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Determining the best practicable control technology and its associated emission levels for Iron and Steel industry in Iran

Maryam Mahjouri[a,*], Mohd Bakri Ishak[a], Ali Torabian[b], Latifah Abd Manaf[a], Normala Halimoon[c]

[a] Department of Environmental Planning and Management, Faculty of Environmental Studies, Universiti Putra Malaysia, Serdang, Malaysia
[b] Department of Environmental Engineering, Faculty of Environment, University of Tehran, Tehran, Iran
[c] Department of Environmental Sciences, Faculty of Environmental Studies, Universiti Putra Malaysia, Serdang, Malaysia

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ABSTRACT

Industrial effluent limitations should be established regarding the special characteristics of each sector with emphasis given to the local context, whereas, in Iran, a uniform "Wastewater Effluent Standard" is employed throughout the country in which no specific industrial effluent limitations have been considered. This gap highlights the essential need for a transparent and scientifically proven methodology for determining effluent emission limit values (ELVs) at the sector level. In this research, an integrated approach is proposed based on the application of the Best Practicable Control Technology Currently Available (BPT) concept. The modelling framework includes a series of sequential steps comprising two main sections: 1. identifying the effluent emission datasets, and 2. computing the emission levels associated with the BPT (BPT-AELs). To identify the datasets, the methodology follows two different procedures: 1. a detailed analysis of the environmental performance of this sector in the country to determine the plants reflecting BPT, and 2. screening their emission datasets through statistical analysis. The Best Available Techniques (BAT) principle is employed as a reference element for determining the best representative plants, and the results indicate that corrective measures in accordance with the BAT considerations should be implemented in many of the plants under consideration. The comparison of the derived BPT-AELs with the existing standards show that they are mainly lower than the standard levels and are reasonable estimations for the involved parameters. Conclusively, this methodology presents a reliable and practical stepwise process at the sector level, which can be developed for other industries.

1. Introduction

Nowadays, the pollution prevention and reduction is considered as a key element in sustainable water and wastewater management. Environmental regulations, such as direct regulation or "command and control", can efficiently reduce pollution. This type of regulation forces dischargers to adapt to new environmental changes by setting specific standards and limits on performance and/or requirements about the adoption of technologies and processes, and, ultimately, by checking their compliance with regulations through inspections and controls (Camisón, 2010; Testa et al., 2014).

In the European Union, a flexible "command and control" regulation has been introduced in the Integrated Pollution Prevention Control (IPPC) Directives for the most significant industrial and agricultural sources of environmental impacts. The main purpose of these directives is to minimize or prevent pollution through the establishment of an integrated pollution prevention and control system (López-Gamero et al., 2009; Testa et al., 2014). The IPPC approach emphasizes the prevention of pollutant generation or where that is not feasible, reducing pollutant generation (end-of-pipe techniques) (Frost, 2009). The key concept in these directives is the Best Available Techniques (BAT), which is applied as a basis for the determination of emission limit values (ELVs). BAT includes a combination of at-source and end-of-pipe techniques (Frost, 2009). Since BAT should be compatible with country-specific conditions and priorities (Schollenberger et al., 2008), the IPPC directive does not prescribe any particular technology in the sector under consideration (Bréchet and Tulkens, 2009; Giner-Santonja et al., 2012) and only a few methodologies correspond exactly to the IPPC requirements and the BAT definition (Laforest, 2014). Thus, the candidate-BAT techniques should be assed in real context and situation (Kalbar et al., 2012; Giner-Santonja et al., 2012; Bugallo et al., 2013; Testa et al., 2014). In this approach, the Best Practicable Control Technology Currently Available (BPT) is determined based on the actual technological set-up and the prevailing structure in the well-managed plants of the industrial sector. Since BPT presents the real image of the pollution prevention and reduction techniques in the country, the

* Corresponding author.
E-mail address: mmahjouri2000@yahoo.com (M. Mahjouri).

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emission levels associated with the BPT, called BPT-AELs, can be recommended as a practical limit at the sector level and applied, by policy makers, in determining national ELVs, without exceeding the BPT-AELs.

In fact, ELVs have to be determined with respect to different characteristics of the plant. Generally, few methods for deriving ELVs have been described in the literature, and, even in the IPPC directives and documents, no details are provided concerning how the emission data analysis should be done to select the ELVs (Carretero et al., 2016). Among the few related researches, Polders et al. (2012) proposed a stepwise methodology in the context of the BREF process. It was based on a detailed analysis of emission data for several industrial sector in the Flemish region of Belgium. However, their study relied a large extent on high quality and quantity emission data and background information on the selected industrial installations especially those applying BAT.

It is clear that, in developing countries, the concept of water and wastewater management is not identical to that in developed countries (Ragas et al., 2005; Kathuria, 2006; Von Sperling, 2008). Hence, the approach to standard setting and the final derived effluent standards should be in accordance with local considerations. In Iran, discharging effluent should be in accordance with the "Wastewater Effluent Standard", which is defined as a maximum concentrated pollution of 52 parameters for three points of discharge, i.e. surface water, absorbent wells, and water used for agriculture and irrigation. This uniform set of effluent limitations is applied regardless of the wastewater characteristics, type of pollution resources, and the environmental quality of the receiving area. In this standard, there is no separate industrial effluent standard, and, hence, it is obviously crucial that one be developed.

The main objective of this research is to determine ELV thresholds in line with the BPT. Therefore, the emphasis is on the environmental performances of the related plants regarding the technical, economic and environmental characteristics of the country. For this purpose, the BAT concept is applied to identify the best current environmental performances, and, as a result, the reference plants in the real context which have to be involved in establishing the ELV approach. The application of this approach was examined by a case study of the Iron and Steel industry in Iran. This industry plays a key role in the country's economy and is considered as one of the most strategic sectors in the country. According to the World Steel Association report (2015), Iran is ranked 14th among the major steel producing countries in the world and is currently the top steel producer in the Middle East. The annual steel production is predicted to reach 55 million tons with the ranking of 11 or 12, in the next few years. This fundamental role along with its drastic growth highlights its importance in sustainable development and the need for the effective prevention and reduction of industrial pollution.

This study follows two different but complementary procedures: 1. analysing the BPT in the Steel industry in Iran and identifying the emission datasets, and 2. determining the BPT-AELs. Accordingly, the paper is organized as follows. Firstly, Section 2 introduces the methodology in detail. Then, Section 3 presents a real case-study of the steel industry to which the methodology has been applied and a discussion of the main findings, and, finally, Section 4 concludes with the implications of this approach.

2. Method

Determining the accurate and defensible country-specific BPT-AELs for the Iron and Steel industry needs a detailed analysis of the sector's environmental performance and its long-term effluent data. This consists of a series of sequential steps which are described in the following paragraphs.

2.1. Analysing the Iron and Steel industry

A profound knowledge of the Iron and Steel industry is required to start the procedure. The European Commission, through the European IPPC Bureau, publishes reference documents for different IPPC sectors (mainly industrial and farming) that contain a description of the main processes, environmental aspects and the associated list of BATs, called Reference Documents on Best Available Techniques (BREF) (Giner-Santonja et al., 2012). The BREF documents are designed to help national policymakers determine BATs and BAT based emission limits (Bréchet et al., 2009). Up to now, thirty-two BREFs and seven BAT conclusions have been adopted under the IPPC directive (Carretero, 2016; European Commission, 2015). Therefore, in this research, the BREF documents related to the Iron and Steel sector (European Commission, 2001; Roudier et al., 2013) were considered as references for familiarization with the operations of this industry.

2.2. Selecting the reference plants

In general, this sector can be divided into two main categorises: Iron and Steel Production and the Ferrous Metals Processing Industry. In Iran, there are more than 130 plants with at least a 30,000 ton capacity. But, among these plants, 12 units are noticeably more important than others. According to Iranian Mines and Mining Industries Development and Renovation Organization (IMIDRO, 2015), their product contributions in Iron and Steel Production and Ferrous Metals Processing Industry are 89 and 69 per cent, respectively (Table 1). Therefore, these plants are considered to be the most representative in Iran's Iron and Steel industry.

On the other hand, the Iron and Steel Production section, in terms of its particular industrial processes, is divided into two main categories: a) Blast Furnace and b) Direct Reduction (DR) followed by Electric Arc Furnace (EAF). Iran is ranked as the second major steel producer by DR in the world and only one plant uses a blast furnace. Therefore, in this research, the priority was given to the main and most commonly used system in the country namely DR and the plant with the blast furnace, Esfahan Steel Company, was excluded. Furthermore, among these 12 plants, two facilities have specific products, one of which only produces galvanized sheets and strips for the automotive industry and the other produces alloys and special steels. Hence, with respect to the prevailing structure of this sector in the country, nine plants were identified as being the most representative installations.

2.3. Analysing the BPT and identifying its related plants

BAT is a major reference point that should be identified at the sector

Table 1
The production contribution percentage of Iron and Steel Production plants and Ferrous Metals Processing plants in Iran.

Ferrous Metals Processing plants	%	Iron and Steel Production plants	%
Esfahan's Mobarakeh Steel Co.	31	Esfahan's Mobarakeh Steel Co.	33
Esfahan Steel Co.	15	Khuzestan Steel Co.	21
Khuzestan Oxin Steel Co.	5	Esfahan Steel Co.	16
Saba Steel Co.	4	Hormozgan Steel Co.	7
Iran National Steel Industrial Group	4	Saba Steel Co.	5
Khorasan Steel Co.	4	Khorasan Steel Co.	4
Ahwaz Rolling and Pipe Mills Co.	2	Iran Alloy Steel Co.	2
Iran Alloy Steel Co.	2	Iran National Steel Industrial Group	1
Azarbaijan Steel Co.	1	Others	11
Chahar Mahal & Bakhtiari Automotive Sheet Co.	1		
Others	31		