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Choosing cleaner and safer production practices through a multi-criteria approach

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ABSTRACT

Through the international (Convention) and European (Industrial Emissions Directive) legislations, industries have to apply preventive measures according to the Best Available Technique (BAT) concept or cleaner production (CP) strategies. Many technical solutions exist to conform, but the major stake is to assess the overall effect or impact of the implementation of a technique on the installation. Several methods have been developed based on LCA or carbon balance methodologies, but they lack the technical, economical and social criteria, which are aspects that should be taken into account when choosing cleaner and safer production practices. This paper presents a decision-making tool based on a multi-criteria analysis approach, likely to encourage manufacturers to implement cleaner and safer production practices in the metal finishing sector. First, a systemic analysis of the industrial facility and its environment is used to identify 15 criteria structured in a hierarchical pattern. These criteria represent the targets which could potentially impacted by a cleaner and safer production practice: for example, water, soil, air, but also the environment of the workstation of an operator, the production processes, etc. Using these 15 criteria, users can then assess up to 86 practices selected in particular in the BREF report dealing with Metal Finishing. Thus, this tool enables the practices the most adapted to a particular company to be chosen not only on financial criteria, but also on a social, environmental and technical view.

1. Introduction

With a view to restoring the balance of production – consumption/health – environmental, the concept of cleaner production was introduced by the United Nations Environment Programme (UNEP) in 1989 in response to the logic of sustainable production and consumption (UNEP, 2001). This concept became a program of action with two specific objectives:

- Improving eco-efficiency of production in the short and medium term (one might see this as an optimization of production systems using current technical knowledge) and,
- A long-term dematerialization

Globally, the process of adopting cleaner technologies is part of the sustainable development policy defined in Agenda 21, adopted in Rio de Janeiro in 1992, in that it promotes and encourages the adoption of new manufacturing processes that make scale economies of both raw materials and energy, and are cleaner with regard to environmental protection and adjacent populations.

Agenda 21(UNCED, 1992) whose overall goal is to "restructure the decision-making process to fully integrate socioeconomic and environmental issues and get a wider public participation" (art. 8.3), defined in Chapters 30 and 34, on the one hand, the role of industry and trade for sustainable development (i.e. in promoting cleaner production) and, on the other hand, their principles of Action to achieve this.

In addition, Section 34 on the Transfer of environmentally sound technologies, cooperation and capacity building defined as a favoured policy the transfer of "environmentally sound technologies" (awkwardly translated "environmentally sound" or "ecotechnologies" in French). They are linked, by definition, to the principle of promoting the use of prevention technologies and therefore cleaner technologies, but they covered end-of-pipe solutions. Nevertheless, they are considered as a fundamental mechanism of a cleaner and sustainable development.

For more than 15 years, high polluting industries are concerned by a European directive on Integrated Pollution Prevention and Control, also known as the IPPC directive. On November 24, 2010, the

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European Parliament adopted the Directive 2010/75/UE relative to the Industrial Emissions (IED). Integrating six previous directives, it includes nowadays the IPPC Directive. General principles of the IPPC directive have been retained for the IED, notably concerning the integrated approaches, the flexibility principle, the participative principle and the key principle of the use of the performance of Best Available Techniques (BAT).

Despite the evolution of the European regulation (from IPPC to IED), priority is given to the reduction at the source as much as possible by taking into account the specificity of the organisation and the media in which it is implemented. One theoretical concept assigned to the application of the priority of the IED is the concept of cleaner production (CP) (Laforest, 2008; Polders et al., 2012).

Moreover, none methodology is proposed to help decision makers in the choice procedure of cleaner production strategy. After having presented the context, the existing methodology and the multi-criteria theory, this article proposed to present a multi-criteria analysis method to support industrialists in their decision procedures.

2. Best available techniques, cleaner production strategies and their assessment procedures

The principle of best available techniques (BAT), as defined by the IPPC directive has become a significant issue for the industry to deal with, and the implementation of this Directive actually compels companies to apply BAT. The BAT principle is defined as being "the most effective and advanced stage in the development of activities and their methods of operation which indicate the practical suitability of particular techniques for providing in principle the basis for emission limit values designed to prevent and, where that is not practicable, generally to reduce emissions and the impact on the environment as a whole" (Directive, 2008).

The terms "best", "available" and "techniques" are detailed as follows:

- ➢ 'techniques' shall include both the technology used and the way in which the installation is designed, built, maintained, operated and decommissioned,
- ➢ 'available' techniques shall mean those developed on a scale which allows implementation in the relevant industrial sector, under economically and technically viable conditions, taking into consideration the costs and advantages, whether or not the techniques are used or produced inside the Member State in question, as long as they are reasonably accessible to the operator, and
- ➢ 'best' shall mean most effective in achieving a high general level of protection of the environment as a whole.

This definition is reinforced in Appendix IV of the IPPC Directive with 12 considerations to be taken into account for the selection of BATs. Unfortunately, this information does not seem to be sufficiently clear to be taken into account for the environmental performance assessment of techniques with regard to BATs.

Otherwise, the cleaner production principle involves the continuous use of industrial processes and products to increase efficiency and to diminish their impact on humans and the environment.

Both BATs and CP represent viable preventive environmental approaches for the reduction of pollution at the source. These two concepts are more or less the same. In application of the principles of cleaner production, the definition of BATs corresponds at first to prevention pollution techniques. Only when reduction at the source is not practicable, curative techniques (i.e. end-of-pipe techniques) can be considered as BATs (Polders et al., 2012). Then the greatest difference is that an end-of-pipe solution (for instance, a wastewater treatment plant) can be a BAT but not a CP strategy (Laforest, 2008).

Therefore, the concept of cleaner production applies to actions which aim at reducing pollution upstream of processes and services with a view to reduce the impact on man and the environment. The ability of cleaner production practices to decrease the pressure exerted on the environment by human activities, improve production processes and generate profit has already been demonstrated (Giannetti et al., 2008; Kjaerheim, 2003). However, and although clean technologies are really interesting, very few applications exist today, and manufacturers show very little concern for the environment (Laforest, 2008). A recent survey conducted with French managers of companies with less than 250 workers illustrated that even though they feel concerned by environmental protection (82%), 72% have not taken any action in this field and do not intend to do so (Gault, 2009). Both ignorance of environmental impact and the fact that impact assessment tools and decision-making tools are not readily available may account for such a disinterest in cleaner production strategies. According to Gault (Gault, 2009), the environmental decision-making stage very often depends on the manager's personal vision (52% of surveyed managers) (Kabongo, 2004). It is also mostly based on financial criteria.

And yet deciding to implement cleaner production practices covers a number of specific features

- A multi-criteria approach; cost is not the only decisive criterion. Other criteria such as the impact of the technology on water, the level of maintenance actions, or the working conditions are also essential to control the impacts of the technique used.
- Decisions are made by many actors who may not always agree, like the ordering party, manufacturers, experts, financers, and even customers.
- A large number of cleaner and safer production (CSP) practices do exist, relating to processes, products and how to implement them.

Today, many environmental assessment tools exist whose scope may exceed the physical limits of an industrial facility. For example, the Life Cycle Assessment methodology helps to quantify a set of potential environmental impacts all along the life of the system studied (ISO, 2006; Aissani, 2008; Styles et al., 2009; Valderrama et al., 2012). Other tools such as carbon balance or ecological footprint propose environmental performances from one single criterion which is the aggregation of a set of indicators. Nevertheless they take into account only environmental impacts even if social and cost criteria are starting to be implemented in some studies. Moreover, these method (LCA, carbon balance, ecological footprint) need a lot of data which are often not available for assessment notably the characterization factors. Then industrial operators have difficulties in assessing their impact as a whole through an integrated approach in terms of management procedures and technologies. Thus, operators need to identify other relevant, coherent, accessible and representative indicators within the general industrial context in order to identify an overall performance level.

Nevertheless, many methodologies have been developed to conform to the IPPC/IE directive (Geldermann and Rentz, 2004; Dijkmans, 2000; Barros et al., 2007). However each of them is focused on a specific activity because of the specificity of the organization of each production system.

Our contribution to all these existing methodology is first of all, to link, by the decision-making tool developed, cleaner production