprises (Fig. 3): "Ammophos" (Cherepovets), "Balakovskie mineral fertilizers" (Balakovo), "Voskresenskie mineral fertilizers" (Voskresensk), "Phosphorite" (Kingisepp).

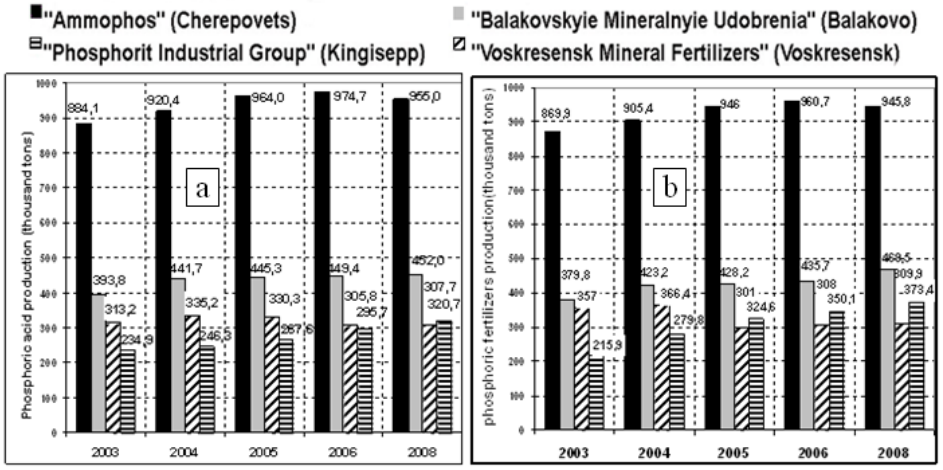

Fig. 3. Dynamics of production capacities of the leading enterprises: a – extraction phosphoric acid; b - mineral phosphoric fertilizers.

Analysis of dynamics (years 2003-2008) of extraction phosphoric acid (Fig. 3a) and mineral phosphoric fertilizers (Fig. 3b) production has shown, that from 2003 stabilization and increase of leading enterprises' capacities was detected.

3.2 System analysis of innovative resources of phosphoric industry

At the next stage system analysis of main indicators of innovative development of phosphoric industry enterprises was carried out. For solution of this task innovative activities at phosphoric industry leading enterprises ware identified for 1995-2008, and level of innovative activity was determined (Bessarabov et al 2009b).

Sources of the statistical information were sieved to obtain the data on the innovative activities in the phosphorus industry sector for the Ministry of Industry of Russia according to a form of the statistical reporting. Innovative indicators were divided into two groups: quantitative (Fig. 4) and qualitative.

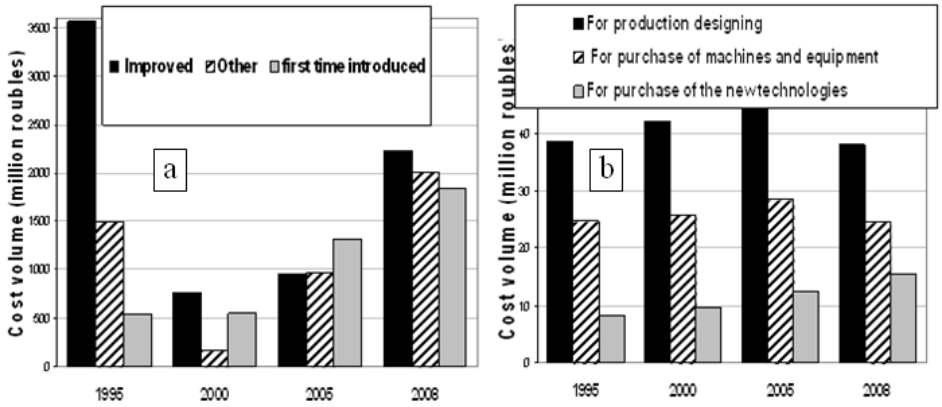

Fig. 4. Dynamics (1995-2008) of quantitative indicators: a – volumes for the main kinds of innovation output, b – cost volume for the main directions of innovation development.

Dynamic analysis for volumes for the main kinds of innovation output has shown that for 1995-2008 increase of "first time introduced" production was detected. As for the main directions of innovative activity, it is shown that the highest volume belongs to the "production designing" and the smallest – to the "purchase of the new technologies".

Analysis of qualitative indicators of innovative development for 2000-2008 was carried out for the factors, preventing the innovations, and influence of results of innovative activities on company development. They were represented as 4-point scale: 3 – The highest degree of indicator influence; 2 – Average; 1 – Less essential; 0 – No influence.

Importance of the main factors deterring the innovations on phosphorus industry enterprises was calculated. The most important factors are: shortage of own cash assets (rating of ~2.8) and low demand for the new products (2.4). Meanwhile, shortage of qualified human resources and information about new technologies didn't get the high rating of the influence, the rating for them being 1.2 and 1.5.

The authors carried out an analysis of the main results of innovative activity for 2000-2008. Introducing of innovations made the most significant influence on the output quality improvement and assortment expansion (rating is 2.7 points and more). Compliance with standards and improvement of labour conditions influenced the development of phosphorus plants in a lesser degree (from 1.2 to 2.3 points). However, influence of innovations on reduction of environmental pollution was estimated by the companies CEOs as inessential (0.4 – 1.0 points). This neglect of the environmental problems results in large volumes of accumulated waste of the phosphorus industry.

3.3 Analysis of phosphoric industry waste

Based on obtained data there was carried out an analysis for newly formed waste for period of 1991-2008. Waste volumes for 1 t of final output: super phosphate simple (0.7-0.8 t), phosphoric acid (2.8-5.4) and yellow phosphorus (0.1-0.2) were taken into

account during the analysis. As the example calculated volumes of phosphoric plaster from mineral fertilizers production for 4 main producers are shown (Table 2).

Table 2 Waste of leading enterprises from mineral fertilizers production for 2003-2008 (phosphoric plaster, 1000 t)

Leading enterprises	*2003*	*2004*	*2005*	*2006*	*2007*	*2008*
"Ammophos" (Cherepovets)	652.4	679.1	709.5	720.5	709.4	658.1
"Balakovskie mineral fertilizers"	284.8	317.4	321.1	326.7	352.1	351.6
"Voskresenskie mineral fertilizers"	267.7	274.8	225.7	231.0	232.4	167.4
"Phosphorite" (Kingisepp)	161.9	209.8	243.4	262.5	280.1	228.6

Obtained information for the waste for all of the phosphoric industry enterprises in the region was included to the program complex (Bessarabov et al 2009a). The other problems related to phosphoric industry waste minimization were analysed elsewhere Tovazhnyansky et al (2010) and Kapustenko et al (2010)

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