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

Antonio MARSAIOLI Junior
Institute of Food Technology (ITAL)

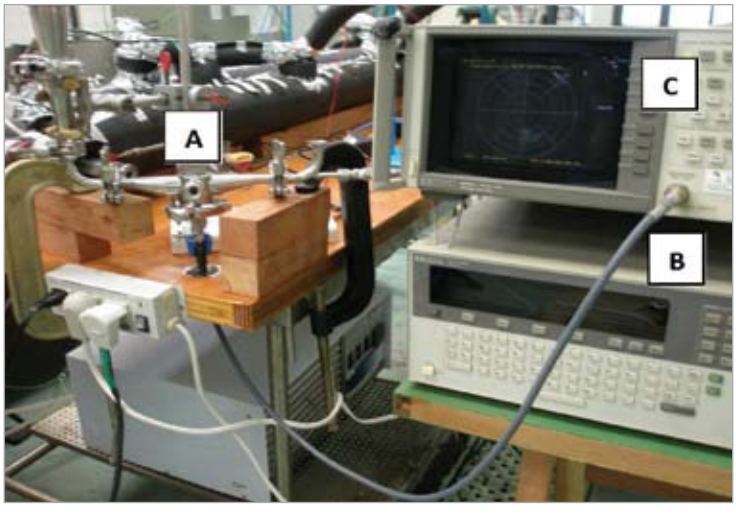

Figure1. Assembly for continuously testing dielectric properties of the sugarcane must as functions of temperature: (A) probe cell; (B) connecting cable; (C) network analyzer

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 and ultrasound, envisaging a better performance during the fermentative process. In order to achieve that target, one of the main 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. Such a must carries a heavy microbiological load made up of bacteria and wild yeasts. The presence of bacteria into the fermentation vats is associated to the decreasing of the fermentation performance, because part of the substrate is wasted to make others 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 its 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 microwaves 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 microwave pre-pasteurization, it is suggested applying ultrasonic 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.

The combination of the two technologies could be offering significant contribution to improve the ethanol production. Besides developing new technologies for the sugar-alcohol industrial sector, employing microwave and sonic energies signifies to take advantage of clean energies that can be obtained by co-generation from the surplus energetic sources of the sugarcane mills.

SUMMARY OF RESULTS TO DATE AND PERSPECTIVES

1. Dielectric properties

The interaction between electromagnetic energy and the constituents of a dielectric material converts microwave energy into thermal energy, by means of several mechanisms of molecular and atomic scale. In order to determine the dielectric parameters of the sugarcane must, which also varies with temperature and frequency of the electrical field, a special cell was designed and developed so as to lodge the probe of a system for measuring dielectric properties, allowing the fluid to circulate continuously through it, inserted into a suitable circuit (*Figure 1*). Flow-rates and temperatures can be adjusted during the operation of this particular system, for continuously determining its dielectric properties within the range of microwave frequencies from 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.

Experiments are being run either in a bench top microwave reactor (CEM Discover) or in a Heated Circulating Bath. Preliminary tests were conducted by using D = 0,5 min and z = 4,5ºC for Saccharomyces cerevisiae as a reference (Stumbo, 1973)*. Glass tubes with distilled water were heated in the microwave reactor, with agitation. At the desired temperatures, a solution of industrial yeast with initial controlled count was added to the tubes and exposed to microwaves to evaluate the cells reduction. The counting of cells and cellular viability (method of coloring) were done with a microscope and Neubauer chamber for confirming the reduction of the initial count. The values adopted for D and z were shown to be adequate, with experiments and entire development of methodology being presently in course.

* STUMBO, C.R. Thermobacteriology in Food Processing, 2nd Ed, Academic Press, New York, 1973.

3. Expected Results

This study proposes to improving the fermentation process of sugarcane must for obtaining ethanol by means of: time and waste reduction in the process; processing of a better quality product, characterized by less contaminants of ethanol; decreasing of acid treatment for ferment deflocculation; reducing the employment of bactericide agents; 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

Andrade RR, Rivera EC, Atala DIP, Maciel Filho R, Maugeri Filho F, Costa AC. 2009. Study of kinetic parameters in a mechanistic model for bioethanol production through a screening technique and optimization. *Bioprocess and Biosystems Engineering* (Print). **32**: 673-680.

Berteli MN, Rodier E, Marsaioli Jr A. 2009. Study the microwave vacuum drying process for a granulated product. *Brazilian Journal of Chemical Engineering*. **26**: 317-329.

Junqueira TL, Dias MOS, Maciel MRW, Maciel Filho R, Rossell CEV, Atala DIP. 2009. Simulation and optimization of the continuous vacuum extractive fermentation for bioethanol production and evaluation of the influence on distillation process. In: 19th European Symposium on Computer Aided Process Engineering, 2009, Cracow. Amterdam, Elsevier. **26**:827-832.

Lunelli BH, Andrade RR, Atala DIP, Maciel, MRW, Maugeri Filho F, Maciel Filho R. 2009. Production of lactic acid from sucrose: strain selection, fermentation, and kinetic modeling. *Applied Biochemistry and Biotechnology*, Online.

Mariano AP, Costa CBB, Maciel MRW, Maugeri Filho F, Atala, DIP, Angelis DF, Maciel Filho R. 2009. Dynamics and control strategies for a butanol fermentation process. *Applied Biochemistry and Biotechnology*. 1-25.

Pereira AB, Souza MAC, Galvão CMA, Atala DIP. 2009. Aplicação da técnica de centrifugação gradiente na análise e separação da população microbiana das dornas de fermentação de bioetanol. In: XVII Simpósio Nacional de Bioprocessos (Sinaferm 2009), Natal, RN, UFRN.

Rivera EC, Andrade RR, Atala DIP, Farias Junior F, Costa AC, Maciel Filho R. A LabVIEW-based intelligent system for monitoring of bioprocesses. 2009. In: 19th European Symposium on Computer Aided Process Engineering, 2009, Cracow. Amterdam, Elsevier. **26**:309-314.

Antonio Marsaioli Junior

Faculdade de Engenharia Química (FEQ)
Universidade Estadual de Campinas (UNICAMP)
Cidade Universitária Zeferino Vaz
Caixa Postal 6066
CEP 13083-970 – Campinas, SP – Brasil

+55-19-3521-3906
tonymars@feq.unicamp.br