

ETHANOL FROM SUGAR CANE IN BRAZIL: EVOLUTION, PRESENT SITUATION AND FUTURE POSSIBILITIES



Ethanol – Gasoline blends: The early experience

Sugar cane production in Brazil started in the 16th Century; in 1931 a 5% (E5) blend of ethanol and gasoline was compulsory. During the 2nd. World War the Northeast Region used a 40% (E40) blend. In 1941, 44 distilleries were in operation in Brazil.

The “ Pro-álcool ” program

- **Subsidies (low interest rates for distillery building; quotas with purchase agreements) were used to start the Pro-álcool program:**
- **Phase 1, 1975**
 - **Anhydrous ethanol blending (E20) with gasoline; use of the existing sugar cane / sugar production infrastructure, adding larger distilleries to the sugar mills**
- **Phase 2, 1979**
 - **“Autonomous” distilleries, new cane producing regions; development of E100 engines; starting of important technology programs.**

From 1985 to 1990 oil prices determined a stabilization of ethanol production 3.2 billion gallons/year.

In the 1990's the sector was de-regulated (no production or commercialization controls, or price support). A strong expansion of cane production was due to increased sugar exports.

Starting in 2000, the introduction of flex-fuel cars resulted in new expansion of the ethanol production ~ 4.3 billion gallons/year,2005)

Ethanol production today

- In 2005, 380 M t sugar cane (in 310 sugar mills) yielded 26 M t sugar and 4.1 billion gallons ethanol.
- Brazil is the world's largest producer of sugar cane (33.9%), sugar (18.5%) and ethanol (36.4%); and the largest exporter of sugar and ethanol.
- It is also the lowest cost producer; from 1975 to 2002 the productivity (gal ethanol/ acre) increased 2.3 X, while ethanol costs (constant US\$/GJ) decreased 3.0 X.
- Today 41 new mills are being built (50 more in evaluation). They could double the present ethanol production.
- Ethanol corresponds to 40.6% of the fuel for light vehicles (total fleet: 22 M vehicles).
- Flex-fuel cars corresponded to 80% of the sales of new units (may 2005).

Some sustainability issues

- **Life cycle (Ethanol energy)/(Fossil input) = 8; this leads to *avoiding GHG emissions ~ 13% of the total emissions from the energy sector in Brazil.***
- **Air pollution in urban areas greatly benefited from ethanol /gasoline blends; legal restrictions on cane burning are providing adequate protection in rural areas**
- **No irrigation is used; and the water uptake for industry has been strongly reduced in the last ten years. Protection of water streams and sources is enforced in the high production areas**

Some sustainability issues

- **The cane agro-industry provided nearly 800000 *formal, direct jobs* in 2002 in spite of increasing mechanization; the wages are *higher than for any other crop, except for soybeans*.**
- **Soil utilization: from its 2,100 billion acres, Brazil uses 7% for agriculture; 35% as “pasture land”, and 55% have natural forests. Sugar cane uses 0,7% of Brazil area (half to ethanol); *areas suitable for expansion are at least 12%*. Today’s growth occurs mostly in “pasture land”.**

Sugar cane and the (near) future

- **Besides continuous process evolution, and some possible larger steps (transgenic sugarcane, for instance) it is expected that energy products (electricity and fuels) will become increasingly important for this industry.**
- ***In 2005, 60 M t sucrose were used for sugar and ethanol in Brazil; but most of the corresponding 120 M t ligno-cellulosic material (cane bagasse and trash) were wasted or used inefficiently. .***

Sugar cane and the (near) future

- **“Bio-refineries” with full utilization of sucrose and wastes (bagasse and trash) in the next 10 – 20 years will increase significantly the range of products and their value.**

Technologies in development (worldwide) are key for this transformation: the hydrolisis of biomass (bagasse and trash),and biomass gasification, leading to power or fuel synthesis.

Sugar cane appears an ideal feedstock for future “bio-refineries”, for its relatively low cost, large availability and an interesting mix of 1/3 sucrose & 2/3 pre-processed ligno-cellulosic material.



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