



Estimate of ecological efficiency for thermal power plants in Brazil

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Abstract

Global warming and the consequent climatic changes that will come as a result of the increase of CO₂ concentration in the atmosphere have increased the world's concern regarding reduction of these emissions, mainly in developed countries that pollute the most. Electricity generation in thermal power plants, as well as other industrial activities, such as chemical and petrochemical ones, entail the emission of pollutants that are harmful to humans, animals and plants. The emissions of carbon oxides (CO and CO₂) and nitrous oxide (N₂O) are directly related to the greenhouse effect. The negative effects of sulfur oxides (SO₂ and SO₃ named SO_x) and nitrogen oxides (NO_x) are their contribution to the formation of acid rain and their impacts on human health and on the biota in general. This study intends to evaluate the environmental impacts of the atmospheric pollution resulting from the burning of fossil fuels. This study considers the emissions of CO₂, SO_x, NO_x and PM in an integral way, and they are compared to the international air quality standards that are in force using a parameter called ecological efficiency (ϵ).

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Keywords: Thermal generation; Atmospheric emission; Ecological efficiency

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Nomenclature

BIG/GT	biomass integrated gasifier and gas turbines
BPT	back pressure steam turbine
CC	combined cycle
CET	condensing/extraction steam turbine
DLNB	dry low NO _x Burners
FGD	flue gas desulfurization
GT	gas turbine
ICE	internal combustion engine
SCR	selective catalytic reduction
SNCR	selective non-catalytic reduction
ST	steam turbine

1. Introduction

Thermal electricity generation, as well as other industrial activities such as chemical and petrochemical operations, presents polluting emissions that are harmful to the health of humans, animals and plants. The emissions of carbon oxides (CO and CO₂) and nitrous oxide (N₂O) are directly related to the greenhouse effect. The negative effects of sulfur oxides (SO₂ and SO₃, called SO_x) and nitrogen oxides (NO_x) are their contribution towards acid rain.

Global warming, caused by the increase of the amount of CO₂ in the atmosphere, has increased the world's concern for reducing these emissions, mainly in developed countries, which are the greatest polluters. Consequently, in December 1997, 38 countries signed the Kyoto Protocol [1]. It established that the industrialized countries would have to reduce their emissions of greenhouse gases by 5%, at least, by the period between 2008 and 2012 in relation to the levels registered in 1990 [1]. This commitment promised to produce a shift in the historical trend of growing emissions in those countries. After a few years, some countries have ratified the agreement, others are about to ratify, but the USA decided not to ratify the Protocol, although it is the country presenting the highest emission of CO₂. After the Kyoto Protocol, there have been other agreements such as the Bonn Convention that was held in July 2001 [1] and was a political mark on the slow international negotiations about the Kyoto Protocol. This agreement [1] created the fundamental basis for the countries to be able to ratify and implement the Protocol and for the negotiation of emissions that will be even more reduced in the future. The financing package included a commitment made by The USA, New Zealand and Switzerland to give US\$140 million to the developing countries every year until 2005, and in 2008, a new analysis will be conducted [1]. Another important agreement was reached at the Marrakesh Conference in October 2001 [1]. Its goal was to solve Bonn's pending issues and conclude the conversion of the Agreement into a United Nations formal and legal text.

Control methods are used at thermal power plants for reducing the emissions of polluting gases. A special attention is paid to CO₂, for the increase in its concentration makes the earth temperature rise. Although it is not toxic, its emission, reaching high concentrations during the combus-

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