

ASSESSMENT OF ENVIRONMENTAL ASPECTS IN A METALLURGICAL ENTERPRISE

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The publication characterises the quantity and quality methods applied in the assessment of the environmental aspects. The method of cumulated environmental loads is particularly interesting, where the network of process connections within an enterprise and between it and the surrounding (the co-operation of the enterprise with the suppliers of resources and materials, the networks of energy resources and distributors of products or other contributors in the chain of added value. The paper finishes with an example presenting the methodological assessment of the environmental aspects in the metallurgical enterprise.

Key words: metallurgical enterprise, environmental aspects, environmental management

Procjena aspekata okoliša u metalurškoj industriji. Ova publikacija karakterizira kvalitativne i kvantitativne metode primjene u procjeni aspekata okoliša. Metoda ukupnog opterećenja okoliša posebno je zanimljiva tamo gdje postoje povezanosti procesa unutar industrije i povezanosti između industrije i okoliša (suradnja ondustrije s dobavljačima resursa i materijala, povezanost energetske resursa i distributera produkata ili ostalih suradnika u lancu dodane vrijednosti). Rad završava s primjerom predstavljanja aspekata okoliša u metalurškoj industriji.

Ključne riječi: metalurška industrija, aspekti okoliša, upravljanje okolišem

INTRODUCTION

Environmental management in an enterprise concentrates first and foremost on the reasons of the creation of pollution and its influence on the environment. One of the most important processes in environmental management is the assessment of the environmental aspects allowing the enterprise to select the relevant aspects which are the basis of their strategic aims in the programs of protection of the environment. In formulation of the environmental strategic aims a given enterprise strives at elimination of negative impact on the environment.

The authors of this publication presents the methods allowing the producers to choose the relevant aspects were also suggested. Besides the descriptive methods and creative thinking (common discussions, opinions of experts) some methods of weight (point) analysis were suggested which use the probability of occurrence (risk score). A method of cumulated loads of the environment was applied taking into account the connections between processes in an enterprise and out of the enterprise in a full lifecycle of a product. The practical part of the article presents examples of tables for the assessment of aspects in the process of ores sintering in a metallurgical enterprise.

ASSESSMENT OF ENVIRONMENTAL ASPECTS

Environmental aspect is defined as the element of the enterprise (its products or services) which affects or may affect the environment [1]. The influence on the environment should be understood as every change in the environment, both positive and negative, which is fully or partially caused by the activities of the enterprise and/or its products [1]. According to the requirements [1,2] a manufacturing enterprise should work out procedures of environmental aspects identification in reference to conducted business activities which would help to define aspects which significantly influence the environment. This paper presents comprehensive range of methods applied in identification and assessment of environmental aspects.

Among descriptive methods the most commonly applied method in manufacturing enterprises is brainstorming. It is a **heuristic method** allowing the participants of discussion for expressing opinion concerning the influence of the business activity of the enterprise on the environment. The participants of discussion are usually the members of the staff of the enterprise who are representatives of different departments chosen on purpose. Their knowledge and experience should be used in the course of discussion over the essential assessment of aspects' relevance. Gathered aspects are divided into groups with applied order criteria. The basic criteria are usually their nuisance to the environment. The distin-

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guished relevant aspects are further classified and ordered, i.e. according to the places where they occur or to their environmental costs. Other methods applied in enterprises in the aspect identification stage are **opinions of experts**. It is assumed that the more complicated a given technological process is, the bigger the need to use the knowledge of experts in identification of the influence of production on the environment. The experts are usually university workers, mostly from technical universities or workers from scientific and research institutes, analytic-research laboratories or experts from the list of the proper ministry with certificates. The opinion stated by the experts is most frequently in a written, descriptive form. The enterprise may use the opinion of one or many experts in a given field or similar field (layer approach to aspect analysis). The knowledge of the experts from many domains allows the enterprises to analyse the topics of environmental aspects more deeply. It takes into account the knowledge of technologists, economists, ecologists, lawyers, sociologists and other branches (i.e. creative branches). Each group assesses the influence of aspects in an enterprise on the environment from their own perspective and then the groups create a common list of relevant aspects. This form of the involvement of experts in the process of identification refers to the rules characteristic for Delphi method. The opinions of experts may have parallel form or the form of following analyses. In case of parallel opinions the relevant aspects are those which were identified as such by the majority. In case of further assessments there is a need to confront the following opinions and working out a common ground. It is assumed that the results of experts' assessments in reference to environmental aspects relevance must be clear and agreed. A useful analysis tool in the stage of identification of environmental aspects is also **work post interview**. The manager in the first line (direct superior) or the team leader conducts an interview with the workers employed on particular working posts in order to get detailed information about the course of their work and its influence on the environment. Such interview may have a descriptive form (survey) or verbal description form (a discussion with an aim). Enterprises may also use computers and IT devices as well as visual devices (cameras) which will register a course of a day at work on particular working stands (monitoring of a working stand) and measure the load on the environment (devices which measure and register the pollution, noise, electromagnetic field etc. (monitoring of the environment). A **risk score analysis** is also conducted for each working station. Although it is usually classified as the method of job risk assessment, it allows the employer to gain information which will be used for identification of environmental aspects. The basis of this method is risk matrix taking into account the probability and frequency of occurrence of particular environmental aspects on a given working station, i.e. explosive atmospheres, activation of sources of ignition, including the electrostat-

ic discharge with definition of scale of the unwanted results. The suggested risk factors in uncontrolled conditions may become relevant aspects for the enterprise and may also activate in the form of environmental failure. Helpful elements of identification and classification of environmental aspects are thoroughly designed **technological diagrams** with the balance of material and energy consumption. They are the basis for product **life cycle analysis** (LCA – Life Cycle Assessment). The LCA method is a relatively new tool of assessment developed in the early 90s of the 20th century. It allows for the assessment of the environmental aspects in the full life cycle of product's existence counting from gaining the resources up to the liquidation of the product by defining the cumulated environmental loads. Some authors compare some methods and try to choose the better in specific situation of enterprises [3].

In modern industrial enterprises which possess financial aids for innovations such analysis refers also to project actions for new or modified products (design LCA) [4,5]. The method of calculated assessment is based on (generally speaking) a matrix of weighted multipliers (relevance criterion) set in reference to a given aspect and its full value in reference to a full life-cycle of product which is a chain of following operations of manufacturing of a given product. In such chain both the arising and the cumulated environmental loads which are generated in a given operation chain are taken into account. The analysis begins from testing burdens resulting from the direct expenditure on a given final product, then the burden of each half-product needs to be tested, then the resources and energy carriers necessary to manufacture a given product and the corresponding processes. On each level the arising burdens referring to the semi-products, resources and energy carriers should be summed up [6,7]. The establishment of the environmental aspects in full lifecycle begins from creation of a connection network for particular operations and then the detailed analysis of each process in context of present and cumulated environmental aspects. In a nutshell, the method may be presented in the form of a diagram of material balance for a single process (plant, process, operation). Due to the fact that this method is both time-consuming and work-consuming some simpler versions of this method are applied, i.e. input-output in which a list of aspects on the input of the production process and on the output of the production process is made for each area of activity in an enterprise. Aspects connected with supply are analysed on the input of the manufacturing system and the products, sewage, noise and other environmental aspects are registered on the output. After the creation of a list of environmental aspects (register of aspects) a period of their ordering is following together with the assessment of the influence of an aspect on the environment.

The main criteria of environmental aspects assessment are the following conditions: **environmental** – which is the scale of the aspect – pollution level, its du-

ration, frequency of occurrence – the number of processes in which a given aspect was identified, level of toxicity, damages caused by this aspect to the environment, sensitivity of the environment to a given aspects, etc., **economic and business related** – these are the costs of environmental tasks completion, costs of ecological investments, ecological fees, ecological fines, costs of waste utilisation, internal recycling and waste transport included in internal recycling, etc., **legal and organisational** – include the existence of the proper legal regulations, meeting the current legal requirements or voluntary environmental management systems and strategy of Cleaner Production (CP), etc., **time and chronological**, i.e. regulations and schedules of actions concerning utilisation of asbestos, limitation of carbon dioxide emissions in manufacturing processes, gaining renewable energy, diversification of sources of production powering, etc., **social and marketing** in which there are social expectations connected with the improvement of the quality of life in reference to ecological conditions, the level of social sensitivity to a given environmental aspect, the expectations of local authorities, ecological institutions and other internal and external groups of stakeholders in an enterprise in context of conduction of ecological promotion strategy and in building the social awareness [8].

The enterprise strives at creation of relevance criteria for environmental aspects of an enterprise right in the stage of aspects assessment. Usually, the enterprises use **point method** which use the frequency of occurrence and the size of damages caused by a given influence on the environment. When assessing the relevance of aspects influences on the environment not only normal working conditions should be taken into account but also conditions during the start and finish of exploitation and special conditions as well as ecological failures. In order to get the full view of the aspects in reference to the whole cycle of product existence, the relevant aspects identified in particular manufacturing processes of products will get cumulated (the sum of points achieved from all the processes in reference to a given category of environmental aspects). The relevant aspects are those which achieved the highest marks in the whole process of manufacturing steel (that is above the weighted average).

$$A_k = \sum_{p=1}^s A_{pk} \quad (1)$$

where:

A_k – environmental aspect k -th factor in a full lifecycle
 A_{pk} – environmental aspect k -th factor in p -th process of manufacturing system

Formula (1) refers to one environmental aspect occurring in particular processes. Thus, to achieve a list of relevant aspects, particular environmental aspects should be compared to those those which exceed the defined reference criterion – formula: IF $A_k > I$, where I is the reference indicator and A_k is the relevant aspect. Identification of the environmental aspects and their assessment is first

conducted in the stage of initial environmental overview. The aim of the overview is the assurance that after the implementation of the system all the environmental aspects connected with planned or new investments, new or modified actions, products and services will be identified. The methods of aspects assessment are based on the choice of the right criteria according to which the assessment of the influence on the environment is conducted. Particular enterprises may decide individually if a given aspect is relevant [9].

ENVIRONMENTAL ASPECTS ASSESSMENT IN STEELWORKS

Theoretical aspects of the paper are referred to the specifics of functioning of manufacturing metallurgical enterprises after defining the example environmental aspects and their influence on the environment. A case study here is the process of ores sintering in a metallurgical enterprise. Some example forms are suggested below for the assessment of environmental aspects for such process (Tables 1-3).

Table 1 **Example grid of environmental aspects for sintering plant of ore** [10]

No	Aspect	SO _{usm}	SO _{ssm}	SO _{sm}	SO _{cs}
1.	Noise emission	x	x	x	x
2.	Dust emission to the atmosphere	x		x	
3. etc	Electricity use	x	x	x	x

x – means a given aspects appears. Action: sintering of ores – SO. Operations/activities: usm – unloading of the sintering materials, ssm – storage of sintering materials, sm – grinding of coke dust, ores, flux and preparation of sintering mixture, cs – cooling and crushing the sinter.

Table 2 **Environmental aspects for sintering plant**

Aspect (examples)	Influence
Grinding of coke dust, ores, flux and preparation of sintering mixture	preparation of sintering mixture
Noise emission by the machines	Increase of noise level in the environment
Electricity use	Using-up the natural resources
Emission of dust	Air pollution
Sintering of the mixture	
Emission of gasses-SO ₂ , NO ₂ , CO, CO ₂ , aliphatic hydrocarbons, methane	Air pollution
Noise emission by the machines	Increase of noise level in the environment
Emission of dust	Air pollution
Electricity use	Using-up the natural resources
Exploitation of natural resources – iron ore, flux	Using-up the natural resources
Cooling and crushing the sinter	
Emission of gas – CO	Air pollution
Noise emission by the sinter breaker	Increase of noise level in the environment
Emission of dust	Air pollution
Electricity use	Using-up the natural resources

Noise emission from ventilators which cool sinter	Increase of noise level in the environment
Dust extraction from fumes of the sintering process	
Creation of waste –iron-bearing sludge	Air, soil, water pollution, taking-up space
Electricity use	Using-up the natural resources
Noise emission from dust extraction device	Increase of noise level in the environment
Purification of circulating waters	
Creation of waste –sludge	Air pollution, soil, water pollution, taking-up space
Water consumption	Reducing the amount of natural resources
Creation of sewage	Water pollution, contamination
Use of electricity	Using-up the natural resources
Storing the sludge on the scrap-yard for iron-bearing waste	
Percolation of water eluates to the soil	Contamination of underground waters, soil
Dusting of external layer	Air pollution
Outflow of drain waters	Contamination of water
Renovations of crushers, sintering conveyor belts	
Creation of waste/steel scrap	Air, soil, water pollution and taking up space
Use of electricity	Using-up the natural resources
Creation of waste – used oils and grease	Air, soil, water pollution and taking up space
Un-organised emission of dusts to the atmosphere	Air pollution
Failures of gas coke installations and mixed gas installations	
Emission of gasses -CO, CO ₂ , aliphatic hydrocarbons, etc.	Air pollution

Table 3 Example of a form for the assessment of the environmental aspects

No	Environmental aspect	Weight 1 - 3	Assessment of the environmental influence 1 - 5	Weighted mark	Relevant aspect
1.	Emission of CO ₂	3	5	15	Yes
2.	Emission of SO ₂	3	4	12	Yes
3.	Consumption of electricity	3	5	15	Yes
4.	Noise	1	2	2	No
etc					

Weighted mark above 10 – relevant aspect. WEIGHTS: 1 – less important aspect, 2 – aspect of medium importance, 3 – very important aspect. The weight defines the importance (relevance) of an aspect for the environment in a global approach. ASSESSMENTS: The assessment of the influence of particular environmental aspects of an enterprise on the environment according to a 5-point scale, where: 1 – very small influence, 2 – small influence, 3 – average influence, 4 – big influence, 5 – very big influence.

CONCLUSIONS

Assessment of the environmental aspects including the selection of the key aspects is an element of environmental management system introduction in an enterprise. The method with the use of which such actions are conducted should be led in such a way so that none of the activities in an enterprise is forgotten in selection of relevant aspects which are significantly burdensome neglected areas in a manufacturing enterprise. In case there are no ready schemes and procedures of action in a given enterprise which undergoes environmental analyses of the processes taking place within it, the enterprise may use: the criteria of environmental aspects classification, methods of their identification and environmental and non-environmental condition in the process of the assessment and the choice of relevant aspects; prepared by the authors of this publication.

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