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ECO-ECONOMIC SWOT-ANALYSIS USE ON THE EXAMPLE OF PROCESSING TECHNOLOGY FOR ARSENIC-CONTAINING RAW MATERIALS

The article demonstrates the theoretical issues of SWOT-analysis implementation and demonstrates its practical use for eco-economic evaluation on the example of a large metal manufacturer, JSC "Kazzink" (Ust Kamenogorsk, the Republic of Kazakhstan).
Keywords: *SWOT-analysis; ecology; production wastes; arsenic.*

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ЕКОЛОГО-ЕКОНОМІЧНИЙ SWOT-АНАЛІЗ НА ПРИКЛАДІ ТЕХНОЛОГІЇ ПЕРЕРОБКИ СИРОВИНИ, ЩО МІСТИТЬ МИШ'ЯК

У статті розглянуто теоретичні питання застосування SWOT-аналізу. Практичне його використання для еколого-економічного оцінювання продемонстровано на прикладі великого металургійного підприємства "Казцинк" (м. Усть-Каменогорськ, Республіка Казахстан).
Ключові слова: *SWOT-аналіз; екологія; відходи виробництва; миш'як.*
Рис. 2. Табл. 4. Літ. 10.

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ЭКОЛОГО-ЭКОНОМИЧЕСКИЙ SWOT-АНАЛИЗ НА ПРИМЕРЕ ТЕХНОЛОГИИ ПЕРЕРАБОТКИ МЫШЬЯКСОДЕРЖАЩЕГО СЫРЬЯ

В статье рассмотрены теоретические вопросы использования SWOT-анализа. Практика его применения для эколого-экономической оценки продемонстрирована на примере крупного металлургического предприятия "Казцинк" (г. Усть-Каменогорск, Республика Казахстан).
Ключевые слова: *SWOT-анализ; экология; отходы производства; мышьяк.*

Problem statement

Since the world economy is not stable, the principal direction of the mining and metal sector development should be based on innovations and technological growth. This is the only right decision to stay a competitive producer at the world markets (Mikhailov, 2009).

The management arrangement based on the basis of SWOT-analysis should use its strengths as much as possible, try to overcome weaknesses, use favorable opportunities and protect itself against potential threats. The SWOT-analysis matrix is shown on Figure 1.

Internal factors	
Strengths	Weaknesses
Opportunities	Threats
External factors	

Figure 1. **SWOT-analysis matrix according to** *(Morozov, 2011)*

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Latest research and publications analysis

SWOT-analysis is widely used in various spheres of economy and management today. Its flexibility allows implementing it at multiple levels and for various objects: production, enterprise, competitors, city, region etc. This method as the instrument of managerial inspection (managerial analysis) can be used for any enterprise to prevent it from crisis. SWOT-analysis technique is multipurpose and consists of internal environment (distinguishing strengths and weaknesses) and external environment algorithms (distinguishing opportunities and threats) of an enterprise (Morozov, 2011). Theoretical and practical problems of SWOT-analysis are presented in the works of T.N. Babich (2005), L.G. Elkina (2007), A.P. Haustov (2005) and, of course, M. Porter (1998).

Research objectives

The flexibility of this method allows applying SWOT-analysis mechanisms for eco-economic comparison evaluation of base and offered technologies (Kotler, 2006).

Key research findings

The authors give as an example a comparative eco-economic grounding of the processing technology of arsenic-containing raw materials of the enterprise "Ust Kamenogorsk Metallurgical Complex of JSC "Kazzink" (Kazakhstan), the biggest manufacturer of lead, zinc and rare metals in the former Soviet Union.

The comparative eco-economic grounding is defined by a number of problems:

– to bring arsenic in less toxic state in the form of the substance of the 4th hazard class;

– to remove considerably the volume of the received arsenic-containing product in comparison with the existing production. The volume of arsenic-containing wastes will be 5 times less, according to our estimations;

– the dilution received after settling arsenic goes into use;

– almost all reagents used in the technology, are industrial products of metallurgical production.

A hydrometallurgical method is used for dearsenication of arsenic-containing raw materials at many enterprises of the nonferrous, zinc, copper, gold mining industries and the related subindustries. For this purpose, the arsenic contained in the source material is transferred into the soluble form where it settles.

The arsenate and calcium arsenite mixtures are received by the lime settling in the ratio of three to one of stoichiometry and after that substances are stored in a special storage.

The basic disadvantages of the existing method of the arsenic-containing wastes utilization are the following:

– ecological hazard to the environment, and as a result, close attention of ecological and social organizations to the problem of these wastes burial. It is very difficult to calculate the losses connected with the liquidation of the negative reaction of ecological and social organizations;

– big and unproductive use of lime going not on technological operations, but directly on the dump. The consumption of lime, according to technological instructions, is dosed on the volume of cleared dilutions and doesn't depend on the content of arsenic in them (i.e., the volume of waste remains constant, both at 8% of As, and at 20% of As);

– substantial volumes of developed wastes, a complex formula of calcium arsenite with $PH > 9$ looks like $4CaO \cdot As_2O_3 \cdot 11H_2O$, that at humidity of 49% increases the wastes volume in the ratio 25:1 (where 25 is the lime volume, and 1 – the arsenic) (Pozin, 1961);

– necessity of constant storage payments for arsenic-containing wastes. The standard fee rate for such a storage is 1920 tenge a year for 1 conditional ton (in the Republic of Kazakhstan).

The current option at the enterprise "Ust Kamenogorsk Metallurgical Complex of JSC "Kazzink" is taken as the base one. Table 1 shows the preliminary data of the base option of technological expenses. Table 2 shows the preliminary data of the offered option of technological expenses. The quantity of arsenic for processing is taken conditionally – 500 tons per year. Eco-economic calculations resulting from the implementation of the offered technology are given in Table 3.

Table 1. **Preliminary data of the base option of technological expenses**

Name	Quantity	Note
Quantity of arsenic for burial	500 tons per year	The figure is conditional. The data on arsenic is the confidential information of "Kazzink.
Quantity of lime necessary for neutralizing and settling of arsenic-containing dilutions	1 595 tons per year	At the rate of 3,19 t of lime per 1 t of arsenic (technological instruction of the Chemical and Metallurgical Department of "Kazzink").
Lime price	60 USD/ton	
Lime cost	95,7 ths USD per year	
The ratio of payments for the burial of the 2nd class wastes	16 USD/ton	In the amount of 1 920 tenge per ton, at the rate of 150 tenge per 1 USD (as of August, 2008).

Source: authors' calculations.

Table 2. **Preliminary data of the offered option of technological expenses**

Name	Quantity	Note
Capital costs	50 ths USD	Project development costs, equipment rebinding costs
Quantity of arsenic aimed for burial	500 tons per year	See the note to the table 6.1
Reagents cost	150,15 USD/ton	
The ratio of the payments for the burial of the 4^{th} class wastes	1,8 USD/ton	In the amount of 220 tenge per ton, at the rate of 150 tenge per 1 USD (as of August 2008).

Source: authors' calculations.

The discount rate at the comparative calculations is 12% – this is the level of a standard interest bank rate in most European banks. The calculations do not include technological and fixed energy costs because they are almost the same in both alternatives.

It is obvious that the benefit of the offered technology is achieved in the first year of the project implementation already. The compensation period is 0,42 of the year, the benefit for the 1st year will be 70,4 ths USD, or 10560 ths tenge, and in the 5th year, even including the discount – 76,5 (direct) or 11475 ths tenge and 485 ths USD or 72750 ths tenge (accumulated). The comparative indicators of the base and offered technologies according to the 3 main parameters are shown on Figure 2.

Table 3. **Comparative eco-economic calculation resulting from the implementation of the offered technology**

Name	Total	Years of the period					
Preliminary data		2008	2009	2010	2011	2012	Total
Discount rate (R)		12%	12%	12%	12%	12%	
Costs, ths USD		50.0					50.0
Comparative costs							
Variant 1. Existing production							
Lime		95.7	95.7	95.7	95.7	95.7	382.8
Burial fee		55.3	55.3	55.3	55.3	55.3	221.2
Variant 2. Offered variant							
Lime							
Burial fee							
Technology reagents		30,6	30,6	30,6	30,6	30,6	122,4
Calculations							
Benefit of the technology							
Lime		95.7	95.7	95.7	95.7	95.7	382.8
Burial fee		55.3	55.3	55.3	55.3	55.3	221.2
Technology reagents		-30,6	-30,6	-30,6	-30,6	-30,6	-122,4
Discount coefficient DF(t)		1.00	0.89	0.80	0.71	0.64	
Capital investments							
Accumulated costs, ths USD		50.0	50.0	50.0	50.0	50.0	
Discount costs, ths USD		50.0					
Accumulated discount costs, ths USD		50.0	50.0	50.0	50.0	50.0	
Project implementation result							
Result, ths USD		120.4	120.4	120.4	120.4	120.4	
Accumulated result, ths USD		120.4	240.7	361.1	481.4	601.8	
Discount result, ths USD		120.4	107.5	96.0	85.7	76.5	
Accumulated discount result, ths USD		120.4	227.8	323.8	409.5	485.9	
Economic benefit from the date of implementation, ths USD		70.4	177.8	273.8	359.5	435.9	
Compensation period, years							
Discount	0.42	0.42					
Simple	0.42	0.42					
The maximum allowable	7.33						

Source: authors' calculations.

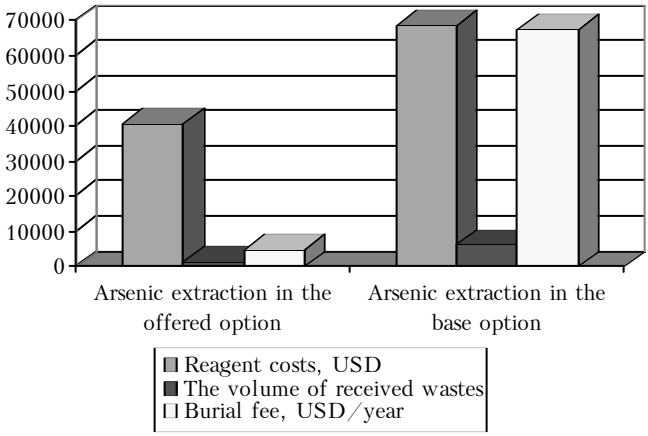

Figure 2. **Comparative indicators of the base and offered technologies** *(developed by the authors)*

The offered methods will allow reducing the volumes of the toxic arsenic-containing wastes at "Kazzink", producing calcium arsenite that belongs to the 2nd hazard class, the volumes of these wastes will be 5 times less.

The reduction of waste storage costs will allow cutting down expenses at "Kazzink" from 67608 USD or 10141200 tenge a year to 4676,4 USD or 701460 tenge a year, that is 14 times. The benefit of the new technology implementation at JSC "Kazzink" will allow receiving the profit of 120 ths USD or 18 mln tenge in the first year already.

The comparative evaluation of eco-economic indicators of the base and the offered technology options allowed filling in the SWOT-analysis matrix, opportunity and threat factors are consistently defined for this purpose, connections between strengths and weaknesses of the enterprise are established or not established (Muravyev, 2002; Simkin, 2001). Comparison results are put in a separate table (Table 4).

Table 4. **The SWOT-analysis including eco-economic grounding of the processing technology of arsenic-containing raw materials at JSC "Kazzink"**

	Strengths	Weaknesses
Opportunities	1. High technical level in the manufacture of base metals may lead to product promotion at new markets. 2. A well-developed network of suppliers gives an opportunity to choose more qualitative raw materials for the base metals manufacture. 3. The availability of free manufacturing facilities allows satisfying the production ramp-up at the enterprise. 4. Environmentally benign processes and products, "green" reputation, readiness of staff to follow regulations and obligatory requirements, R&D potential for "green" products and technologies.	1. The concentrates that enter the production initially have arsenic circulating through technological conversions, accumulating in reverse and intermediate products. 2. The processing of these materials is performed with arsenic extraction into the dump waste product belonging to the 2nd hazard (highly hazardous).
Threats	1. Big manufacturing facilities cause the heating of substantial quantities of arsenic in nodes and machines. 2. The emphasis on a high technical level during product promotion shall also be directed to the quality of produced wastes including the toxicity volume reduction. 3. Performance of research and development activities in this process must change the current situation at the enterprise for better.	1. Close attention of ecological and social organizations to the problem of wastes burial. 2. Deprecation of a large part of equipment, lack of experienced engineering and technical workers, weak promotion of new technologies may strengthen competitive pressure. 3. An obsolete quality system can make it difficult to overcome market barriers. 4. Lack of the important eco-economic enterprise policy may cause ecological and consequently financial problems.

Source: authors' calculations.

Conclusions

The offered methods will allow reducing the volumes of toxic arsenic-containing wastes at Ust Kamenogorsk Metallurgical Complex of JSC "Kazzink", producing at

the chemical and metallurgical department the calcium arsenite that belongs to the 2nd hazard class, the volumes of these wastes will be 5 times less.

The reduction of waste storage costs will allow cutting down expenses at the enterprise "Kazzink" from 67608 USD or 10141200 tenge a year to 4676,4 USD or 701460 tenge a year, that is 14 times. The benefit of this technology implementation at Ust Kamenogorsk JSC "Kazzink" will allow receiving the profit of 120 ths USD or 18 mln tenge in the first year already.

The SWOT-analysis matrix demonstrates the strengths and weaknesses of the processing technology of arsenic-containing raw materials at JSC "Kazzink". Substantial investments in R&D works are required to change the current situation at the enterprise. But if the company is overcoming the crisis now, it may be premature. It is necessary to make full use of current resources and technologies that have the functional leadership.

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