

ENVIRONMENTAL ASSESSMENT OF THE HOT-DIP GALVANIZATION PROCESSES

Received – Prispjelo: 2016-04-22
Accepted – Prihvaćeno: 2016-08-30
Preliminary Note – Prethodno priopćenje

Processes of the hot-dip galvanization, refraining from application of dangerous chemical substances together with the necessity of ensuring the high temperatures, both pose a special threat to the environment. Therefore, the subject of analysis was environmental impact of the hot-dip galvanization process. Here has been done the identification and the assessment of the environmental aspects as well as has been pointed at the key-aspects requiring the special supervision. The developed assessment methodology can be applied by each of the organization wanting to master the processes by minimizing their environmental influence.

Key words: zinc, coating, hot-dip galvanization, environmental aspects and impacts

INTRODUCTION

The technologies being applied within the metal industry – regardless the production is of the metallurgical character or concerns the metal and alloy processing – posing the threats especially for the environment [1]. One of the most applied and the most economical process, which protects steel against corrosion is hot-dip galvanization processes [2, 3]. Structure, and at the same time features of the zinc layer, mainly depend on the technological parameters of the process, and especially on the following: chemical composition and temperature of the zinc bath, pickling bath and flux [2-5].

Ensuring these parameters, especially the high temperatures of the bath with the aggressive chemical composition, is extremely troublesome for the environment [6, 7].

Therefore, it is so crucial to define the impact of these processes on the environment and taking up the actions aiming at minimizing it.

Such an assessment should cover the identification of the environmental aspects and impacts, their assessment and defining the meaningful environmental aspects. Within the range of assessment, the organization should take into consideration the following ones: possible damages for the environment, its sensitivity, size, number, frequency and reversibility of the aspect or impact as well as the legal requirements [8].

Tools for aspects assessment are not directly defined, therefore, the particular organization can develop the assessment methodology as well as define own criteria for environmental aspects assessment [9, 10].

Taking into consideration the above stated as the analytical aim, one has approved the environmental as-

pect assessment in the hot-dip galvanization processes together with the application of the developed methodology.

METHODOLOGY

The developed research methodology enables the assessment of environmental influence of processes with the application of environmental risk assessment evaluation matrix. It covers the assessment of environmental impact occurrence probability as well as the environmental impact significance assessment, and next estimation of the environmental risk value expressed by the five-degree-scale.

As the environmental aspect one has defined: "element of an organization's actions or products or services that can interact with the environment [8]", on the other hand, the environmental impact has been defined as: "any change to the environment, whether adverse or

Table 1 **Comparison of the guidelines for the estimation of the environmental impact occurrence – O.**

O	Criteria of the estimation
impossible (1)	occurrence of the environmental impact improbable, there have never been any impacts connected with the similar processes
low (2)	occurrence of the environmental impact of little probability, rare short-time cases of the environmental aspect occurrence linked with the similar processes
moderate (3)	occurrence of the environmental impact probable, there have been cases of the environmental impact occurrence
high (4)	occurrence of the environmental impact highly probable, there have been cases of the long-lasting and numerous environmental impact occurrence
very high (5)	occurrence of the environmental impact almost unavoidable, the environmental impact occurrence is always present

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Table 2 Comparison of the guidelines for the estimation of the environmental aspect and impact significance – S.

S	Criteria of the estimation
very low (1)	insignificant-area, quality and quantity contamination of environment, almost immediate back to the original balance condition; environmental aspect constantly controlled, environmental aspect undergoes the steering; lack of the legal regulations applying in the range of the environmental aspect
low (2)	area-insignificant contamination of environment, violation of the environmental balance, reversible in the natural way, within the short time after the environmental aspect occurrence; environmental aspect constantly controlled, environmental aspect undergoes the steering; the legal regulation exists and it is always fulfilled
moderate (3)	area-significant contamination of environment, violation of the environmental balance, reversible only due to the interference of human; the control actions brings little or any chance for steering this environmental aspect; the legal regulation exists and there have been cases of the non-fulfillment of it
high (4)	contamination of the environment, amount, quality, area-significant; serious degradation reversible only due to the heavy interference of human; environmental aspect rarely controlled, the control actions of low effectiveness, non-steerable aspect; the legal regulation exists and there is high probability of exceed
very high (5)	area-significant, total degradation of the environment; environmental aspect not undergoing any of the control actions, non-steerable environmental aspect; the legal regulation exists but it is never fulfilled

Table 3 Matrix of the environmental impact assessment – EI.

Environmental impact probability of occurrence - O	Environmental impact significance - S				
	very low (1)	low (2)	moderate (3)	high (4)	very high (5)
impossible (1)	very low (1)	very low (2)	low (3)	moderate (4)	moderate (5)
low (2)	very low (2)	low (4)	moderate (6)	moderate (8)	moderate (10)
moderate (3)	low (3)	low (6)	moderate (9)	high (12)	high (15)
high (4)	moderate (4)	moderate (8)	high (12)	high (16)	very high (20)
very high (5)	moderate (5)	moderate (10)	high (15)	very high (20)	very high (25)

beneficial, wholly or partially resulting from an organization's environmental aspects [8]".

The number describing the probability of environmental impact occurrence, with taking into consideration all of the preventive actions, has been named the occurrence priority number (O) and it has been ascribed value 1-5. The guidance indispensable for the occurrence assessment has been compared in Table 1.

The number describing meaning of the environmental aspects results has been named as the significance priority number (S) and it has been ascribed value 1-5. The guidance indispensable for the number assessment has been compared in Table 2.

Environmental impact (EI) of each of the environmental aspects has been evaluated based on the environmental risk assessment matrix – Table 3.

Acceptability of the environmental impact has been defined based on the EI value:

- 1 ÷ 10: very low ÷ moderate – acceptable (A),
- 12 ÷ 16: high – acceptable under control (CA),
- 20 ÷ 25: very high – non-acceptable (NA).

RESULTS IN HOT-DIP GALVANIZING PROCESS

The prepared methodology has been applied for the assessment of environmental influence of the hot-dip galvanization processes, together with taking into consideration the following operations: pickling with the hydrochloric acid solution, rinsing, fluxing with the zinc and ammonium chloride and glycerin, drying and hot-dip galvanization in bath.

One has identified the potential environmental aspects, among which the following have been the specific ones:

- metal-pickling waste water and rinsing liquids,
- risk of the industrial accident, connected with application of the pickling bath, metal-pickling waste water and flux,
- waste water as used-up flux,
- consumption of zinc and other resources,
- emission of hydrochloric acid and zinc in the particulate matter,
- emission of the particulate matter, sulphur dioxide, nitrogen dioxide, carbon monoxide,
- occurrence of the waste both as a steel and zinc scrap, and the municipal ones,

Table 4 Comparison of the results of chosen environmental impacts' assessment in the hot-dip galvanizing process.

Environmental aspect	Environmental impact	O	S	EI	A
zinc combustion	decrease of the natural sources	5	2	10	A
industrial accident – metal-pickling waste water and rinsing liquids	uncontrolled pollution of the soil	1	5	5	A
emission of the nitrogen dioxide	pollution of the air with the nitrogen dioxide, acid rains and soil acidification	5	3	15	CA
occurrence of the waste – as a steel and zinc scrap	storage before recycling	5	1	5	A
energy intake	using-up the natural sources	5	2	10	A

- energy and water intake,
- noise emission.

For each of them one has defined the occurrence priority number and the significance priority number, and next – using the evaluation matrix – one has defined the environmental risk and its acceptability. The results of the carried out analysis have been presented in the Table 4.

CONCLUSIONS

The presented methodology of environmental aspects assessment can be the tool for environmental improvement of processes by being the base of minimizing or eliminating their negative influence on the environment.

Application of the developed methodology within the range of the analyzed process has confirmed that it poses especially high threat in the scope of environmental influence.

The most meaningful, from the point of view of environmental impacts, are the aspects connected with the following:

- producing the metal-pickling waste water and rinsing liquids, being the effect of pickling in the acid solutions and resulting in water and soil contamination,
- emission of the particulate matter, sulphur dioxide, nitrogen dioxide, carbon monoxide, being the effect of heating-up the pickling and zinc bath and resulting in pollution of the air, acid rains and soil acidification.

For the pointed environmental aspects, value of the environmental impact ratio was $EI = 15$. At the same time, the environmental impact has been defined as the high and acceptable after the application of the supervision means limiting the environmental risk.

The results of the carried out assessment represent the confirmation of meaningful threat for the environ-

ment and represented by the galvanization process. Simultaneously, the results are the base for pointing these environmental aspects as the meaningful in the galvanization process and which should be under the special control.

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Note: The professional translator responsible for English language is Dominika Wnukowska, Katowice, Poland