



IBP1115_06 CLEANER PRODUCTION RESEARCH IN THE PETROLEUM INDUSTRY

Flávia B. B. Azevedo¹, Julio C. F. A. Wasserman²

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Resumo

Em 1989, a UNIDO (Organização das Nações Unidas para o Desenvolvimento Industrial) e a UNEP (Programa Ambiental das Nações Unidas) definiram o conceito de Produção Mais Limpa (P+L) como um conjunto de estratégias tecnológicas, ambientais e econômicas a serem integradas no processo industrial. O conceito foi baseado em mudanças no projeto industrial, produção, consumo e disposição dos produtos, mas também numa mudança de mentalidade. Os objetivos destas estratégias seriam promover a redução da produção de resíduos e utilização de material-prima, aumentar a eficiência energética e diminuir os impactos ambientais em todas as fases da produção e do consumo. Neste artigo foram selecionados e avaliados publicações de 1989 (ano da definição do conceito) até 2005 para determinar as áreas de relativa deficiência na pesquisa. Somente 41 publicações foram encontradas, dentre as quais 32 eram artigos publicados em periódicos, 6 eram artigos publicados em congressos, 2 eram notícias de revistas e 1 era uma monografia de especialização. Isto mostra a falta de estudos ou a falta de trabalhos publicados na área. A maior parte dos trabalhos abordava o P+L em refinarias. Devido à crescente preocupação da sociedade e de instituições internacionais com o meio ambiente e a saúde humana, as indústrias têm estudado cada vez mais sobre estratégias e tecnologias limpas. Porém estes trabalhos têm se concentrado em relatórios internos. Estas experiências precisam ser publicadas como artigos em periódicos avaliados por pares mais freqüentemente para serem mais divulgados e ganharem mais credibilidade.

Abstract

In 1989, the United Nation Industrial Development Organization (UNIDO) and the United Nation Environmental Program (UNEP) defined the concept of Cleaner Production as a set of economical, environmental and technological strategies to be integrated in the industrial processes. The concept was based on changes in the industrial project, production, distribution, consumption and disposal of products, but also on a change of mentality. The objectives of these strategies would be to provide the reduction of waste and raw material, the increase in energy efficiency and the decrease of environmental impacts in all phases of production and consumption. Peer-reviewed papers from 1989 (year of the concept definition) to 2005 were selected and evaluated to determine areas of relative research deficiency. Only 41 papers were found, among them 32 were articles published in periodics, 6 were conference articles, 2 were magazine articles and 1 was a monograph. This shows a lack of studies or a lack of published works in this area as a whole. Most of the papers focused on cleaner production in oil refineries. Industries have been studied clean technologies and strategies due to the increasingly concern of people and international institutions about health and environment, but this works are concentrated in internal reports. Those experiences must be published more frequently as peer-reviewed papers to have more credibility.

¹ Mestre, Bolsista – Universidade Federal Fluminense

² PHD, Professor Adjunto – Universidade Federal Fluminense

1. Introduction

There was a time when wastes generated by industries were discharged in water, air or soil without control. However with increase and development of industrial activities and consequent increase in waste generation, the society began to care about environmental health and to demand the industrial atmospheric emissions, solid wastes and water effluents control and treatment. The presence of an environmental thought in the industry became necessary, and then because of some serious accidents that happened in the last decades the search for environmentally sound practices, involving all employees of the industry, became crucial. Certifications like ISO 14001 were also created to certify that companies are complying with the legislation and looking for the continuous improvement of their practices (CEBDS, 2003). Throughout the time, however, even certified companies have realized that the costs of treating their wastes increased together with their production, so, they decided that better than thinking of “what to do with the wastes” is to think “what to do not to generate wastes” (CNTL, 2003b). In that way, improving the understanding of how the waste generation chain works, pollution control policies developed from the methods called “end of pipe” to the preventive ones.

As a result, in 1989 the United Nation Industrial Development Organization (UNIDO) and the United Nation Environmental Program (UNEP) defined the concept of Cleaner Production. Cleaner Production strategies are defined as preventives approaches in processes and products that allow the company development through loss minimization; raw material and energy reduction; energy efficiency improvement; and total minimization of environmental impacts in all phases of production and consume (Christie et al., 1995). The concept was based on changes in the industrial project, production, distribution, consumption and disposal of products, but also on a change of mentality. In 1991, UNIDO and UNEP started the Ecoprofit project (Ecological Project for Integrated Environmental Technologies) that aimed to economically strengthen industry through pollution prevention. This project encouraged countries to create National Centers of Cleaner Production (Centros Nacionais de Produção Limpa – CNTL, in portuguese) for helping their industries to implement cleaner production strategies, reaching economic benefits and reducing environmental impacts (Mello, 2002).

In July of 1995, UNIDO and UNEP chose the National Service of Industrial Apprenticeship (Serviço Nacional de Aprendizagem Industrial – SENAI, in portuguese), from Rio Grande do Sul, in Brazil, to host the 10th CNTL of the 23 implemented throughout the world. The CNTL/SENAI-RS aims to establish a net of institutions and experts with the objective of facilitating the exchange of information and technology among companies, allowing the incorporation of cleaner production techniques in their environmental management systems (CNTL, 2003b).

The objective of this work was to evaluate and determine areas of relative research deficiency about Cleaner Production through the assessment of peer-reviewed papers published about the subject.

2. Methods

The study was based on a comprehensive search of the literature available through the Periodicos.Capes database (<http://www.periodicos.capes.gov.br/portugues/index.jsp>), which offers access to complete articles from international, national and foreign periodics, national thesis and 90 databases with abstracts in all areas of knowledge. Searches for keywords and combinations of keywords were run with ISI Web of Knowledge, Compendex on Engineering Village, CrossRef Search, Wilson Web and Scopus™. Single keyword searches were performed using “clean(er) production”, “clean(er) technology(ies)” and “petroleum”, “refinery(ies)”, “oil and gas”. We acknowledge that much of the literature, particularly non-peer reviewed publications, may not have been covered by this search. However, the intention was really to obtain published scientific papers and hence access in what extend this subject is being exposed to a broader public and not only in industrial level.

Literature identified by the search was read and only those articles and thesis that talked exclusively about Cleaner Production (theoretical discussions about the theme or presentation of practical applications) were included in the database. Data obtained from each paper included year of publication, country or region where the research was carried out (when mentioned), type of publication (magazine article, journal article, conference proceedings or thesis) and area of application in the petroleum industry (refinery, petrochemical, offshore or general). Articles that discussed about the theme in international level or did not make clear the region of the research were classified as “general”.

3. Results and discussion

3.1. Trends in publication number and type over time and region of the world

The search revealed a total of 41 papers over the period from 1989 (year of the concept definition) to 2006. The majority of publications on Cleaner Production found was journal articles (Figure 1).

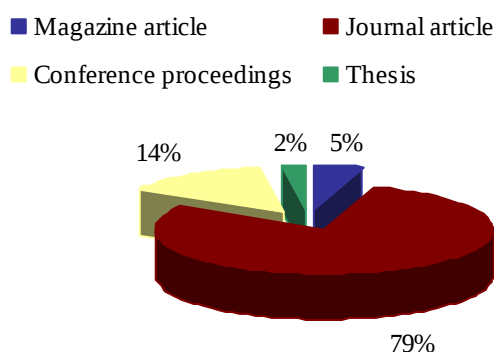


Figure 1. Relation among the number of different types of publications researched.

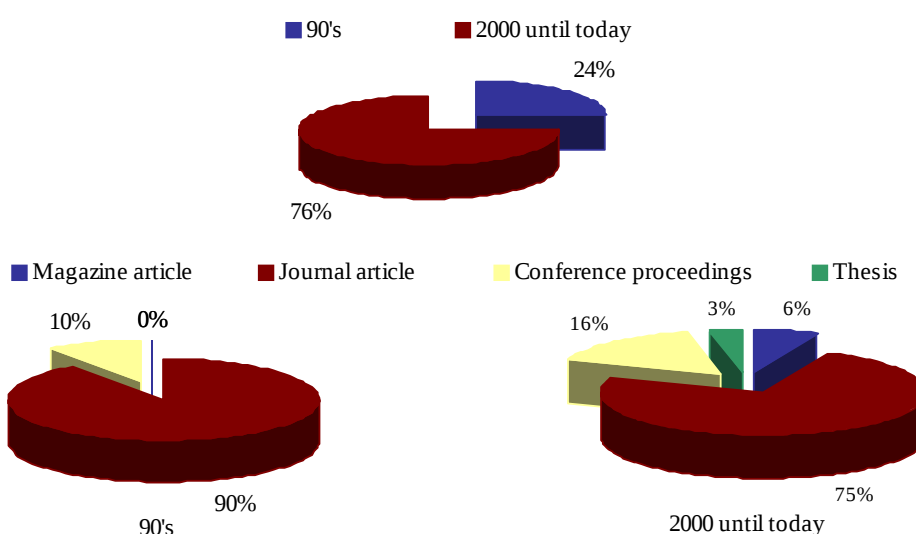


Figure 2. Number of publications through the decades.

Figure 2 shows that the number of publications increases through the years, from 2000 to nowadays three times more articles were published in relation to the whole 90's decade. The types of publications were also more diversified.

In relation to the regions of the world where the researches were carried out, the group named as "General" in Figure 3 corresponds to papers that did not specify the study area or have an international approach. It is interesting to verify that in the 90's most of the publications was concentrated principally in Europe and North America. However the majority of the works developed more recently was developed in Asia and there are also other regions starting to publish their researches. It probably reflects the recent advances in economy and technology faced by Asiatic countries, principally China: from the 7 papers of researches developed in Asia, 4 were from China.

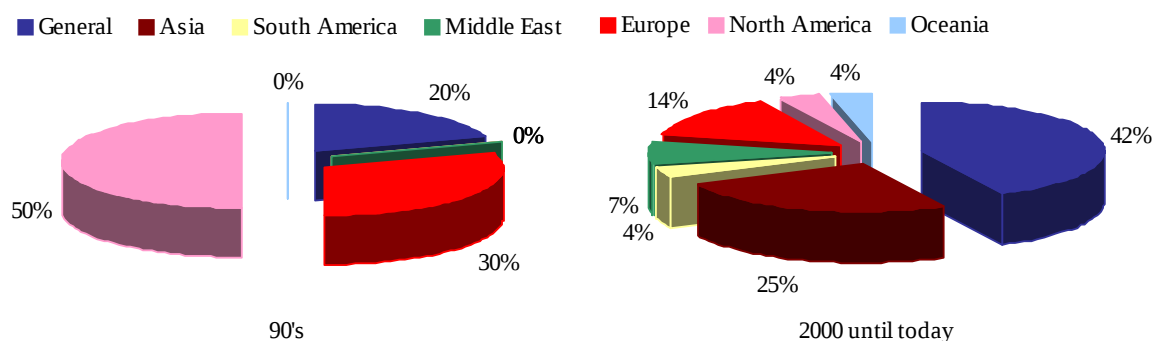


Figure 3. Number of studies in different regions of the world through the decades.

3.2. Area of application in the petroleum industry

The papers were categorized into 4 broad areas: general papers, refinery, petrochemical and offshore (Table 1). As can be seen from Figure 4, most of the publications was about refineries followed by the petrochemical area. But from 2000 on, papers that related refineries to Cleaner Production decrease in relation to the other areas. Studies in the offshore area appear and there is also an increase in the general papers, which includes here the ones that discusses about the oil and gas industry as a whole, without specifying a sector.

Table 1. Number of studies on Cleaner Production with topics in particular areas of the petroleum industry.

Area	Nº	Exemples
Refinery	23	Chen (2003); Furlong (2002); Gertler and Ehrenfeld (1996); Hall (1992); Sadhukhan and Simons (2005); Wang et al. (2004); Xu (2001); Zhang (2003); Zhang et al. (2001)
Petrochemical	8	Baas (1998); Englande Jr (1994); Hur et al. (2004); Shu et al. (2001); Tanimoto (2003); Zbontar and Glavic (2000)
Offshore	3	Gracey and Palmour (2001); Gurden and Cramwinckel (2000)
General	7	Al Nuaimi et al. (2004); Pavlinic et al. (2003); Sharfman et al. (1999); Ren and Zhao (2005)
Total	41	

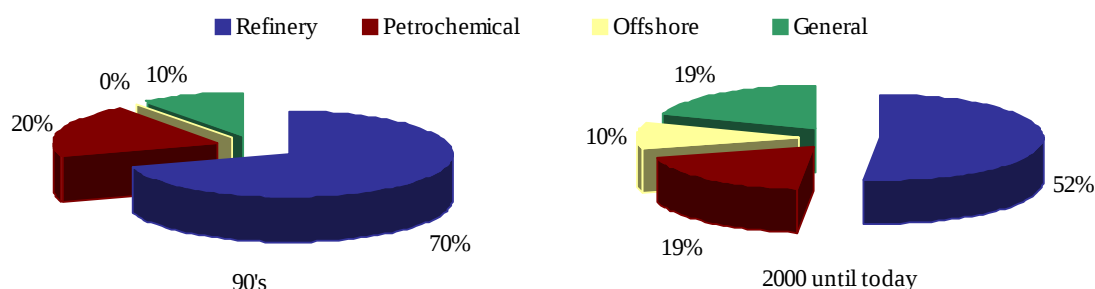


Figure 4. Number of publications in relation to the broad areas of petroleum industry.

Among the general papers the subjects more frequent were reviews of existing technologies of Cleaner Production and future trends and challenges in application of the concept in oil and gas industry. In the case of the refinery area, the principal subjects were the description of practical application of Cleaner Production strategies or technologies and discussions about the evolution of Cleaner Production concept and application. All the researches in the offshore area were about practical application of Cleaner Production, but still in experimental level. The discussion about the evolution of the concept and its application were the main topic in the petrochemical area. Other subjects also presented in the papers included the application of management models with the Cleaner Production approach, industrial symbiosis and green productivity indexes.

Figure 5 shows the relation among the areas of the petroleum industry studied in the papers assessed and the region of the world where the study was carried out. Also in this kind of analyze refinery is the main area of application of Cleaner Production. However, general papers have also importance as can be seen. Since Figure 4 shows that in the last six years we have almost twice general papers than in the 90 decade and considering that the subjects more frequent were reviews of existing technologies and future trends and challenges in application of the concept, perhaps we are facing a phase of review of what have been done and what the future directions. With the advance of researches, the studies are also diversifying and, for example, experiments are beginning to be developed in the offshore area.

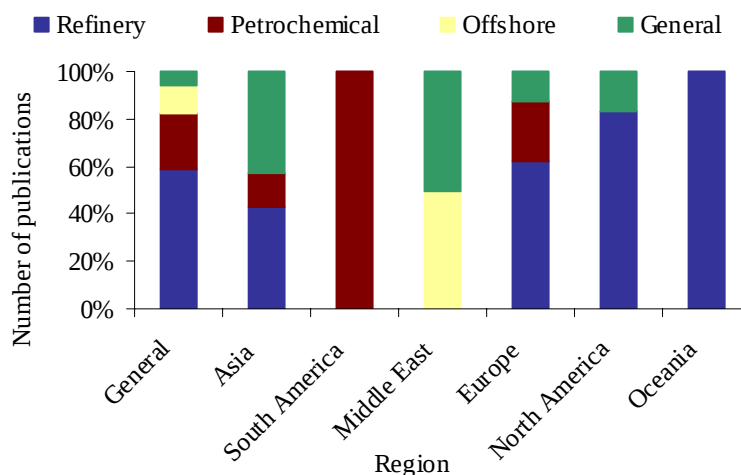


Figure 5. Relation among the broad areas of petroleum industry and the study region.

Although the attractive economic benefits and the significant environmental impact reduction, the large application of Cleaner Production strategies remains limited. Through studies that identified a number of potential barriers for the implementation of Cleaner Production in industries, the CNTL (2003a) evaluated that the lack of conceptual understanding and the limited access to adequate technical information are the most critical ones. The number of studies found in the search performed by this work may corroborate with this affirmation. The first step to the implementation of a Cleaner Production program is the targeting of the company staff, presenting successful experiences (CEBDS, 2003). However, it will only be possible if there is available information through a variety of sources. This does not mean that there are not researches being carried out about Cleaner Production. Industries have been studied clean technologies and strategies due to the increasingly concern of people and international institutions about health and environment, but this works are concentrated in internal reports. Those experiences must be published more frequently as peer-reviewed papers to reach a large public and have more credibility.

4. Conclusions

The objective of this work was to evaluate and determine areas of relative research deficiency about Cleaner Production through the assessment of literature available about the subject. A total of only 41 papers were returned by our search showing a lack of peer-reviewed papers published about the subject. The majority of publications found was journal articles and most of the papers presented studies carried out in refineries.

Probably much of the literature, particularly non-peer reviewed publications, may not have been covered by this search and the few published scientific papers obtained shows that the research on Cleaner Production is probably limited to internal reports, remaining unavailable to a broader public.

The implementation of Cleaner Production Programs allows the company to better know its processes through the constant monitoring of it for the development and support of an eco-efficient system of production. If published and spread the results of this monitoring would help with the identification of the lack of applied researches, technical information and capacity programs. It may also contribute to the development of environmental and process indexes, which is valuable for the company reputation and image.

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