INTERNATIONAL WORKSHOP ON BIOENERGY POLICIES, TECHNOLOGIES AND FINANCING
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DEDINI`S DHR TECHNOLOGY
A BREAKTHROUGH IN CANE BASED ETHANOL

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OPERATIONAL VICE PRESIDENT

DEDINI S/A INDÚSTRIAS DE BASE
FOUNDED IN 1920, IN BRAZIL, DEDINI BASICALLY ACTS IN THE CUSTOM-MADE CAPITAL GOODS SECTOR

PARTS, COMPONENTS, EQUIPMENT, COMPLETE PLANTS (TURN-KEY), SERVICES

DEDINI INDÚSTRIAS DE BASE IS A COMPANY ORIGINATED FROM THE MERGER OF DEDINI METALÚRGICA, ZANINI AND CODISTIL DEDINI.
DEDINI’S CONTRIBUTION TO SUGARCANE INDUSTRY

<table>
<thead>
<tr>
<th>OWN TECHNOLOGY</th>
<th>COMPLETE TECHNOLOGY</th>
<th>OWN DEVELOPMENT</th>
<th>PIONEERING</th>
</tr>
</thead>
</table>

**• DEDINI TECHNOLOGIES**
- EQUIPMENT TECHNOLOGY
- PROCESS TECHNOLOGY
- COMPLETE UNITS TECHNOLOGY
- RESEARCH AND TECHNOLOGICAL DEVELOPMENT

**• DEDINI’S SUPPLIES**
- PARTS AND COMPONENTS
- EQUIPMENT
- COMPLETE LINE OF PRODUCTS
- COMPLETE PLANTS (TURN-KEY)
- SERVICES

**HISTORICAL MARKET SHARE IN BRAZIL: OVER 80%**

**OVER 80% OF THE ALCOHOL PRODUCED IN BRAZIL USES DEDINI’S DISTILLERIES AND EQUIPMENT.**
### DEDINI’S NUMBERS – SUGAR AND ALCOHOL

**TURNKEY PLANTS INSTALLED IN BRAZIL:**

- **ALCOHOL DISTILLERIES** 734
- **ALCOHOL MILLS - AUTONOMOUS ALCOHOL PLANTS** 106

**ALCOHOL / SUGAR PLANTS ABROAD:**

VENEZUELA / EQUADOR / PERU / HAITI / PAKISTAN
ETHIOPIA / COSTA RICA / PARAGUAY / BOLIVIA / GUATEMALA / ARGENTINA / MEXICO 23

<table>
<thead>
<tr>
<th>MILLING UNITS</th>
<th>BOILERS</th>
<th>COGENERATION PLANTS (TK)</th>
</tr>
</thead>
<tbody>
<tr>
<td>2.370</td>
<td>1.200</td>
<td>112</td>
</tr>
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</table>

**WORLD’S GREATEST SALES VOLUME**

DEC/2003
INTRODUCTION TO THE HYDROLYSIS PROCESSES

THE THREE STAGES OF THE PROCESS OF ALCOHOL PRODUCTION FROM CELLULOSIC MATERIALS

HYDROLYSIS (SACCHARIFICATION)

FERMENTATION

DISTILLATION

[Diagram showing the three stages of the process of alcohol production from cellullosic materials, including hydrolysis, fermentation, and distillation.]
INTRODUCTION TO THE HYDROLYSIS PROCESSES

HYDROLYSIS MAY BE APPLIED TO ANY CELLULOSIC MATERIAL: FORESTRY RESIDUES, WOOD, GRASSES, AGRICULTURAL RESIDUES, THAT ARE THE RAW MATERIALS FOR HYDROLYSIS.

NECESSARY CONDITION FOR THE RAW MATERIAL

- AVAILABILITY
- LOW COST/PRICE

IN BRAZIL, THE MOST SUITABLE RAW MATERIAL IS SUGARCANE BAGASSE

- ALREADY PREPARED BY THE MILLS
- AVAILABLE IN LARGE QUANTITIES
- MINIMUM COST OR ZERO COST
- AVAILABLE AT THE PLACE WHERE USED

IN THE NEAR FUTURE, CANE STRAW MAY BE RAW MATERIAL OR, BEING USED AS BOILER FUEL, RELEASE BAGASSE FOR HYDROLYSIS.

SUGARCANE BAGASSE COMPOSITION

<table>
<thead>
<tr>
<th>NATURAL POLYMERS</th>
<th>CELLULOSE</th>
<th>HEMICELLULOSE</th>
<th>LIGNIN</th>
</tr>
</thead>
</table>

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WHAT IS THE DHR-DEDINI RAPID HYDROLYSIS PROCESS

MAIN PROBLEMS OF CHEMICAL HYDROLYSIS PROCESSES

- LIGNIN restricts access to cellulose, and first needs to be removed.
- The conditions for removing lignin are severe and it takes a long time (hours).
- The medium in which hydrolysis is processed attacks the sugar formed. Thus, soon after the sugar is formed, its degradation is processed, reducing the yield of the reaction.
WHAT IS THE DHR-DEDINI RAPID HYDROLYSIS PROCESS

HOW DHR-DEDINI RAPID HYDROLYSIS SOLVES THESE PROBLEMS

- Use of a strong lignin solvent, at high temperatures, enabling rapid access to cellulose and hemicellulose, after lignin has been dissolved.
- Very fast sugar formation speed (minutes), raising yields.
- The medium in which hydrolysis is processed, favoured by the lignin solvent, has a minimum acid concentration.
- Immediate removal of sugar formed, with rapid cooling of the hydrolyzed product, interrupts sugar degradation by the action of temperature.
- Neutralization of the hydrolyzed product, stabilizing the sugar obtained.
WHAT IS THE DHR-DEDINI RAPID HYDROLYSIS PROCESS

CONTINUOUS DHR REACTOR

BAGASSE “IN NATURA”

HYDROLYZED PRODUCT

HYDROLYZED PRODUCT

HYDROLYZED PRODUCT

FLASH

NEUTRALIZER

MASH

HYDROSOLVENT SOLUTION, LOW ACID CONCENTRATION

DHR PROCESS = ORGANOSOLV PROCESS + CHEMICAL HYDROLYSIS WITH VERY DILUTED ACID

LIGNIN SOLVENTS - IN GREAT NUMBER (26 ANALYSED)

DEDINI USED VARIOUS SOLVENTS. THE FINAL CHOICE WAS ETHANOL.
NEW TECHNOLOGIES OF GREAT IMPACT

ALCOHOL PRODUCTION FROM BAGASSE

DHR – “DEDINI HIDRÓLISE RÁPIDA” - RAPID HYDROLYSIS DEDINI: ENVOLVING HYDROLYSIS (+) FERMENTATION (+) DISTILLATION FOR THE ETHANOL PRODUCTION FROM BAGASSE.

DHR – PROCESS DEVELOPED BY DEDINI WITHIN THE 80’s. APPROVED AND FINANCED BY GOVERNMENTAL BRAZILIAN AGENCIES WITH FUNDS FROM THE WORLD BANK.

PATENTS ISSUED IN THE USA, EU, CANADA, MEXICO, BRAZIL AND RUSSIA. PATENTS REQUESTED AND UNDER APPRECIATION IN JAPAN AND OTHER COUNTRIES.

DEDINI DEVELOPED AND OPERATED A PILOT PLANT OF 100 L ALCOHOL/DAY, CURRENTLY INSTALLED AT THE CTC-COPERSUCAR.

TECHNICAL COOPERATION AGREEMENT DEDINI - COPERSUCAR, SIGNED NOVEMBER/97.

A 5,000 L ALCOHOL/DAY SEMI-INDUSTRIAL PLANT WAS INSTALLED IN NOVEMBER/2002 AT SÃO LUIZ SUGAR AND ALCOHOL PLANT, DEDINI GROUP, LOCATED IN PIRASSUNUNGA - SP, BRAZIL. PROJECT GATHERED DEDINI, COPERSUCAR AND FAPESP (STATE OF SÃO PAULO RESEARCH SUPPORT OFFICIAL AGENCY)

TODAY: SEMI INDUSTRIAL PLANT IN CONTINUOUS OPERATION STAGE, IN ORDER TO CONCLUDE THE DEFINITION OF ENGINEERING PARAMETERS THAT WILL BY UTILIZED TO DEVELOP A FULL SCALE INDUSTRIAL PLANT.
DHR IS A PERSONAL PROJECT OF MR. DOVILIO OMETTO, SHAREHOLDER AND CHAIRMAN OF DEDINI, WHO BELIEVED IN DHR – DEDINI RAPID HYDROLYS PROCESS AND LEADED IT SINCE ITS BEGINNING (DECADE OF 1980)
DEVELOPMENT OF THE DHR-DEDINI RAPID HYDROLYSIS TECHNOLOGY

DHR PILOT AND LABORATORY

GENERAL VISION – DHR PILOT PLANT

PILOT 100 L ALCOHOL/DAY

BAGASSE FEEDING

SAMPLE: BAGASSE “IN NATURE”, HYDROLYZED FROM THE REACTOR, HYDROLYZED FROM THE COLUMN OF SOLVENT RECUPERATION; DHR ALCOHOL.

DHR REACTOR

ALCOHOL PRODUCTIVITY
L HYD ETH / TON BAGASSE “IN NATURE”

<table>
<thead>
<tr>
<th>Description</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>PILOT – ACTUAL (ONLY HEXOSE)</td>
<td>109</td>
</tr>
<tr>
<td>DHR PROCESS POTENTIAL (HEXOSE+PENTOSE)</td>
<td>180</td>
</tr>
</tbody>
</table>
DEVELOPMENT OF THE DHR-DEDINI RAPID HYDROLYSIS TECHNOLOGY

MAIN RESULTS ACHIEVED

YIELD IN TRS – TOTAL REDUCING SUGARS

| AVERAGE - RUN | - | 68,2% |
| STABLE PEAK – STABILITY CONDITION | - | 88% |

TRS CONCENTRATION IN HYDROLYZED PRODUCT: 10,9%

FERMENTATION YIELD (HEXOSE): 89%

REACTOR FEED RATE: 343,7 G/MIN (20,6 KG/H)

STABLE AND CONTINUOUS OPERATION
DEVELOPMENT OF THE DHR-DEDINI RAPID HYDROLYSIS TECHNOLOGY

THE SEMI INDUSTRIAL PLANT - 5,000 L/DAY

BAGASSE: RAW MATERIAL FOR THE DHR AND DHR HYDROLYSIS PLANT

REACTOR TOWER WITH BAGASSE FEEDING SYSTEM
POTENTIAL AND IMPACT OF DHR - DEDINI RAPID HYDROLYSIS PROCESS

DHR INTEGRATION TO TRADITIONAL PLANT

ALCOHOL PLANT
OR SUGAR MILL WITH ANNEX ALCOHOL DISTILLERY
(ENERGY-OPTIMIZED TRADITIONAL PROCESS)

SUGARCANE
STRAW
SUGAR
ALCOHOL

LIGNIN
SURPLUS ENERGY

STILLAGE
STRAW
ENERGY
BIODIGESTION

BOILER + TURBOGENERATOR

DHR

HIDROLYSATE
BAGASSE + STRAW
LIGNIN
ENERGY

SUGAR
ALCOHOL
STALKS
VEHICLE EMISSIONS FROM ETHANOL-GASOLINE MIXTURES ARE LESS POLLUTING

ETHANOL FROM BIOMASS HAS ADVANTAGES AS REGARDS VEHICLE EMISSIONS AND BECAUSE THEY DO NOT CONTRIBUTE TO THE GREENHOUSE EFFECT.

BEING A RENEWABLE SOURCE OF ENERGY AND REPLACING PETROLEUM, PROMOTES CARBON SEQUESTERING, REDUCING THE GREENHOUSE EFFECT. VALORIZING STRAW, CONTRIBUTES TO ELIMINATE CANE BURNING.
POTENTIAL AND IMPACT OF DHR - DEDINI RAPID HYDROLYSIS PROCESS

DHR – ECONOMIC IMPACT

REDUCTION IN THE COST OF ALCOHOL WITH THE EVOLUTION OF DHR TECHNOLOGY

- Conservative initial productivity.
- Acceptable for emergent technology.
- Greater productivity results from experience and development of the technology.

**Potential and Impact of DHR - Dedini Rapid Hydrolysis Process**

- Potential productivity of the process
- Competitive with traditional alcohol production process
- Near US$ 26/Barrel

**Legend**

- PILOT PRODUCTIVITY
- COMPETITIVE WITH TRADITIONAL ALCOHOL PRODUCTION PROCESS
- NEAR US$ 26/Barrel

**Graph**

- Y-axis: US$/L
- X-axis: L hyd. ALC/t bag

**Notes**

- Greater productivity results from experience and development of the technology.
### POTENTIAL AND IMPACT OF DHR - DEDINI RAPID HYDROLYSIS PROCESS

#### DHR – IMPACT ON PRODUCTION AND PRODUCTIVITY – CONTRIBUTION TO THE OFFER

**Autonomous Alcohol Plant - Average Productivity – Brazil Center South – Traditional Alcohol Process - Example**

<table>
<thead>
<tr>
<th>1 HA</th>
<th>80 T Clean Cane</th>
<th>Juice</th>
<th>6.400 L Alcohol</th>
</tr>
</thead>
</table>

**Autonomous Alcohol Plant - Average Productivity – Brazil Center South – Traditional Alcohol Process + DHR (Productivity at the Potential) Example – With Energetic Optimization in the Traditional Alcohol Process**

<table>
<thead>
<tr>
<th>1 HA</th>
<th>96 T Integral Cane (Incl. Straw)</th>
<th>Juice</th>
<th>6.400 L Alcohol</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Baggasse + Straw</td>
<td></td>
<td>5.650 L Alcohol</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>12.050 L Alcohol</td>
</tr>
</tbody>
</table>

**It is possible to almost double the alcohol production in the same cultivated land area**
THANK YOU FOR YOUR ATTENTION