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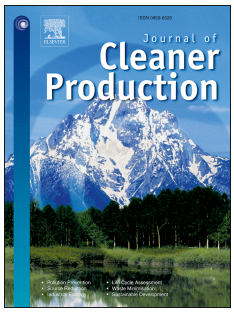

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Influence of process operating parameters on CO_2 emissions in continuous industrial plants

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ABSTRACT

There is a growing awareness of the need for environmental protection, and in this context, the control of CO_2 emissions is particularly important. The use of environmental indicators to measure process efficiency can help to reduce the impact and pollution generated in manufacturing processes.

This article features a case study that analyzes the influence of the main operating parameters of the paper production process (specifically the drying section) in CO_2 emissions. The plant was selected on the basis of its current low levels of CO_2 emissions, which are lower than established by the European Commission product benchmark for the type of paper produced. Based on the information gathered by factory quality control system, a general linear regression and an experiment were designed (orthogonal arrays of Taguchi). Through a multi-factorial analysis of variance for the indicator 'ton CO_2/ton Paper' the study reveals that the surface density and outside temperature have significant influence on the process and on CO_2 emissions and can be set a value to minimize CO_2 emissions and maximize production in the facility bottleneck. Thus, CO_2 emissions can be a good indicator of the operating status of the drying section. The study identified new lines of study, with which can be achieved the overall target of reducing energy consumption and CO_2 air pollution associated with paper manufacturing process.

Keywords: Industrial process; CO_2 emission; Indicator; Papermaking; Drying section; ANOVA

1. Introduction

One of the most important features of industrial manufacturing is control of the production process. Numerous systems are therefore used to provide plentiful data to measure the efficiency of the manufacturing process. Certain operating parameters plays a particularly important role in this control, especially in continuous processes, and even more so when it is focused on the bottleneck in the process (Jin and Ni, 2012). Paper manufacturing has its bottleneck mainly in thermal drying section because this section limits the maximum machine speed due to it is necessary to reach the specified moisture of paper when leaving the drying section. Machine speed may be adjusted lower to the maximum mechanical speed because the drying section is limited to a total amount of water that can remove from the paper to obtain the moisture. A 'CO_2 Emissions (ton)/Production (ton)' (hereinafter 'ton CO_2/ton Paper') indicator was identified in the paper manufacturing drying process (Calvo and Domingo, 2013a), which can be used to make decisions (Li and Ni, 2009) to act in maintenance operations that have a direct influence on production performance in drying section. In this study, this indicator will relate to process operating parameters. Using this simple indicator streamlines management and helps to identify the performance of the main production parameters to reduce CO_2 emissions.

There is currently great awareness of greenhouse gas emissions and of their impact on the atmosphere and on the environment. Since 2005, two plans for the allocation of emissions rights (R.D. 5/2004; R.D. 1866/2004; R.D. 60/2005; R.D. 777/2006; R.D. 1370/2006) have therefore been issued with a view to raising awareness of industry of the importance of controlling the emissions generated in their processes and to compelling them to reduce the volume of these emissions. Recently a third plan (Law 13/2010) have been done, which begins in 2013 and will be effective until 2020, takes a further step and prompts a drastic reduction or even elimination through the imposition of a carbon tax. This has turned CO_2 emissions into a significant cost in production processes that involve significant thermal energy consumption, which in turn significantly affects the competitiveness of plants and may cause more than one to close.

Since the initial allocation scheme of 2005 arising from the Kyoto Protocol, CO_2 emissions have often been seen to be the result of the production process. Emissions only represent an administrative cost and are perceived more as a tax rather than as a potential tool with which to evaluate production process operation.

The methodology used in this paper is a case study. A paper manufacturing plant was used as a reference and data on its bottleneck and the drying section (the section responsible for 100% of this plant's direct CO_2 emissions from thermal