Comparative analysis of sugarcane processing technologies for environmental impact and energy efficiency

By Jean-Luc Magalhaes

Fives Cail, 22 rue du Carrousel - BP 10374, 59669 Villeneuve d'Ascq, France.
Tel: +33 (0)320 889 639
Email: jean-luc.magalhaes@fivesgroup.com
www.fivesgroup.com

abstract

An evaluation of the energy performance and greenhouse gas (GHG) emissions of front end (preparation and extraction) and boiling house process (evaporation, crystallization, curing and drying) equipment of a sugarcane factory has been carried out and is presented. Different technologies have been compared and have highlighted that technologies supplied by Fives Cail give significant energy advantages. Compared with conventional technologies, Fives Cail's In-line Shredder (cane preparation), Millmax® (milling), continuous vacuum pans (compared with batch pans) and 5 effect falling film evaporators (compared with 5 effect rising evaporators) showed decrease in energy consumption by 16%, 37%, 10% and 3%, respectively, and thereby making available additional 11 kWh per tonne cane for export and revenue generation. Energy efficient technologies lead to reduced GHG emissions and GHG emissions for the manufacture and end-of-life disposal of sugar processing equipment are very small compared to those generated during operation of the equipment.

Keywords: batch pans, cane preparation, cane sugar processing, continuous vacuum pans, diffusion, energy efficiency, evaporators, greenhouse gas emissions, milling
1: Introduction

In recent times the sugarcane industry has undergone some important changes with respect to energy conservation, diversification and environmental factors.

The first of these changes has been a focus on energy conservation and environmental issues leading to a better appreciation of the value of bagasse as an important resource. In the first instance, for satisfying both the steam and electricity generation needs for sugar processing and in the second instance to use surplus electrical production capacity to maximize cogeneration. These surpluses are typically sold to the local electric network or are used for other needs such as irrigation. To carry out this change effectively, it is necessary to reduce steam and electricity consumptions of the energy consuming operations by increasing the capacities and by optimizing the processes and the technologies. This change is in progress and is far from being completed: many sugar factories could benefit from comprehensive optimisation.

This production of electricity from biomass (bagasse) makes it possible to avoid greenhouse gas (GHG) emissions that would have been incurred if this electricity had been produced from other sources such as oil, coal or natural gas. Moreover, funding for projects that avoid or achieve a reduction in GHG emissions can be obtained through a United Nations programme called the “Clean Development Mechanism” (CDM). Currently (in 2010) there are 90 cogeneration projects, in 16 countries, that have received financing through this mechanism. These projects will achieve a reduction in, or avoid, GHG emissions of 4.3 million tons of CO$_2$e each year (UNFCCC). CO$_2$e is an abbreviation for ‘carbon dioxide equivalent’ and is the internationally recognised measure of greenhouse gas emissions.

The second of these changes involves diversifying the use of sugarcane, particularly in the field of bioethanol production. Sugarcane is no longer just a food crop, but also a feedstock to generate new revenue streams from the production electricity, ethanol and CO$_2$ (Figure 1).

Therefore, in addition to the traditional areas of focus for the cane industry, of agriculture and sugar processing, new concerns relating to energy and the environment have to now also be included (Moor 2008, Rein 1995). These new concerns have had far reaching implications, which even extends to manufacturers communicating to consumers information about their carbon emissions; Tate and Lyle, and British Sugar have published the GHG emissions of their productions of raw, white or refined sugars. On another aspect the bioethanol industry is the subject of detailed environmental analyses, in particular in Brazil (BNDES and CGEE 2008, Macedo et al 2008, Wang et al 2008).

In this context where the industrial, economic and environmental requirements are closely dependant, this article aims at quantifying the environmental impact of the main technologies used in the sugarcane processing industry. For the environmental aspects, there is particular focus on energy and GHG.

2: Evaluations

Selected technologies evaluated in this study are: