ETHANOL PRODUCTION AND USE: THE SUMMARY OF THE ISSCT CO-PRODUCTS WORKSHOP

By

M. REGIS L.V. LEAL

Copersucar Technology Center - Fazenda Santo Antônio, Piracicaba - SP – Brazil
regis@copersucar.com.br

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Abstract

This paper presents the summary of the ISSCT Co-Products Section Workshop that had 'Ethanol Production and Use' as the central theme. This workshop, hosted by Copersucar Technology Center in Piracicaba, São Paulo, Brazil in July 2003, was attended by 58 delegates from 12 countries. The two days of plenary sessions had a total of 31 presentations distributed in eight technical sessions covering ethanol programs in Brazil and in other countries, automotive use of ethanol, alternative raw materials for ethanol production, energy balance, ethanol production technologies, ethanol by-products, other co-products production within the sugar factory, and energy cogeneration. Site visits occupied the last two days of the workshop and gave the delegates the opportunity to see different technologies used in Brazil to produce ethanol: conventional process (continuous and batch fermentations; dehydration alternatives), innovative technology (hydrolysis-ethanol from bagasse), environmental aspects and cogeneration. During the plenary sessions and site visits, the discussions between delegates provided fruitful exchange of ideas and experiences.

Introduction

Copersucar Technology Center organised and hosted, in Piracicaba, São Paulo, the Co-Products Workshop that took place from July 14 to 18, 2003. Since ethanol is the fastest growing co-product of sugar production, the central theme selected was 'Ethanol Production and Use'. In Brazil, this liquid fuel has reached the status of a product as important as sugar and the sugar from milled cane is dedicated in equal parts to their production. Many other important sugar producing countries like India, Colombia, Thailand, Australia, China, and Mexico have started, to some extent, their national ethanol fuel programs. Fifty-eight delegates from 12 countries participated in the event that had two days dedicated to plenary sessions, consisting of the opening session and eight technical sessions totaling 31 oral presentations. Each session was followed by discussions on the themes presented. The two days of field visits closed the workshop.

Objectives

Due to the increasing interest worldwide to evaluate the use of ethanol to displace fossil fuels, thus reducing the greenhouse gas (GHG) emissions, the workshop chose as the main objective to discuss all aspects of the production and use of this renewable fuel and its integration with sugar production.

Plenary session

The opening session consisted of the welcome speech by Copersucar Technology Center General Manager, Mr. Tadeu Andrade. The technical sessions were organised to cover all aspects of the chain production/use, starting with the legal and institutional framework used or planned to be used to foster the utilisation of ethanol fuel, going through technology aspects and ending with byproducts. These sessions will be summarised below.

Ethanol program in Brazil and other countries

This session was opened by Mr. Luiz Carlos de Carvalho who detailed the steps that ethanol had to climb from the beginning of the 20th century to become a major transportation fuel in the last quarter of that century, with an importance equivalent to gasoline and diesel in the national fuel pool; indication of the future was given such as the introduction of flexible fuel vehicles and ethanol use to displace diesel oil.
A new concept of integrated production of an extensive line of co-products of sugar cane in Iran was presented by Mr Ezatollah Rezaee; this complex is anchored in seven sugar mills and involved the production of cattle feed, paper/pulp, refined sugar, particle boards, ethanol and yeast. The Guyana perspectives for the production of ethanol were presented along with the alternatives for raw materials and the expectations of the country regarding the economic impact on the sugar sector. Mr Muttu Jothi from India introduced an energy efficient alternative for ethanol production and also discussed the country’s situation and future trends with respect to this fuel. The session was closed by the presentation of Cenicana showing the multi ministry effort to create the necessary framework, including environmental regulations, to establish Colombia’s ethanol program.

**Automotive use of ethanol**

The experience of Brazil with the use of ethanol fuel was discussed from the point of view of the automakers by a representative of Volkswagen; both neat ethanol and gasohol (ethanol/gasoline blends) required modifications to fuel systems in the vehicles and they were presented in detail for the various ethanol concentrations in the gasohol. The flexible fuel vehicle was also presented. The environmental benefits of ethanol were pointed out by Mr Alfred Szwarc indicating that the octane enhancing effect of ethanol made possible the phasing out of leaded gasoline in Brazil in early 1990, facilitating the use of catalytic converters in the exhaust pipe, reducing drastically the vehicular emissions. CTC presented the experience with ethanol specifications for hydrous and anhydrous types along with the quality control at the mills.

The results of a fleet test of ethanol/diesel blend with 7% anhydrous ethanol, without any additive, was reported by an engineer of the Catanduva mill, who explained also the test procedures for the 10 cane transport trucks test fleet.

**Alternative raw materials for ethanol production**

The production of ethanol by hydrolysis of lignocellulosic materials is being intensively researched around the world. The Dedini Rapid Hydrolysis (DHR) process was presented as an innovative alternative in this line; the 5000 L per day demonstration plant is being commissioned at the São Luiz AA mill using bagasse as raw material. Dr Ross Broadfoot from SRI discussed the alternatives in Australia for raw materials for ethanol production, having the 10% ethanol blend with gasoline as target.

**Energy balance in ethanol production**

Two presentations by IPRO engineers indicated how energy could be saved in the distillation process and how the cogeneration could be maximised by an optimum integration of the ethanol and sugar factories.

The greenhouse gas emission reduction of the ethanol was demonstrated in the joint work of CTC and the University of Campinas; the life cycle analysis of the sugar cane and ethanol production indicated that the ratio of renewable energy output to fossil energy input is of the order of 9:1.

**Ethanol production technologies**

Two presentations by engineers of Dedini and Bionanotech Research Institute (BNRI) of Japan covered the dehydrolysis process; the former described an azotropic dehydration technology while the latter dealt with a modern and innovative zeolite membrane alternative that can produce ethanol with a very low moisture content.

The importance of two co-products, ethanol and electric energy, in the economic survival of the Rocky Point Sugar Mill and Distillery in Australia was analysed by David Heck.

The point of view of a mill owner with respect to the associated production of ethanol and sugar was presented by Mr Paulo Nogueira Jr, pointing out the flexibility to change the sugar/ethanol ratio based on market conditions.

The evolution of the ProAlcohol program was explained by Mr Jaime Finguerut of CTC indicating the efficiency levels that became a common place in most ethanol/sugar mills in Brazil.

This presentation was nicely supplemented by Mrs Idalina Spina from Santa Adélia mill describing their struggle to overcome a very serious chronic bacterial infection in the mill continuous fermentation system. A Bolivian way to face the ethanol option was presented by a representative of Guabira Sugar Factory indicating the required modifications in the sugar mill to produce ethanol in increasing amounts.
By products of the ethanol production

Under Brazilian conditions for conducting fermentation, the yeast is recycled but it is necessary to bleed a certain portion of the recycled yeast in order to maintain its fermentative strength. CTC work to find alternatives to add value to this bled yeast was described, showing different byproducts that could be obtained.

The Andhra Sugar Ltd, from India, introduced its broad spectrum of by products that are produced from the sugar mill flows such as ethanol, CO₂, electricity, acetic acid, acetic anhydride, ethyl acetate, butyl acetate and Aspirin. CTC demonstrated that vinasse if well handled can become a very important material for fertigation, increasing cane yields and reducing fertiliser costs, all without any appreciable environmental impact.

Other co-products from sugar cane

Dr Carlos Rossell from CTC made a presentation of the most important and viable alternatives of co-products from sugar, ethanol and bagasse production, indicating routes to produce valuable chemicals such as organic acids, amino acids, polymers, solvents, flavouring agents, manitol, sorbitol, furfural, xilitol, waxes, sterols and others. He also described the technology of producing bioplastic polyhydroxy butirate (PHB) by sugar fermentation.

The biocomposting technique for filter cake mixed with vinasse used in the Shakarganj Mill, in Pakistan, was presented showing how it resulted in increased efficiency of nitrogen, phosphorus and potassium resulting in an economy of fertilisers.

Integration of co-products production with the sugar factory and energy cogeneration

The history of cogeneration in the Mauritius sugar mills was presented by Mauritius Sugar Authority focusing on economic aspects and in the smart way found to solve the power revenue sharing problem between mill owners and small cane growers. A presentation by MSIRI explained the differences in power generation between the production of only sugar and associated production of sugar and ethanol.

Procknor Engenharia explored other aspects of energy balance when ethanol and sugar are produced in the same mill. The last presentation by CTC covered the integration of the DHR process with a sugar/ethanol mill, quantifying the energy flows and optimising the use of bagasse for the joint production of ethanol and energy.

The review of the workshop presentations and discussions has indicated some important observations:

- Those countries planning to start the large-scale production of ethanol are planning to increase sugar cane production and maintain the present level of sugar production.
- Final molasses seems to be the preferred raw material—an option different from that adopted in Brazil that uses rich molasses and sugar cane juice blends as raw material.

Site visits

The first day consisted of a tour to CTC installations and a visit to the DHR demonstration plant at the São Luiz Mill (Dedini Agroindustrial) where the delegates received detailed explanation about the process and plant equipment. The design capacity of the facility is 5000 L of ethanol per day and it was a joint design of Dedini and CTC.

At the mill, the visitors had the opportunity to see the prototype of the Riviere juice extractor designed and built by CTC based on the patent of the process developed by the late Maxime Riviere from Reunion. The third area visited was the distillery where the PDE distillation process developed by Dedini could be seen.

The next and last day, July 18, was occupied by visits to two Copersucar mills in the Ribeirão Preto region which is the most important sugar cane center in Brazil.

The morning visit was to Santa Adelia mill that has a very modern cogeneration facility based on 65 bar boilers and 42 MW of installed capacity; the mill is a medium size unit that crushes around 2 million tonnes of cane per year and has a very efficient (97.7%) milling tandem with a high level of automation.

The distillery is based on a four stage continuous fermentation of CTC design with recovery and drying of bled yeast. The farms were included in the visit to demonstrate the technology of vinasse application in the cane fields.
The da Pedra mill, which crushes 3.4 million tonnes of sugar per season, was visited in the afternoon. The visit concentrated on the distillery that has a very energy efficient dehydration system based on molecular sieves. The PHB plant was seen from the outside due to the proprietary aspects of the technology.

The mill has a cogeneration facility with 65 bar boilers and a turbo-generator of 20 MW.

After the visit to Ribeirão Preto, the workshop was officially closed and the delegates dispersed.

**LA PRODUCTION ET L'UTILISATION DE L'ÉTHANOL: RÉSUMÉ DE L'ATELIER DE TRAVAIL DE L'ISSCT SUR LES CO-PRODUITS**

**M. REGIS L.V. LEAL**

*Centro de Tecnologia Copersucar – Fazenda Santo Antonio, Piracicaba – SP – Brasil*

**regis@copersucar.com.br**

**MOTS CLÉS: Ethanol, Co-Produits, Combustible Renouvelable, Balance Énergétique.**

Résumé

CETTE PRÉSENTATION résume les travaux de l'atelier de travail de la section co-produits de l'ISSCT dont le thème principal était «La production et l'utilisation de l'éthanol». En juillet 2003, 58 délégués venant de 12 pays ont assisté à cet atelier de travail, placé sous l'égide du ‘Copersucar Technology Center’ situé à Piracicaba, São Paulo, Brésil. Durant deux jours de sessions plénières, 31 communications ont été présentées, distribuées en huit sessions techniques couvrant les programmes d’éthanol au Brésil et ailleurs, l’utilisation de l’éthanol pour les véhicules, les alternatives aux matières premières dans la production d’éthanol, la balance énergétique, les technologies de production d’éthanol, les sous-produits de l’éthanol, la production d’autres co-produits des sucreries, et la cogénération d’énergie. Les deux derniers jours de l'atelier de travail étaient consacrés à des visites sur le site, offrant ainsi aux délégués l’occasion de voir les différentes technologies utilisées au Brésil pour produire l’éthanol: les procédés conventionnels (fermentation continue et discontinue, déshyrations alternatives), les nouvelles technologies (production d’éthanol par hydrolyse de la bagasse), les aspects environnementaux et la cogénération. Durant les sessions plénières et les visites de sites les discussions animées entre les délégués ont permis des échanges fructueux d’idées et d’expériences.

**PRODUCCIÓN Y USO DEL ETANOL: RESUMEN DEL TALLER DE LA ISSCT SOBRE CO-PRODUCTOS**

**M. REGIS L.V. LEAL**

*Centro de Tecnologia Copersucar – Fazenda Santo Antonio, Piracicaba – SP – Brasil*

**regis@copersucar.com.br**

**PALABRAS CLAVES: Etanol, Co-productos, Combustible renovable, Balance Energético.**

Resumen

EL TRABAJO presenta el resumen del Taller de la Sección de Co-productos de la ISSCT que tuvo ‘La producción y uso del etanol’, como el tema central. En este Taller en el que fue anfitrión el Centro de Tecnología de Copersucar en Piracicaba, Sao Paulo – Brasil en julio de 2003, participaron 58 delegados de 12 países. Los dos días de sesiones plenarias contaron con 31 presentaciones distribuidas en ocho secciones técnicas que cubrieron los programas de etanol en Brasil y en otros países, usos automovilísticos del etanol, materias primas alternativas para la producción de etanol, balances de energía, tecnologías de producción de etanol, subproductos del etanol, otras producciones de co-productos en la fábrica de azúcar y la cogeneración de energía. Las visitas ocuparon los últimos dos días del Taller y brindaron a los delegados la oportunidad de ver diferentes tecnologías utilizados en Brasil para producir etanol: (fermentaciones continuas y en lotes; alternativas de deshidratación), tecnologías innovativas (hidrólisis – etanol de bagazo), aspectos ambientales y cogeneración. Durante las sesiones plenarias y las visitas, las discusiones entre los delegados proveyeron fructíferos intercambios de ideas y experiencias.