

# Environment and environmental effects of pollution. Model of eco-dashboard – A tool for analysis of environmental management performances

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**Environment and environmental effects of pollution. Model of eco-dashboard – A tool for analysis of environmental management performances**

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**Abstract**

*This article presents some conceptual approaches to environment and pollution phenomenon, describing the main factors of pollution and their evolution in Romania. There are described the main centers of pollution from the Slatina area. There is presented a definition of eco-dashboard, the main flight specific businesses within the non-ferrous metallurgical industry of Romania and a model for analysis of environmental management performance of this specific field.*

***Keywords****: steel industry, pollution, eco-dashboard, indicators of environment, performance.*

## 1. Conceptual approach of the environment and environmental pollution

Environment means all the energies, physical, chemical, biological conditions, which surround a human being or a group of individuals, being placed permanently in exchange relations. European Union by directive no. 67/848 states that the environment is "*water, air earth and the relationship between these elements, all living organisms*".

According to Government Emergency Ordinance no. 195/2005 on environmental protection in Romania, the environment is defined as "*all conditions and natural elements of earth: air, water, soil, subsoil, the characteristic of the landscape, all the atmospheric layers, all organic and inorganic materials and living beings systems in interaction with natural elements listed above, which may affect human health and welfare.*"

Natural environment is diverse as the landscape, climate, soil, plants, animals, etc. constituting a complex system in which life takes place from all points of view. Environment means the natural environment itself, and the environment change by man called *artificial* or *anthropic environment*. Anthropic environment (created by humans) is composed of: human settlements, ways of communication, industrial installations, clothing, etc.., but also the waste water and residues from production of consumption. As a result, the environment is a relationship of interdependence between the components, like in a body relationship that refers to the interdependence of the abiotic, biotic elements and man-nature relationship.

The breaking of the natural balance through human activity is achieved either by pollution or by the elimination of certain species of plants, animals and deforestation.

The phenomenon of pollution (isolated) occurred much earlier, with the use of fire by the first tribes, but this and the protection environment have become a major problem of contemporary society at the end of the century XX century.

Pollution has been defined in 1974 by the OECD as "*any introduction by man into the environment, directly or indirectly, of substances or energy with deleterious effects such as to endanger human health, to prevent injury to biological resources, ecosystems and material property to reduce benefits or to prevent other legitimate uses of the environment.*" In Romania, the pollution was defined in the old law of environment as "those actions which can cause break the ecological balance" or "may harm health, the state of peace and comfort to the people" or "produce harm to the national economy by altering the quality or natural factors by human activities", and in the law no. 137/1995, the notion of pollution is integrated into the "environmental damage" designating "altering physico-chemical and structural characteristics of natural and anthropic components, damage to biological diversity and productivity of natural ecosystems and anthropic, affecting the ecological balance and quality life caused mainly by water pollution, air and soil, overexploitation of resources, management and use of their loss, as well as poor spatial planning. Pollution is after all the intoxication caused by pollutants.

According to Government Emergency Ordinance no. 195/2005 on environmental protection, the pollutant is "*any substance, solid, liquid, gaseous form of steam or energy (electromagnetic radiation,*

*ionizing, thermal, noise or vibration), which introduced into the environment, change the balance of constituents and bodies and cause damage to assets*".

Environmental degradation now affects all the components of ecosphere: air, water, soil and subsoil (abiotic components) and the flora and fauna (biotic components). This degradation is due in particular to anthropogenic sources of pollution, and among them, an important place is held by industry, all factors that pollute the environment with a diverse range of pollutants: emissions into the atmosphere, in surface water, waste ground, in basement biological and radioactive contamination.

## 2. Phenomenon of pollution in the steel industry in Romania

Steel industry has an important role in the development of many economic sectors, ensuring in turn the raw materials necessary to manufacture a wide range of highly finished products. In Romania, this branch has a long tradition in geographical and economic landscape of the country. As testimony stands archaeological evidence, from VIII-IX centuries BC, the shift from tools and weapons of bronze, the iron produced in kilns and workshops. In time it emerged metallurgical centres: Resita, Hunedoara, Bistra (Otelul Rosu) Campia Turzii, Galati, Targoviste, Baia Mare, Zlatna, Roman Zimnicea, Calarasi, Copşa Mica, Slatina, Braila, Drobeta Turnu Severin, Focşani, Braşov, Nădrag and Calan.

After 1999, the establishments of this industry were forced to lower their production and to record significant losses. Today metallurgy provides over 75% of domestic steel and nonferrous metals, which gives her character as a determinant for industrial sector boosting the national economy, all sectors of the economy consuming metal. Metallurgical industry is composed of ferrous steel industry (steel) and nonferrous metallurgy.

Nonferrous metallurgy recovers nonferrous ore resources to satisfy the national economy of non-ferrous metals and products. In recent years, against the background of a general economic decline, industry, ferrous metallurgy had a downward trend. Currently operates 11 companies in which:

- 3 ferrous metallurgical enterprises: ALRO Slatina (primary aluminium and alloys), SOMETRA Copşa Mică (electrolytic zinc and lead) and CUPROM Baia Mare (electrolytic copper)
- 4 processing complex ores enterprises and golden-argentiferous: Baia Mare, Zlatna, Brasov and Brad.
- 2 companies producing alumina: Oradea and Tulcea.

To these are added after the year 1990 about 100 SME's, whose activities consist in the recycling of nonferrous metals and alloys, nonferrous metal casting, etc. having a share of about 5-10% of this industrial minor branch production. All non-ferrous metallurgy enterprises producing aluminum, lead, zinc and copper are associated to non-ferrous metals Exchange in London, trading products after the stock market, LME (London Metal Exchange). In addition, all these companies are privatized non-ferrous metallurgy. Because of non-ferrous metallurgical industry, in the environment are issued:

- Into the atmosphere, *particles of metal oxides* (lead, zinc, copper, cadmium, etc.) *gaseous compoun*ds (sulphur oxides, nitrogen oxides, carbon oxides, hydrogen fluoride and fluorides)
- in surface water, *fluorides, suspensions, chlorides, extractable substances*
- on the soil, *industrial waste*.

## 3. Overview of the main centre of pollution aluminium industry in Romania

*Slatina* is the most important centre of the aluminum industry in our country and in south-eastern Europe. In this town, there are two enterprises in the ferrous metallurgy industry, which are also polluting [1], these being:

1. *SC ALRO Slatina SA* is the main representative of the aluminium industry in Romania, the only producer of primary aluminium in the country and the largest in Europe. It was established on 1 March 1961 as the Aluminium Enterprise Slatina. First Romanian cast aluminium was produced in 1965 and by 1982 reached the maximum capacity of 263,500 tons/year. The activity of the company is the production of aluminium, aluminium trade on internal and external, know-how, consulting, expertise, technical assistance, design, etc. The company has facilities to produce electrographic by grafitizare and has controlled landfill (capacity 40 tons/day). The main products of SC ALRO Slatina SA are primary aluminium block 99.7% Al, aluminium block refined 99.99% Al, the block of primary aluminium alloys, cast bars half-continuum vertically, mixed alloy blocks of aluminium, wire prefabricated from basic aluminium.

At present, production capacity is 240 000 t/year, in a continuous growth due to modernization, so that in 2010 will reach 400 000 t/year. This combination of aluminium is owned by the Group VIMETCO (MARCO been Industries). From SC ALRO Slatina SA come: waste gases from central heating, Anode

Section, Department of Foundry, gas compounds of chlorine and fluorine in feeds used in the Foundry Department, sulphur dioxide ($SO_2$), particulates, petroleum coke, etc.. Anode Section, aerosols, carbon monoxide (CO), sulphur dioxide ($SO_2$), particulate matter containing fluorine from sections electrolysis; domestic sewage are discharged into city sewerage system, the average volume is 1800 cubic meters/day, technological and waste waters are discharged into Valea Urlătoarea (Milcov). The main beneficiary of the SC ALRO SA Slatina is S.C ALPROM S.A. Slatina, with a proposed merger by absorption finalized by SC ALRO SA. The merger created a strong company that was achieved by vertical integration.

*2. SC ALPROM SA Slatina* does aluminium production and processing, marketing of products (aluminium-rolled sheet, bar, sheet, wire, aluminium alloy), facilities for melting nonferrous metals (capacity 185.3 t/day) facility for treatment metal surface by electrolytic process (capacity 64 cm.). A particularly important aspect is that SC ALPROM SA (together with SC ALRO SA) is the only manufacturer of sheet, bar, foil and aluminium wire on the Romanian market, being one of the largest in Europe. Pollutants resulting from the technological process, emitted into the atmosphere are carbon dioxide, carbon monoxide and particulates. Sewage wastes (average volume 700 cubic meters/day) are also discharged into the city sewerage system, and those that require cleaning are discharged Valea Urlătoarea.

## 4. Eco-dashboard and specific piloting indicators for nonferrous metallurgical industry in Romania

*Eco-Dashboard* is a tool that allows the classification, selection, arrangement and presentation of performance indicators of environmental objectives, viewing and contributing to the synthesis of information necessary piloting performing of an enterprise. The form of eco-dashboard may vary depending on the objectives pursued and established by an enterprise, adopting a variant, or an amended version.

Among the Eco-Dashboard characteristics there are the following:

- the presentation in a more systematized form of the most significant information concerning the evolution, the factors of influence and partial or final results of the work of organization, the compartments or sectors, providing data needed for decision and control;
- fuses information about the current activity with statistics information and the foreseeable information in the proportions determined by the specific of the activity;
- indicates the existence of deviations from plans and programs, and development of undesirable phenomena in the organization;
- presents a non-standard form determined according to the specific of the activity pursued, to the needs and the information of the organization management.

Indicators of eco-performance present information in a precise and concentrated way on the segment of the environmental enterprise. An enterprise may use several types of indicators: operational, state of the environment, managerial, economic, etc.

In category of operational indicators, specialized literature uses so-called indicators of "pressure" on the environment with emphasis on environmental elements: air, water, soil. Indicators of “pressure” on the environment have the following features that relate to:

- the usual "pressure" on the environment are ***emissions of pollutants***;
- assessing these pressures is carried out based on indicators characterizing the pollutants and sources that generate *issues and associated environmental impacts;*
- economic agents are bound by specific regulations to monitor the impacts of products on the environment, reporting on a regular basis the environmental situation registered;
- in the absence of specialized devices of measurement and control of pollutants, the determination of the emissions can be done by calculations using standard methods or other national or international methodologies;
- to reduce impacts on the environment, the calculated indicators are at all times compared with maximum allowable (CMA) [2] defined by standards or other regulations;
- indicators of "pressure" on the environment are important components of environmental impact assessment by *studies of the impact* and *environmental balances*, on which there are issued "*environmental agreements*“ and “*environmental authorizations*“.

Romania use to assess the impact on the environment concepts and methodologies similar to those of the European Union.

Among indicators of "pressure" on the air, we can mention:

1. emission monthly/annual $SO_2$, $NO_x$ (nitrogen oxides), CO, $CO_2$, particulate matter (kg);

2. emission specific monthly/annual $SO_2$, $NO_x$, CO, $CO_2$, powders related input/raw material (kg pollutant/unit of raw material);

3. emission specific monthly/annual $SO_2$, $NO_x$, CO, $CO_2$, powders reported production kg pollutant/unit of production or product;

4. specific emission of $CO_2$ in relation to population (t / capita);

5. monthly/annual emission of heavy metals (kg);

6. level of noise emitted by various sources (decibels-dB).

In Romania, the maximum permissible concentrations are determined according to STAS 12574-87. Further, we illustrate some values such as $SO_2$ – 0.125 mg/m$^3$ air for 24 hours (daily average), $NO_x$-0.1 mg/m$^3$ air for 24 hours, CO - 0.03 mg/m$^3$ air for 24 hours, F – 0.005 mg/m$^3$ air for 24 hours.

From the category of indicators of "pressure" of water, we can remember:

1. concentration of nitrogen (N) and phosphorus (P) in waste water discharged (mg/dm$^3$);

2. concentration of suspended matter of organic substances or oil or toxic waste discharged into water (mg/dm$^3$);

3. emission/discharge monthly/annual material matter or organic or toxic substances or heavy metals (lead, copper, zinc) in surface water, groundwater, sewage (kg);

4. total volume of waste water discharged annually (m$^3$);

5. specific volume related to production or product (m$^3$/unity of production or product).

Indicators of "pressure" on the ground may include: the monthly/annual waste generated (kg) on the waste category (%), the monthly/annual waste recycled (kg) quantity of waste deposited (kg), quantity of industrial waste generated in relation to GDP (kg/10$^3$USD).

The second large category of indicators that can be used by an enterprise to develop the eco-dashboard is the *indicators of environmental status*. They present the following features:

- quantify the environmental quality in the area bordering polluting source, local, national, regional or global;
- provides useful information on the changes which the environmental factors undergo due to pressure of natural phenomena and / or anthropogenic activities;
- correct interpretation of the indicators require complex investigations including a correlation with the related indicators of "pressure";
- developing and using environmental indicators don't concern polluting organizations, being the responsibility of local agencies, national, regional or global, non-governmental organizations and scientific institutions and research;
- the usual indicators relate to concentrations of pollutants in environmental factors (emissions), use of reference values contained in the standards or other regulations.

In order to prepare and analyze the eco-dashboard we propose to follow the next steps through specific method Activity-Based Costing:

*Stage 1*. Identifying users of environmental information related to the environmental departments of a company (who are they and what are their powers regarding the environment).

| Metallurgical profile enterprise | Information users |
|---|---|
| Foundry department | Head foundry Department, production responsible, workers. |

*Stage 2*. Identification of the most significant environmental activities with impact on the environment and specific units of measurement. By choosing activities it is intended to provide information on:

- the consumption and the use of raw materials and natural resources;
- atmospheric residue, pollutants, etc.;
- solid and liquid waste;

| Metallurgical profile enterprise | Type of activity | Issued substances | Environmental impact |
|---|---|---|---|
| Foundry department | transformation of electrolytic aluminium in semi-processed elements | gas compounds of chlorine and fluorine | deteriorating urban air quality |

By reporting to a relevant unit of reference, environmental data are significant and relevant units of measurement and related activities in an enterprise becomes much more simple and compact.

| Metallurgical profile enterprise | Type of activity | Type of unit reference |
|---|---|---|
| Foundry department | transformation of electrolytic aluminium in semi-processed elements | Tones of semi-processed elements |

*Stage 3*. Identifying departments that will provide data necessary for identification, collection and compilation of environmental indicators and final users to motivate decisions.

| | Departments | Type of information collected |
|---|---|---|
| Metallurgical profile enterprise | Production | - establishing monthly production of finished products and wastes;<br>- technological descriptions of dangerous products. |
| | Accounting | - establishing quantitative monthly consumption of alumina, water, gas, electricity, oil based on invoices. |
| | Leadership | - economic data. |
| | Purchasing | - types, costs and quantities of raw materials and products. |
| | Sub treatment | - type and quantities of raw materials used (maintenance products, food, packaging, waste, etc.) |
| | Human Resources | - the type and frequency of future staff training. |
| | Environment | - analysis, technical expertise or representations of the emission of gaseous and particulate matter (monitored), the ejections of wastewater technology, waste and noise measurement. |

The performance of each activity is measured based on 2-3 piloting indicators and criteria used for selection are: activity level, cost, effectiveness, efficiency, non-quality. To measure the performance of an environment are necessary more analysis criteria. This analysis is done using various indicators that cannot be exclusively of a financial nature. Diversity is increasingly common, but it is not enough important in the selection of indicators. Thus, it is not enough to appreciate the relevance of resources allocated to an activity or performance, from the cost, but we should measure the value created for users of the information about environment.

| | **Indicators type** | **Calculation relationship** | **Uses** |
|---|---|---|---|
| Metallurgical profile enterprise | Quantity needed of anode for electrolysis process | No. of anode/tonne alumina | Eco- effective |
| | Amount of alumina in total tonne of aluminium electrolytic | Tonne alumina per tonne of aluminium electrolytic | Supply policy |
| | Information level of personnel and the population about the environment | Number of days *open doors* /365 days | Information level of personnel and the population |
| | Rate of monthly recovery of ecological Investment | Value of ecological environmental investment (RON)/ Number of months | information of shareholders |

It is easier to react when the items we see are visible, but the most effective result of actions comes from its influence on the causes and not on disruption effects. Analysis of disruption effects is not sufficiently debated in business in the present. In order to analyze performance using the eco-dashboard of an enterprise in the steel industry based on ABC method, we suggest a number of indicators which are characterized by: the findings made, highlighting the causes identified (positive or negative) and actions to be taken as a result.

| **Stages** | | | | **Types of indicators** |
|---|---|---|---|---|
| **Findings** | **Causes (negative) identified** | **Causes (positive) identified** | **Actions made** | |
| Lower compared to the target | Too high anode consumption | Reduction of the anode number | Automation of the tower, no pasta. 1 by a seat formed of 3 process computers falling under the technological parameters and operation of filters making the online monitoring of their | Required amount of anode for the electrolysis |
| Normal compared to the target | Alumina consumption in normal limits | Reduce multiplication tank for the electrolysis on 6 halls | Improvements in energy efficiency through the purchase of equipment and technologies of modern ovens | The amount of alumina in total aluminium electrolytic |
| Lower compared to the target | Poor participation in the information of productive staff | Increased interest of population | Campaign mass of information | The degree of information personnel and the population on the environment |
| Lower compared to the target | Higher costs | Depollution of the environment | Compliance Plan for the recovery of investment | Monthly rate of recovery of environmental investments |

## 5. Conclusions

Informational coverage with indicators of the environment provides a system of coherent and comprehensive flight. These kinds of indicators of environmental component of eco-dashboard complete management and its employees. Knowledge of the status and trends of environmental indicators listed in the eco-dashboard panels on target objectives set out, allowing management to improve performance of the enterprise environment. Informational content of eco-dashboard is made known to other departments or functional services, just as the final decision to be taken at managerial level to be based more rigorously and, difficult decision to consider the opinions and conclusions and all involved in the smooth running of the enterprise.

Using the ABC method in this framework enables enterprises in the steel industry and not only to develop their concern for comparing the performance of their ambient environment in relation to other competitors, improve the quality of products, works and services performed as well, and focus attention ecologically on the services offered to customers.

**Footnotes**

[1] **Martinescu D.M.**, Sources of pollution in the area municipality Slatina, Romanian Statistical Review, supplement no. 6/2009, p. 210-214.

[2] MAC - Maximum allowed concentration.

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