SIMULATION OF 1st GENERATION SUGARCANE BIOREFINERY IN EMSO PLATFORM

Antonio Maria Francisco Luiz José Bonomi
Brazilian Bioethanol Science and Technology Laboratory (CTBE) / National Center for Research in Energy and Materials
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co-PIs: Jose Antonio S. Gonçalves, Marco Giulietti, Maria Regina Wolf Maciel, Rubens Maciel Filho, Silvia Azucena Nebra

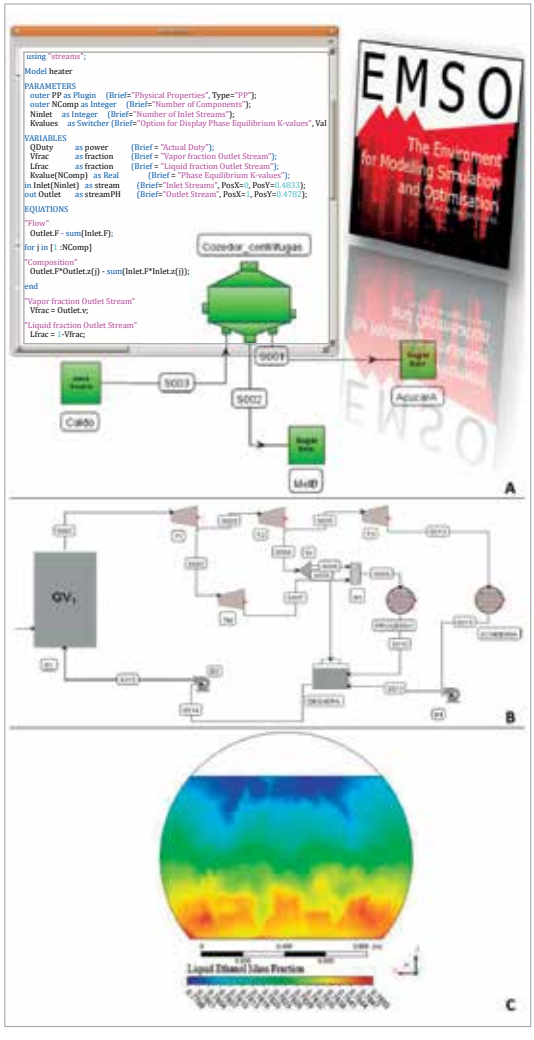

Figure 1. (A) EMSO's user interface and the representation of a unit operation; (B) CHP simulation using models developed by a group of the research team; (C) Mass transfer analysis of a sieve tray, using computational fluid dynamics, performed to provide stage efficiencies to EMSO's distillation models

In the last decade, several R&D institutes, as well as private sector initiatives, have focused on the development of technological solutions aiming to increase the efficiency and sustainability (economic, environmental and social) of the production process of sugar, ethanol and bioelectricity from sugarcane. The use of new technologies and energetic integration of the process may cause a substantial impact on the revenue of the business, as a result of the increase of surplus electricity, reduction in the use of process steam, rational use of subproducts and increase on productivity and efficiency of the unit operations. Moreover, it is clear that understanding and optimizing the 1st Generation plants are essential to enable the production of 2nd Generation ethanol. In this context, this project focuses on the development of a library of mathematical models that represents a "Virtual 1st Generation Sugarcane Plant", providing a framework that allows the comparison and optimization of different technological routes in the production of sugar, ethanol and bioelectricity.

In order to achieve the objectives of this project a simulation platform called EMSO (Environment for Modeling, Simulation, and Optimization) is been used for the development of the Virtual Sugarcane Plant. This software, designed and developed in Brazil, is an equation-oriented dynamic simulator and process optimizer. Besides its solver, the main features of this software are the full access to the developed mathematical models, the ease of insertion of new models or improvements in existing ones. These characteristics make EMSO a suitable environment for the development of a library of models specially focused on sugarcane plants.

The development of the "Virtual 1st Generation Sugarcane Plant" represents a great challenge in terms of gathering and managing large amount of information, so it is required a collaborative and synchronized team-effort and synergic actions of the various groups involved, CNPEM(CTBE), UFSCar(DEQ), UNICAMP(FEQ), UFABC(CECS) e USP (EESC e FZEA), through the management and sharing of the mathematical models generated along the project.

SUMMARY OF RESULTS TO DATE AND PERSPECTIVES

In order to develop the "Virtual 1st Generation Sugarcane Plant" using the process simulator EMSO, the research groups elaborated several mathematical models of the main processing areas and unit operations of the production process of sugar, ethanol and bioelectricity from sugarcane. Two modeling levels, with simplified and rigorous models, are used to represent the process. The former one, a simplified version, is more adequate to provide analyses and balances for the whole process, and the later one – more complex, when more in-deep area-specific assessments are required. The simplified models of all processing areas are already developed, documented and tested by the research groups. Now, the whole process representation and testing phases, are in progress.

Within the project, the groups have specific responsibilities. One of them is in charge of characterizing samples of sugarcane and bagasse collected from several industrial plants, providing a representative and reliable information to the other groups. In the extraction area, a diffuser's rigorous model is being developed and dynamic models of the crystallization and fermentation areas are already available. The combined heat and power (CHP) and the biodigestion areas already counts with rigorous models of the main equipment and the distillation's rigorous models are being refined and improved to accurately reproduce the expected behavior of this operation. The final whole plant simulation is in progress, but an initial version is being used to perform optimization assessments, energy integration studies and to support the development of the methodology for estimating capital investment cost of 1st Generations plants.

Besides results from the specific researches of each group, some other important deliverables will be available online to the general public on the project's repository, for example, a library of mathematical models, developed specifically to represent and simulate the process operations of 1st Generation Sugarcane Biorefineries, a tool to estimate its capital investment cost and optimization methods, implemented in the EMSO simulator, that can be used to evaluate different technological scenarios.

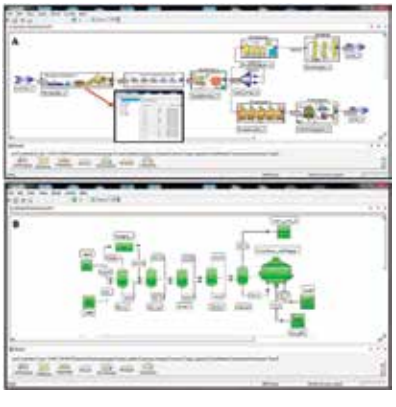

Figure 2. (A) User interface of the capital investment cost estimation tool; (B) EMSO's representation of part of the sugar production process

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Antonio M. F. L. J. Bonomi

Laboratório Nacional de Ciência
e Tecnologia do Bioetanol (CTBE)
Centro Nacional de Pesquisa em Energia e Materiais (CNPEM)
Divisão de Avaliação Integrada de Biorrefinarias (AIB)
Rua Giuseppe Máximo Scalfaro, 10.000 – Bairro Guará
CEP 13083-100 – Campinas, SP – Brasil

+55-19-3512-1010
antonio.bonomi@bioetanol.org.br