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Implementation LCA rules into the Polish mining industry

Life–Cycle–Assessment is an environmental management tool of increasing importance. Definitions of fundamental concepts of LCA, its methodology and application are described now in the ISO 14040-1404X series of standards. These standards have already been introduced in some countries, but in Poland they are in stage of translation into Polish. Even though, there are some companies in Poland which try to foresee how they products – according to LCA rules industry – influenced environment and what are possibilities of technology improvement at the existing production process in order to minimize the environmental impact.

For any mining activities environmental aspect is very important, as all mining industries are burdensome to the environment, especially by generating a massive of solid waste. The primary non–ferrous industries are particular examples of this, as non–ferrous ores contains only a few percent of metals. The rest of extracted mineral has to eliminate gradually in the successive stages of production.

The basic metals sector is a significant component of the Polish industry. It contributed only about 5% of the sold production of the industry, but the export of metals and metal articles contributed about 15% of export revenue in the last ten years. Metalliferous mining and processing are important, with copper and its various by-products (silver, gold, platinum and palladium, lead, cobalt), lead, and zinc being the main commodity produced. Zinc and lead deposits are nearly exhausted but copper deposit will allow mine copper for next at least 25 years.

In Poland one of the main assumptions for minerals industry policy - introduced in 1989 - is pro-ecological development of that industry. As a result there have been a lot of legal changes of which one of the most important was introducing high fees and penalties associated with polluting the natural environment, e.g. fees for emission of dusts and gases, for storing wastes. To lower environmental penalties many companies started to invest

mainly in pro-ecological operations, and now emissions to air and water mainly from non-ferrous mining industries have declined dramatically (Tab. 1).

Table 1. Environmental fee paid by KGHM Polska Miedź SA (the European largest primary copper producers)

YEARS	1996	1997	1998	1999
Investments for the environmental protection ['000 \$]	16 286	41 280	6 380	7 520
Environmental fee [\$/'t Cu]	96,24	53,94	38,78	32,79
Environmental fees ['000 \$]	17 765	19 495	15 123	15 274

Source: KGHM Polska Miedź S.A.

The other result of Polish economic reform was the increase of energy price, which also caused reduction of energy consumption for metals production as well as other materials (Tab. 2).

Table 2. The volume of inputs (materials, energy) and output (pollutants) at Polish copper and zinc producers

YEARS	1996	1997	1998	1999
Copper				
Production of copper [t]	424 708	440 640	447 000	470 494
Material consumption [ore/t Cu]	61.15	56.11	58.4	57.4
Fuel and energy consumption [MJ/t Cu]	10 582	10 391	9 343	9 295
- Of which electricity [kWh/t Cu]	1 022	1 163	1 219	988
Water consumption during copper production [dcm ³ /t Cu]				
Salted water released [m ³ /day]	73 235	72 378	59 342	42 989
Dust and gas emission [t/year]	2199	1691	958	977,4
Solid wastes ['000 t]	25 657	24 447	26 202	26 973
In which utilized ['000 t]	7 024	12 816	18 099	19 887
Zinc				
Zinc production [t]	163 100	170 600	174 800	177 000
Material consumption [concentrate/t Zn] ^e	1.13	1,05	1,16	1,09
Fuel and energy consumption [MJ/t Zn]	16 791	16 421	16 389	15 761
- Of which electricity [kWh/t Zn]	3 655	3 697	3 775	3 739

Source: KGHM Polska Miedź SA, ZGH Bolesław, Trzebieńka SA., GUS

These technological changes, which were necessary from economic point of view, influenced environmental effects. As a result some mining companies started to apply for ISO 14000 certificate (e.g. Cedynia Copper Wire Mill), and to evaluate the influence on environment according to LCA assumption.

The implementation of LCA in mining industry should take into account three groups of investments:

1. „Greenfield sites where provision for minimizing the impact of mining on the environment is an integral part of the mine design.
2. Redevelopment of deposits on the sites of previous mining where mine design is constrained by old surface and underground operations and options aimed at minimizing any additional impact on the environment may be constrained.
3. Ongoing investments in active operations where fundamental modifications to the existing mine design are not practical and may even be counterproductive.”¹

For new mining projects concentrated to some extent on protection of the environment implementation of the LCA is possible only by using already existing databases. In the second case one can use data from the previous mining operation thanks to them try to minimize the environmental impact at the very beginning. Data used from the ongoing operations are current data so they give a possibility for conducting real assessment of environmental impact. (Such data are analyzed in the EU project: Life Cycle Assessment of mining projects for waste minimization and long term control of rehabilitated sites, with Imperial College as coordinator).

To implement LCA for ongoing mining operation the whole life of the product/process in light of environmental aspects should be analyzed. As the whole mining production constitutes of different technological stages, therefore at the beginning for each stage environmental problems should be recognized. For underground non-ferrous metals production the most important environmental problems are presented in Table 3².

Table 3. Environmental aspects on every stage of primary metal production

Stage	Environmental aspects
Prospecting for the raw material	Small local pollution
Mining	Mining water discharge – also salted water
Processing	Solid wastes disposal
Manufacturing	Dust and gas emission and solid wastes disposal
Transportation	Dust and gas emission
Distribution	Dust and gas emission
Use	—
Waste utilization	Solid wastes disposal
Recycling or final disposal	Improvement of the environment

The basic analysis of Life Cycle Inventory for Polish non-ferrous mining (by comparing the inputs, i.e. energy, materials, and outputs, i.e. wastes, pollution) shows that the highest

amount of wastes and pollution (also the highest fee) is generated at mining and processing stage. Therefore these two stages are further divided into operations, processes and activities to create the database of wastes and pollutants, and to evaluate the significance of potential environmental impacts in any operation and activity (using the results of the life cycle impact analysis, i.e. for every functional units). In general, this process shows where in the whole life of the production process the highest amount of wastes and pollution is generated and assess the effects of the environment (Life Cycle Impact Analysis). Then solutions concerning minimization of generated wastes and pollution can be suggested in order to help decision-makers in their work (Life Cycle Improvement Analysis).

Solid waste disposal is now the largest environmental problem for KGHM Polska Miedź SA which has already produced copper for 30 years. The capacity of existing tailing pond can be sufficient for the future production (the mine life based on the reserves available for the extraction has been calculated for the next 25 years), but the environmental hazard and the cost of reclamation and monitoring (acc. Polish law) will have to be conducted for the 30 years after closure. To solve the problem of the post-flotation waste management research has been conducted on the possibility of utilising post-flotation wastes in underground mining technology to backfill exploited areas and to fill abandoned works. Probably, such solution – now too expensive – after implementation of LCA will be proper one, and let to minimise disposed solid and at the same time — the most hazardous — wastes. It will then reduce the amount of fees and fines that KGHM must pay for generation of wastes, and let avoid the cost of tailing damp reclamation and monitoring after closure of the mines.

Polish mining producers can expect that implementation of LCA will lead not only to improve the environment, but also to more effective environmental management what means:

- cost-saving by reducing wastes emission, and reducing fees and fines,
- an effective tool for decision-making by showing the connection between the activity and the devastation of the environment,
- improvement companies' image on the world market.

¹ Durucan Sevkət, Korre Anna: Life Cycle Assessment of mining projects for waste minimization and long term control of rehabilitated sites, Proceedings of the third annual workshop, Athens, 2000, p. 257.

² Kulczycka Joanna, Wąsik Anna: Wykorzystanie Ekologicznej Oceny Cyklu Życia (nowej normy ISO) w górnictwie. Przegląd górniczy (w druku).