Analysis decision about the sugarcane straw recovery for cogeneration in unity operation industry

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Resumo

Este estudo revela uma nova tendência no gerenciamento ambiental para redução da poluição a partir da prevenção de queimada pelo uso de resíduos agrícolas para vantagens competitivas e geração de um ciclo limpo de energia alternativa com utilização de biomassa (palha) de acordo com o Protocolo de Kyoto. Além disso, a redução de fontes poluentes também foi considerada para melhoria da saúde da população e qualidade de vida enquanto contemple o bom uso do Mecanismo de Desenvolvimento Limpo (MDL).
Este trabalho enfatiza que uma análise de simulação deve considerar os setores de agricultura e indústria ficando sujeito a um desenvolvimento isolado. Também foi determinado através de uma equação linear que a palha contribui com um aumento para a disponibilidade de energia a partir da palha no intervalo de 5,59 % a 55,94 %, dependendo do estágio da cana plantada e do percentual de tipo de colheita adotado e a viabilidade para a utilização da palha.

Palavras chaves: palha, MDL, geração de energia e rotas de simulação.

Abstract

This study reveals new trends in environmental management for pollution reduction from sugarcane burning prevention by using agricultural residues for some advantages competitive and generating of a clean cycle of alternative energy with biomass utilization (straw) according to Kyoto Protocol. Moreover, the reduction of pollutant sources are also considered for improving the population's health and life´s quality while making good use of Clean Development Mechanism (MDL).
This work emphasizes that an analysis of the simulation must consider both agricultural and industrial sections avoiding incurring isolated evolution. It was also determined by linear equation that the straw contributes with increment to energy readiness to the bagasse into the range from 5,59 % to 55,94 %, depending on the suck sugarcane plantation and on the percentile of harvest adopted and the viability for straw utilization.

Keywords: straw, MDL, energy´s generation and route´ simulations

Resumen

Este estudio revela una nueva tendencia en la gestión ambiental para reducción de la polución a partir de la prevención de quemada por el uso de residuos agrícolas para obtener ventajas competitivas y generación de un ciclo limpio de energía alternativa con utilización de biomasas (paja) en consonancia con el Protocolo de Kyoto. Además de eso, la reducción de fuentes contaminantes también fue considerada para mejoría de la salud de la población y calidad de vida a través del Mecanismo de Desarrollo Limpio (MDL). Este trabajo enfatiza que un análisis de simulación debe considerar los sectores de agricultura e industria quedando sujeto a un desarrollo aislado. También fue determinado a través que una ecuación lineal que la paja contribuye con un aumento para la disponibilidad de energía a partir de la paja en el intervalo de 5,59 % a 55,94 %, dependiendo de la plantación de caña soca y del percentil cosecha adoptado y la viabilidad para la utilización de la paja.

Palabras Llaves: paja, MDL, generación de energía y rutas de simulación.

INTRODUCTION

Brazil has an area of 851 billion of hectare in which 376 million are arable land and only 5 million that are been used for sugarcane cultivation, which represents 1.3% of the available area for agriculture. Overall, the national average is 75 t of sugarcane per hectare, which provides 8.5 t of sugar or 5,400 liters of ethanol and 19.5 t of bagasse with 50% moisture.

The activity of burning sugarcane produces 1.2 t of CO_2 and absorbs 0.9 t of oxygen from the atmosphere. The burning of the bagasse, which produces the same energy, that alcohol releases 4.0 t of CO_2.

Moreover, the 5400 liters of alcohol, or 4.27 ton to be burned produces 8.2 tons of CO_2. Thus, the fuel cycle ethyl sends 13.4 t CO_2 to the atmosphere.

The same ton of sugarcane removes from the atmosphere 109 tons of CO_2 to grow and returns 70 ton of oxygen.

To sum up the sugarcane cycle up to bioethanol removed from the atmosphere about eight times the CO_2 it produces while gasoline produces three tons of CO_2 per tons of fuel without any other environmental compensation and it produces even more aggressive pollutants, according to Eston (1990).

A non-optimized waste burning from sugarcane harvest produces 1.2 tons of $CO_{2,}$ however, if this residue that were tapped as a fuel in the boilers, it could produce steam for the generation of bioelectricity.

The use of residual biomass sugarcane in São Paulo would allow the final recovery of 34.8% of the culture available energy generating 12 to 33 million MWh and 22-60 million MWh in Brazil.

For Paturau (1982) the oldest industries consumed 500-550 kg bagasse for generating a ton of steam. Nowadays the most modern industries, with low-pressure boiler consumption are in the range 450-500 kg / t of steam. The consumption for the boilers of medium and high pressure becomes in the range of 400 to 450 kg / t of steam allowing the use of the excess for other purposes, which can be a generation of bioelectricity to be sold to private utilities.
These crop residues have moisture around 50% and its heterogeneity has caused obstruction in the supply system of high-pressure boiler operating with a fluidized bed instead of racks.

The alternative has been to burn these mixed waste such as stalks of cane sugar before desfibration operation.

This technique is not be recommended, since it can affect the extraction efficiency and increases the fiber content in the industry, causing a reduction in milling capacity according to equation 1 Hugot (1984) in which the fiber is a divisor parameter.

$$C = \frac{\{0{,}8\ K[c\ n\ L\ D^2 N^{1/2}(1-0{,}006 n\ D)]\}}{f} \tag{1}$$

C =milling capacity;

K =factor forced feeding = 0,8;

f =fiber content in sugarcane;

c =coefficient for the sugarcane preparation;

c = 1.20 (when using two sets of knives);

c = 1.25 (when using two sets of knives and one disintegrated);

c = 1.15 (when using one set of knife);

N = speed of the first mill tender (rpm);

L =length of tender milling (m);

D=diameter of tender milling (m) and

n = number of tender milling.

The determination of the best technological route to the use of crop residue can be evaluated by the company with mathematical models of reduce costs, risks and time tests.

It can also determine what increment of power that was generated by the use of crop residues in relation to bagasse contributing energy matrix type of alternative biomass.

In the impossibility to test systems and procedures these linear equations can be used in the simulation as developed from the problem to define the shielding of a nuclear reactor in 1940 by von Neumann and Ulam cited by Silva (2003), which became known as analysis "Monte Carlo".

Therefore, the typical plant producing sugar and alcohol should in future become an island of alternative energy production with the total use of sugarcane.

MATERIALS AND METHODS

The methodological approach was been characterized from a basic conceptualization in the field of operation research with objective functions and equations of restriction for each alternative technology route with the straw received at the industrial unit from some different forms according to the process diagrams and simulation.

The systems of equations for each model were analysed using the techniques of operations research through a spreadsheet calculation with Microsoft Excel to determine the most economical route. The method adopted was one that aimed to provide better modelling of alternative processing of straw for energy cogeneration with percentage of residues collection of 30, 50, 70 % and integral:

Collection System:

a) System cane harvest in full;
b) System of collection of crop residue mechanized bulk;
c) Collection system mechanized crop residue baled.

Percentage of residues collection:

a) Integral
b) 30%
c) 50%
d) 70%

The aim of studying bioelectricity cogeneration is support the mill owners to make a decision by the analysis on the use of trash from sugarcane, which was brought by the agricultural area and taken to the industrial area. The field experiment been done in Usina Guaira; Usinas do Grupo Andrade, Techpetersen and Santa Adélia.

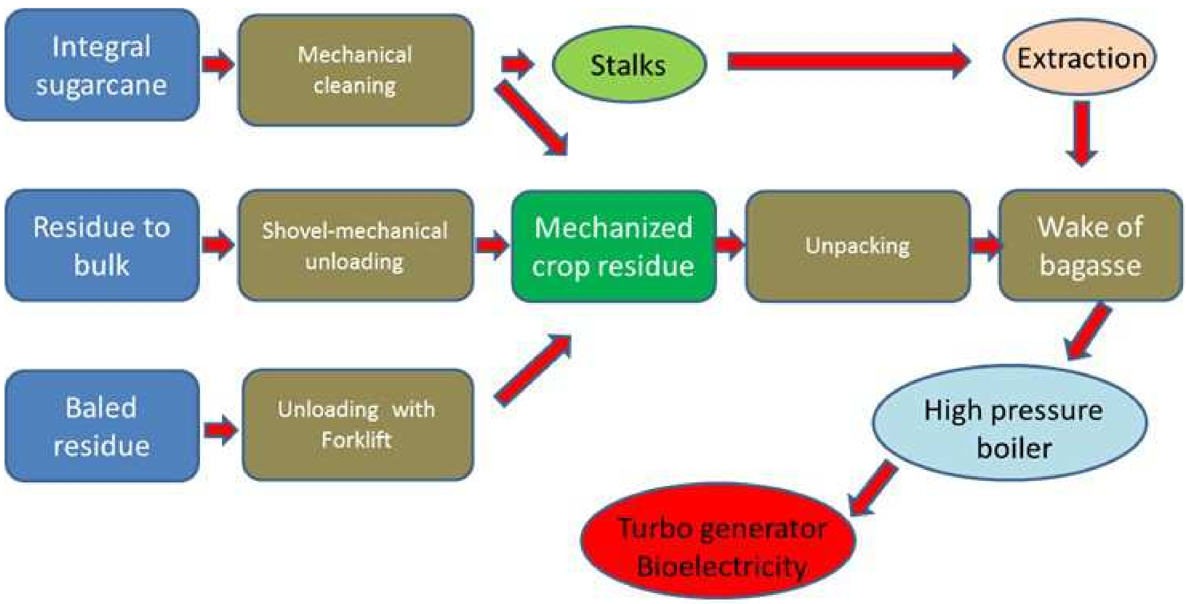

Figure 1 - Analysis decision on the utilization of straw sugarcane.

RESULTS AND DISCUSSIONS

In the example (Table 1), a unit that processes 100TCH, can generate 10.48MW to process all bagasse resulting from the industrialization of sugarcane, while processing all bagasse along with all agricultural waste, it can be generated 16.33 MW.

Table 1 - Power generated (KW) to 100 t/h of sugarcane in some different uses of biomass.

Use of Biomass	Power (MW)	Energy harvest (MWh)
Bagasse	10.48	50.300
Agricultural waste (Minimum)	0.58	2.800
Agricultural waste (Maximum)	5,85	28.000
Bagasse Residue + (Min)	12.40	59.520
Bagasse Residue + (Max)	16,33	78.380

As 50% of biomass, the industrial process for the production of sugar and alcohol consumed bioenergy. Spare for marketing in the public's equivalent to about 50% of this bioelectricity.

With the additional use of agricultural waste mechanical harvesting there will be an increase that could double revenue with agribusiness marketing bioelectricity to the public.

Table 2 - Analysis decision about the sugarcane straw recovery for cogeneration in unity operation industry.

Table 3 - Percentages of increase of power due to the use of agricultural crop residue as an additional source of fuel, type of biomass to bagasse.

Minimum Scenario:	**Maximum scenario:**
$\boldsymbol{E_T = (TCH/3600)x4,18\ \{TR/TC\ x\ f_{rr} x\ Q_r + [TB/TC\ \ x\ Q_b]\}R}$	
Et = Ep +Eb = 385 x 10^6 x 4,18 { [4 / 71,3 x 0,30 x 1.500] + [250 / 71,3 x 1.800] } x 0,20	Et = Ep +Eb = 385 x 106 x 4,18 { [12 / 71,3 x 0,90 x 1.500] + [250 / 71,3 x 1.800] } x 0,25
Et = 2.039.485,34 x 10^6MJ/safra x 0,278 = **5,7 x 10^{10}MWh/safra**	Et = 2.630.400 x 10^6MW/safra x 0,278 = **7,32 x 10^{10}MWh/safra**

fpr(%) **tTC(%)**	**30%** **(%)**	**50%** **(%)**	**70%** **(%)**	**100%** **(%)**
0,056	5,59	9,32	13,05	18,65
0,084	8,39	13,99	19,58	27,97
0,112	11,19	18,65	26,11	37,30
0,140	13,99	23,31	32,63	46,62
0,168	16,78	27,97	39,16	55,94

fpr (%) fraction collection of agricultural residue harvest
TTC (%) ratio the percentage of tons of agricultural waste per ton of cane

It should been noted that the availability of this type of biomass - agricultural residue of mechanized harvesting and surplus bagasse can be accessible in the sugarcane harvest periods, which corresponds to the dry season in the east of the country where the water reservoirs of hydroelectric are in their minimum.

Considering that Brazil produces about 558 million tons of sugar cane per year according to UNICA (2012), in an area of 9.5 mi ha, and that the availability of agricultural residue harvest is mechanized in the range of 4-12 tons per hectare (Ripoli, 2003) and also considering the average farm income of 71.3 t / ha according to Vieira (2003). It is possible to estimate available electricity to be provided by the sugarcane sector for utilities, and remunerated by the Table Proinfra 2012, which contributes to creation of new job opportunities and ensuring energy supply for the implementation of projects in various sectors in Brazil.

CONCLUSIONS

Considering that the 18 turbines of 700MW of hydroelectric Itaipu on the Paraná River, can generate 12.6 MWh. The potential values that the sugarcane industry can offer with its biomass to generate electricity (Bioelectricity) for the utilities of the public is in order 45-58% of potential Itaipu, when compared with the potentials mills in Brazil (5.7 to 7.3 MWh).

It should be emphasized that the creation of jobs by the Brazilian sugarcane sector is very representative, reaching people from different social classes and workers who are geographically distributed throughout the national territory. This is an important moving of chain for agribusiness in Brazil, which involve companies that produce capital goods, producers of inputs, training facilities and improvement of workforce, research institutions, carriers, educational institutions. Directly and indirectly, contribute to improving the quality of life of people with competence and social responsibility.

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