

## THE EFFECTIVENESS OF ENVIRONMENTAL MANAGEMENT IN A METALLURGICAL COMPANY'S SUSTAINABLE DEVELOPMENT

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In the article metallurgy enterprises are being characterised, taking into account, in particular, the environmental management systems as well as the effects of their introduction, on the example of Ferrum SA. In the first part of the article the environmental management system and the applied production technologies in metallurgy enterprises are characterised. In the second part the effects of environmental management systems introduction are presented, based on the published environment reports of the enterprise in the years 1990-2007. In the last part the attention was turned to the future aspects connected with the development of environmental management systems. The issue was summarised in the end.

*Key words:* cleaner production strategy, environmental management system, metallurgical company

**Djelotvornost upravljanja okolišem kod održivog razvoja metalurške tvrtke.** U članku se navode značajke metalurškog poduzeća, posebice uzimajući u obzir, sustave upravljanjem okolišem, kao i posljedice uvođenja sustava zaštite okoliša, na primjeru poduzeća Ferrum SA. U prvom dijelu članka navode se značajke sustava zaštite okoliša i primijenjene tehnologije proizvodnje u metalurškom poduzeću. U drugom dijelu članka su prikazani učinci uvođenja sustava upravljanja okolišem, a temeljem objavljenih izvješća o utjecaju na okoliš poduzeća u razdoblju 1990-2007. U posljednjem dijelu pozornost je okrenuta prema aspektima u budućnosti vezane uz razvoj sustava upravljanjem okolišem. Na kraju je dan zaključak provedene analize.

*Ključne riječi:* strategije čiste proizvodnje, sustav upravljanja okolišem, metalurška tvrtka

### INTRODUCTION

Metallurgical companies, driven by the need to meet market demands and the quickly changing environment, carry out actions that enable them to reduce their negative environmental impact. The environmental management systems increasingly become an integral part of a company management. The systems introduced by metallurgical companies are based not only on the ISO14001 standard principles but also on EMAS regulations as well as on the international Cleaner Production programme. The environmental management system is based on the assumption that environment management is crucial for the improvement of both the environment and the company's profit. The implementation of environmental management system ideas in metallurgical companies requires a modification of manufacturing processes management and auxiliary functions. The achievement of environment-related goals consists in the identification and elimination of negative environmental impact or their systematic reduction. The environmental management systems necessitate the application of the best available technique (BAT). The tech-

nique makes it possible to use the environment in a rational manner and leads to cleaner production [1]. The EMAS system, ISO 14001 standard and the international Cleaner Production programme are all different means of applying the corporate sustainable development concept. In general, sustainable development ensures a balance between a company's economical and environmental and social targets. The concept is realized through a number of strategic and operational activities such as the Cleaner Production strategy, rational resources and space management, waste reduction procedures, product eco design and the economical and environmental effectiveness assessment procedures. The sustainable development concept is about the creation of conditions for a gradual elimination of processes and actions that are harmful to the environment and people's health and promoting environment friendly management methods [1, 2].

### ENVIRONMENTAL MANAGEMENT IN THE MANUFACTURER OF WELDED STEEL PIPES

Ferrum SA was a pioneer in the Polish steel sector in terms of the Cleaner Production (CP) strategy implementation. At the beginning of 1990s, in order to meet the free market demands, the company implemented an

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industrial production management strategy based on economic principles and respect for environmental resources. By adopting the CP concept the company emphasises the need to reduce pollution "at the source" i.e. at the time and place of its generation. It does not exclude treatment (purification) but it is treated as a last resort, a solution that must be applied to waste that cannot be eliminated [3].

The CP strategy covers both the product manufacturing process and the services rendered throughout the whole life cycle of a product i.e. from the moment the need for a product appears until the product's recycling after the end of its working life (LCA). The integrated approach principle, which is the basis of sustainable development, means that the company needs to search for such solutions that would prevent the occurrence of any significant impact or threat to the environment and would lead to their reduction. The integrated approach required equal treatment of all three elements necessary for the performance of manufacturing processes: land (resources and waste), water (use and waste water) and air (demand for oxygen and the emission of gases).

The company signed the Cleaner Production declaration in 1992. In 1993 it joined a CP school. Three years later i.e. in 1996 Ferrum received the CP certificate. Since the beginning of 1990s Ferrum SA has been working towards the reduction of discharges to the environment and the achievement of environmental effectiveness. Already in 1990 the company started investments related to the application of methane from the Staszic Coal Mine in its boiler rooms. The investment led to the reduction of coal consumption by 50 %. In 1993 4 Mm<sup>3</sup> of methane were used. In the years that followed the amount of methane used was on the increase reaching 7,8 Mm<sup>3</sup>. The subsequent investments and modernization resulted in the reduction of waste, reduction of electricity, heat and water consumption in the technological processes. As a consequence of those investments and technology-related changes the company succeeded in creating products that meet international standards and are manufactured with the use of energy efficient technologies and eliminate pollution at the source. A consistent transformation of the company's management, based on the best available technique enabled it to receive the Cleaner Production Prize in 1996. In 2000 an environmental management system, in compliance with ISO 14001, was implemented by the company and certified by an independent institution. The basic principles of the environmental policy applied by the company are based on the application of the best available techniques in company development plans and reduction of its negative impact on the environment in terms of the air, waste management and resources and space management [3].

In order to limit its negative impact on the environment the company carried out modernization invest-

ments that included, among others, the technological process of spirally welded steel pipes (1995), the thermal cutting process in the production of welded structures (1996), rail transportation on the site (1996), a line for internal cement lining of pipes (1998), heat production process (a concept from 1998), a line for high frequency induction welded steel pipes (1999). Moreover, the company's energy balance was improved through the installation of new, energy efficient compressors [3, 4].

## TECHNOLOGICAL INVESTMENTS IN FERRUM SA

Ferrum SA's key investments included: the modernization of the thermal cutting process in the welded structures production and the investment of the high frequency induction welded steel pipes line. The investment no 1 was realized as in Welding Department, now (2002) it is a separated firm but in ZKS Ferrum SA. While carrying out the former, an important stage of the programme was the alteration of the half-finished product preparation work station in the welding department. The manual operations of laying, laying out and making structure elements were replaced by micro-computer controlled automatic devices. The welding shop is used to produce a wide assortment of welded structures, pressure vessels, containers for liquid fuels including environment-friendly containers with a double-layer wall. The basic raw material for the production of the particular products is carbon sheets and low-alloyed sheets out of which the following are cut: rollers, rings, flanges, brackets, core grids and others. Manual production of the said elements led to the generation of unnecessary waste in the amount of approx. 15 % of the starting material. Moreover, manual laying out and centre-punching was a source of noise that exceeded the acceptable limits for a work station. It also needs to be noted that the resulting products were of a relatively low quality: the cuts on the surfaces were inaccurate and therefore mechanical processing with the use of manual grinders was applied. The development and modernization and the thermal cutting technology resulted in a full automation of the process. In every process, computer-controlled devices were put to use to perform sheet cutting by gas or plasma. They were capable of precise and optimal cutting of the required elements of any shape or in any number [5].

The subsequent technological investment concerned the upgrading of the high frequency induction welded steel pipes line. After investment Ferrum could manufacture small diameter pipes. Besides after the investment was complete the technology was replaced by high frequency induction welding. The assortment of products on offer was modified and the pipe expander, which was the source of toxicity category 2 waste i.e. scale, was removed [6].

Table 1 Environmental and economical effects of the CP system implementation in Ferrum SA [4]

Detailed data	Unit	YEAR			Environ-mental effect (t <sub>0</sub> - t <sub>6</sub> )
		1990 (t <sub>0</sub> )	1993 (t <sub>3</sub> )	1996 (t <sub>6</sub> )	
Solid waste	Mg /year	15 000	1260	1000	↓ 14000
Liquid waste and waste water	m <sup>3</sup> /year	400 000	208 000	170 000	↓ 230 000
Water consumption	m <sup>3</sup> /year	528 000	275 000	220 000	↓ 308 000
Gas and dust waste emission	Mg / year	650+70	255+15,4	90+12	↓ 560+58
Electricity consumption	GJ / year	73 663	66 916	68 400	↓ 5263,2
Thermal energy consumption	GJ / year	233 900	229 000	250 000	↑ 16 100 *
Economical effects	EUR /year	-	-	143 000	↑ 143 000

Legend: decrease ↓, increase ↑; \*- lack of environmental effect

### EFFECTS OF THE CP PROGRAMME IN FERRUM SA

For the purpose of this analysis, statistical data for the years 1990-1996 were compared. The year 1990 was the base (t<sub>0</sub>) – the situation at the company prior to the CP strategy implementation. Data regarding the company's discharges to the environment in 1990 were compared with data from 1993 (the company joins the CP school) and 1996 (the company is awarded the CP certificate). The environmental effects are shown in Table 1.

The data presented in the table shows that the CP implementation already in the first years after its commencement, brought about environmental effects in a significant reduction of the amount of generated waste, waste water and air pollution. The company managed its water and energy resources in a reasonable manner. As a result, the CP strategy implementation contributes to economical savings in the amount of EUR 143 thousand. In the years that followed the amount significantly increased. In 1997 it reached EUR 0,28 mln whereas in 1998 it increased five-fold to EUR 1,47 mln [4].

### EFFECTS OF ENVIRONMENTAL MANAGEMENT IN COMPLIANCE WITH ISO 14001 IN FERRUM SA

In November 2000 Ferrum was awarded the ISO 14001 certificate for the environmental management

system's compliance with the standard. For the purpose of this analysis the year 2000 was the base (t<sub>0</sub>). As part of the system several environmental programmes were carried out. Environment-related expenses reached a few million € Euro (in 1999 EUR 6.43 mln was spent, in 2000 – EUR 54 thousand). Table 2 shows environmental effects of environmental management in Ferrum SA. [4, 7].

The implementation of environmental system and investments has contributed to a reasonable waste management, over 98% of generated waste is now recycled and re-used. The water and waste water management has improved significantly. In 2007 as compared with 2000 data, effectiveness reached 43% because the water consumption for production purposes and the amount of waste water was reduced. Data analysis also shows a decrease in air pollution emissions. In 2007 electricity and thermal energy consumption for production and service purposes was also reduced. Moreover, in 2007 the company generated 3 624 GJ of thermal energy for sale to other consumers on the market [5, 8]. For the purpose of this analysis the rate of generated waste and waste water as well as water and energy consumption rate per 1 Mg/products was calculated (Table 3). The calculations indicate that both generated pollution and resources consumption per 1 Mg of products systematically decreases. It is evidence of the effectiveness of the company's operations towards environment protection and sustainable development.

Table 2 Environmental effects of environmental management in Ferrum SA [4]

Detailed data	Unit	YEAR			Environmental effect (t <sub>0</sub> - t <sub>7</sub> )
		2000 (t <sub>0</sub> )	2005 (t <sub>5</sub> )	2007 (t <sub>7</sub> )	
Solid waste including recycled waste	Mg /year	8 300	3 756	4 897	↓ 3 403
	Mg /year	6 900	3 676	4 816	share in total waste t <sub>7</sub> =98,35%
Liquid waste and waste water	m <sup>3</sup> /year	70 000	50 000	40 000	↓ 30 000
Water consumption	m <sup>3</sup> /year	73 000	53 000	45 000	↓ 28 000
Gas and dust emissions (excluding CO <sub>2</sub> )	Mg /year	32,1+4,4	31,05 +6,4	22,4 +3,2	↓ 9,7+1,2
Electricity consumption	GJ/year	48 121	36 385	47 206	↓ 915
Thermal energy consumption	GJ /year	118 791	70 400	65 340	↓ 53 451

Legend: decrease ↓, increase ↑;

Table 3 Pollution emission and waste rate per 1Mg/products in Ferrum SA [5]

Detailed data	Unit	YEAR		
		2000	2005	2007
Production output	Mg	68 544	78 552	76 400
Solid waste	Mg / year	0,12	0,047	0,064
Waste water	m <sup>3</sup> / year	1,021	0,636	0,523
Water	m <sup>3</sup> / year	1,065	0,674	0,589
Electricity	GJ / year	0,702	0,461	0,616
Thermal energy	GJ / year	1,733	0,896	0,855

### PROBLEMS WITH TRANSPORT ASPECTS IN METALLURGY ENTERPRISES

A well functioning environment management system should be constantly developed. One of the main elements leading towards the development is a new identification of the environmental aspects [9]. The identification of the environmental aspects connected exclusively with the production process is not enough. In case of metallurgical enterprises the problem of the pollution is becoming more and more visible, these are the fumes, dusts or noise connected with inner transport (movement of the materials and migration of people connected with organisation of production) as well as outer transport (for example, delivery of the materials necessary for functioning of the enterprise). Due to that fact new environmental aspects occur, which will have to be included in the environment management system in the future.

### CONCLUSION

The Cleaner Production (CP) strategy implemented by Ferrum SA has contributed to the reduction of negative environmental impact, reduction of air pollution and waste products. The principles of reasonable natural resources management were also developed. The company in question operates in compliance with the sustainable development concept which is corroborated by the data presented above. The high environmental effects are guaranteed by the Environmental Management System (EMS) accordance to ISO 14001 and strategy of CP.

The process of environmental management consists in the search of possibilities of reducing the products' negative environmental impact in all stages of its life

(design, production, use, after use processing). The rationalization of metallurgical products is conducted through, among others [8]:

- reduction of energy consumed during manufacturing processes by the introduction of new, less energy-consuming manufacturing technologies,
- reduction of the amount of raw materials used by the introduction of less material-consuming technologies,
- reduction of water consumption in manufacturing processes (closed water cycles),
- reduction of the amount of waste water generated,
- reduction of the amount of waste at every stage of the product's life cycle (waste management, reduction of hazardous waste),
- reduction of air pollution,
- modernization of the heating system (savings of heat, renewable energy sources),
- modernization of the transportation system,
- improvement of work organization.

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**Note:** Translated at Niuans Translation Agency – Gliwice, Poland. All information's about the enterprise Ferrum SA was accepted by its manager.