CONTRIBUTION TO THE PERFORMANCE IMPROVEMENT OF THE INDUSTRIAL PROCESS FOR OBTAINING ETHANOL FROM SUGARCANE BY USING MICROWAVE AND ULTRASONIC ENERGIES

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Figure 1


Figure 2

Figure 1. Assembly for continuously pasteurizing sugarcane must by using a microwave applicator. Figure 2. Assembly for studying the effect of applying US on the fermentation of pasteurized sugarcane must

The present study consists of searching techniques to improve the productive capacity of the ethanol industry, by developing new technologies based on the application of microwaves (MW) and ultrasound (US), envisaging a better performance during the fermentative process. One of the first objectives is to pasteurize the sugarcane must before fermentation. The must is composed by the mixture of the sugarcane juice and the syrup coming from milling the cane and from the sugar manufacturing, respectively, carrying a heavy microbiological load of bacteria and wild yeasts. The presence of bacteria into the fermentation vats is associated to the decreasing of process performance, because part of the substrate is spent to make other products like acetic and lactic acids, thus decaying the quality of the ethanol. Besides, bacteria may induce the occurrence of ferment flocculation, bringing a series of drawbacks to the process, such as yield reduction, expenditures with additives and bactericides, decrease of productivity, among others. On the other hand, wild yeasts are mostly flocculants by their nature, exhibiting low ethanol productivity and high multiplication rate. The industrial ferments utilized in most of the Brazilian sugar mills, selected in conformity to their excellent fermentation potential at the beginning of the harvest season, are rapidly substituted by the wild yeasts, changing the process performance. Pasteurizing by MW is an efficient and rapid method, easily adaptable to the present ethanol plants, where the majority of equipment operations are based on batch processes. In order to aggregate efficiency to the fermentation process after MW pre-pasteurization, it is suggested applying low power US energy: a few research works have already shown that its ministration under controlled conditions can accelerate the metabolism of *Saccharomyces cerevisiae*, among other capabilities, although this kind of energy for stimulating fermentation has not found any industrial scale application yet. Combining the two technologies could bring significant contribution to increase the ethanol production. Besides developing new technologies for the sugar-alcohol industrial sector, employing MW and US would take advantage of clean energies by co-generation from the surplus energetic sources of the sugarcane mills.

SUMMARY OF RESULTS TO DATE AND PERSPECTIVES

1. Dielectric properties. Electromagnetic energy and dielectric materials interacts by the conversion of MW into thermal energy, by means of several mechanisms of molecular and atomic scale. In order to determine the dielectric parameters of the sugarcane must, variable with temperature and frequency of the electrical field, a special cell was designed and developed so as to lodge the probe of the dielectric properties measuring system, allowing for the fluid to circulate continuously through it, inserted into a suitable circuit. Thus it was possible to determine dielectric properties within the range of MW frequencies (300 kHz to 6 GHz), as functions of temperature.

2. Lethality parameters. The lethality parameters, known as D and z values, specify times and temperatures needed to destroy the deteriorating target microorganisms, making possible to determine equivalent values of pasteurization at any other temperature. One continuous MW heating system of 2.45 GHz x 1,900 W (*Figure 1*) was assembled for the pasteurization and determination of the thermal death time studies. It terminates by a specially designed coiled-shape holding tube, immersed into a precisely adjusted constant temperature bath, having five orifices plugged with silicone septa, for withdrawing the sample aliquots. The MW system adjustment is such as to establish a standing wave with the electric field increased to a maximum value in the tubular applicator. The bath holding temperature is set according to the desired pasteurization temperature obtained from adjusting the MW power, whereas five treatment times of the samples are automatically obtained for each flow rate. After expiring the processing period, a counting of cells is done by using a microscope for confirming the reduction of the initial count.

3. Ultrasound Application. A bench scale fermentation system was prepared and filled with a pasteurized model solution inoculated with a selected strain of Saccharomyces cerevisiae in order to study the effects of applying low intensity ultrasound energy to the ethanol productivity of the yeast (*Figure 2*). The system consists of a glass cylindrical vessel of about 1.5 liters useful volume immersed into a constant temperature bath, equipped with an agitator, as well as access points for samples withdrawal, for purging CO_2 from fermentation and recovering escaped ethanol vapors by condensation, for feeding the solution at the process start up, and for inserting a probe connected to a lab size low-power US generator. As samples are withdrawn, they are sent for RMN and HPLC analyses in order to determine the relative rate of evolution of glucose, sucrose, fructose and ethanol from the fermentation reactions, as functions of applied specific US power and time cycle mode of such application.

4. Expected Results. This study proposes to improving the fermentation process of sugarcane must for obtaining ethanol by means of: 1. Time and waste reduction in the process; 2. Processing of a better quality product, characterized by less contaminants of ethanol (lactic and acetic acids, among others); 3.Decreasing of acid treatment for ferment deflocculation; 4. Reducing the employment of bactericide agents; 5.Clean energy utilization, possible of being obtained by co-generation through taking advantage of the bagasse from sugarcane.

It is expected through this study to get significant improvements in obtaining products and processes for the bio-combustibles fabrication, specifically ethanol, keeping the Brazilian leadership in the production of bio-ethanol.

MAIN PUBLICATIONS

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