Continuous improvement in cane raw sugar decolorisation technology

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NOVASEP PROCESS
BSST meeting Nov 2010
Novasep Process

**Biomolecules**
- Biopharmaceuticals
- Food Ingredients
- Functional Ingredients
- Bio-Industries

Novasep Synthesis

**Synthetic Molecules**
- Pharmaceuticals
- Agrochemicals
- Cosmetics
- Fine Chemicals
1995
Creation by Roger-Marc NICoud
Niche expertise in continuous purification technologies

1997

1998
US subsidiary
Local presence on world major pharmaceutical market

1999
Acquisition of PROCHROM
World leadership in industrial chromatography for synthetic molecules

2000

2003
Acquisition of SERIPHARM
Global manufacturing of HPAs

2004
Acquisition of APLEXION and ORELIS
World leadership in purification technologies for bio-industries

2005
Acquisition of DYNAMIC SYNTHESIS
Leading API manufacturing capabilities

2006
Acquisition of TANGENX
Innovative membrane and chromatographic technologies for biopharmaceuticals DSP

2007
Acquisition of PHARMACHEM
Key expansion of API manufacturing in North America

2008
Contract Biomanufacturing
30 M€ investment 2 cGMP production facilities

2009
Acquisition of Henogen cGMP upstream and downstream bioprocessing
Close to our Customers

Pompey (F)
Headquarters

St-Maurice-de-Beynost (F)
Purification Process Development Process Engineering

Shrewsbury MA-USA
Tangential flow filtration technologies

Boothwyn- PA-USA
Sales office & R&D lab Process Engineering

Tokyo (J)
Sales office

Shanghai (PRC)
Sales office & R&D lab Process Engineering

Seneffe (B)
cGMP contract biomanufacturing (drug substances and drug products)
European & local regulations AfMPS BL2 containment

Pompey (F)
Chromatography technologies, Biopharma DSP
FDA inspected European & local regulations AFSSAPS

Mourenx (F)
Chiral Technologies Multi-ton Synthesis
FDA inspected European & local regulations AFSSAPS Japanese FDA certified

Chasse-sur-Rhône (F)
Chiral Technologies Scale-up Multi-ton Synthesis
FDA inspected European & local regulations AFSSAPS Japanese FDA certified

Le Mans (F)
Highly Potent Active Pharmaceutical Ingredients
FDA inspected European & local regulations AFSSAPS SafeBridge® certified

Leverkusen (D)
Hazardous Chemistry Scale-up Multi-ton Synthesis
FDA inspected European & local regulations Bavaria, Kais Japanese FDA certified Korean FDA inspected

Freeport (BS)
Multi-ton API production capacity
FDA inspected Local regulations & FDA Japanese FDA certified

Gosselies (B)
cGMP contract biomanufacturing (drug substances and drug products)
European & local regulations AfMPS BL2/BL3 containment
Novasep Process Markets

- **Biopharma**
  - Blood Fractionation
  - mAbs
  - Recombinant Proteins
  - Vaccines
  - Cell Therapy

- **Food Ingredients**
  - Sugar
  - Starch
  - Milk

- **Functional Ingredients**
  - Polyphenols
  - Anthocyanes
  - FOS
  - Sweeteners

- **Bio-Industries**
  - Vitamins
  - Antibiotics
  - Organic Acids
  - Aminoacids
Decolorization of Raw Cane Sugar syrup

- Decolorization is one of the critical steps in raw cane sugar refining.
- Reduce color of filtered syrup from 500-1200 Icumsa to 100-300 Icumsa in order to crystallize white refined sugar at 25-45 Icumsa (R1+R2+R3 refined sugar).
- 70-90% color reduction.

Must remove color:
- Initially present in canne: Polyphenols
- Developed during the refinery process: Caramel, Melanoidins, Hexose Degradation Products.
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3 industrial technologies are used for decolorization of raw cane sugar syrup in sugar refineries:

- **Bone char**
- **Activated carbon**
  - powdered carbon + filtration for small capacities
  - Fixed-bed granular carbon columns for large capacities
  - Pulse-bed granular carbon systems
  - External thermal reactivation / onsite thermal reactivation
- **Ion-exchange resins**

Only ion-exchange resins systems are Capex and Opex competitive for smallest to largest refinery capacities.

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**Inventory for 2000 tons refined sugar per day**

<table>
<thead>
<tr>
<th></th>
<th>Installed m³</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bone char</td>
<td>1600</td>
</tr>
<tr>
<td>GAC</td>
<td>600</td>
</tr>
<tr>
<td>IX</td>
<td>90</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>BV/h</th>
<th>0.05 - 0.1</th>
<th>0.25 - 0.5</th>
<th>1 - 4</th>
</tr>
</thead>
</table>

Decolorization of Raw Cane Sugar syrup

Capex/Opex for 2000 tons refined sugar/day

- Bone char: 1600 m³, Capex 5.6 MEuros, Opex 1.8 Euros/ton sugar
- GAC/Kiln: 600 m³, Capex 5.2 MEuros, Opex 1.8 Euros/ton sugar
- IX/VAP/NF: 90 m³, Capex 2.8 MEuros, Opex 1.3 Euros/ton sugar
Decolorization of Raw Cane Sugar syrup
Decolorization of Raw Cane Sugar syrup

Novasep Process combined refining capacities:

Novasep Process SAS - Sugar decolorization systems
Combined installed capacity in tons refined sugar /day

Year

0 5 000 10 000 15 000 20 000 25 000 30 000 35 000 40 000
Decolorization of Raw Cane Sugar syrup

- Success driven by continued innovation in the ion-exchange decolorization process:
  - 1978: downflow → upflow syrup decolorizers
  - 1983: double-cell upflow compact decolorizers
  - 1996: regenerant brine recovery from effluent by NF (first industrial system worldwide, after pilot trials by SMRI, Tongaat, Applexion)
  - 1997: preconcentration of dilute regeneration effluent by atmospheric concentration (procédé Lorant)
  - 2004: development of pre-engineered solutions for customers projects
    - 9 capacities
    - Decolo
    - Decolo + NF
    - Decolo + VAP + NF
    - Efficient toolbox = many solutions for all refinery projects
Decolorization of Raw Cane Sugar syrup

PFD-1: HCl 33%

PFD-2: NaCl 9%

PFD-3: HCl 33%

Applexion SAS

Kg NaCl /tS

10xm3 Water /tS

10xm3 Effluent/t S
Decolorization of Raw Cane Sugar syrup

PFD-1

22-102 PR01.01 1/1

ION-EXCHANGE DECOLORIZATION

E 22-101 PR01.05

REV DATE CHECK
20/01/2006

DESIGN
0R M 1 24/08/2006 RM

PFD-2

REV DATE DESIGN CHECK
20/01/2006

FR

BRINE NF RECOVERY

Applexion SAS

PFD-3: HCl 33%

C120A

C120B

C120C

DS

PDS

PDS

PDS

PT

PT

PT

PI

PI

PI

Applexion SAS

PFD-2: NaCl 9%

CIP WATER

NFR NF Retentate

NFP NF Permeate

MEMBRANES

NF260

PFD-1: NaCl 9%

COLD WATER

NEUTRALIZATION TANK

NEUTRAL  BRINE 300 g/l

PREPARATION TANK

Decolo NF

Kg NaCl /tS

10xm3 Water /tS

10xm3 Effluent/t S

Kg NaCl /tS

10xm3 Water /tS

10xm3 Effluent/t S
Decolorization of Raw Cane Sugar syrup
Success driven by continued cooperation and shared process improvement with major Refiners in this industry:

- 1978 : First complete replacement of bone char decolorization system with Generale Sucrière in Marseilles
- 1995-1997 : First NF brine recovery process with Generale Sucrière in Marseilles
- 1989-2005 : Bone char replacement project at Lantic Sugar in Montreal 2000 tons sugar/day
- 1990-2009 : Cosumar in Casablanca 3000 tons sugar/day
- 2000-2009 : Cevital in Bejaia 5000 tons sugar/day
Decolorization of Raw Cane Sugar syrup

- Presentations from many team members at professional exhibitions and industry meetings:

  2000 CANE SUGAR REFINING HANDBOOK
  Dr Chi-Chou 2nd Edition - John Wiley & Sons
  CHAPTER 10 : ION-EXCHANGE RESIN PROCESS FOR COLOR AND ASH REMOVAL
  Denis Bourée/François Rousset

  SIT 2001 ION-EXCHANGE DECOLORATION : A FLEXIBLE WAY TO MODERNIZATION AND CAPACITY EXTENSION
  Jean de Lataillade/François Rousset

  SIT 2004 DECOLORIZATION OF REFINERY LIQUORS : A TECHNICAL AND ECONOMIC COMPARISON BETWEEN THE DIFFERENT SYSTEMS USING ACTIVATED CARBON OR RESINS.
  Francis Gula/Dominique Paillat

  SIT 2006 NEW DEVELOPMENTS FOR THE REDUCTION OF THE CHEMICAL CONSUMPTIONS AND THE PRODUCTION OF EFFLUENTS IN MODERN ION-EXCHANGE DECOLORATION SYSTEMS FOR THE SUGAR REFINERY
  Xavier Lancrenon/François Rousset

  SIT 2007 PROGRESSIVE REPLACEMENT OF BONE CHAR DECOLORIZATION BY AN ION-EXCHANGE RESIN SYSTEM AT LANTIC MONTREAL
  Francis Gula/Xavier Lancrenon/François Rousset
  BEST PAPER AWARD SIT 2007
Decolorization of Raw Cane Sugar syrup

SIT 2008  NEW TECHNOLOGIES USED IN MINIMIZING WASTE WATER IN SUGAR FACTORIES AND REFINERIES  Xavier Lancrenon

IAA 2004  DES PROCEDES D'ECHANGE D'IONS RESPECTUEUX DE L'ENVIRONNEMENT : MYTHE OU REALITE  Francis Gula/Dominique Paillat

IAA 2008  NOUVELLES TECHNOLOGIES UTILISEES POUR REDUIRE LA PRODUCTION D'EFFLUENTS DES SYSTEMES D'ECHANGE D'IONS DANS L'INDUSTRIE SUCRIERE  Xavier Lancrenon

IAA 1980  DECOLORATION DU SIROP DE REFONTE DE SUCRE DE CANNE A LA RAFFINERIE DE MARSEILLE  Raymond Celle/Daniel Hervé

1997  DESALINATION 113 – NF BRINE RECOVERY FROM REFINERY DECOLORIZATION EFFLUENT  Stéphanie Cartier/Marc-André Théoleyre/Martine Decloux

SPRI 1999  RESIN DECOLORIZATION OF HIGH COLOR SYRUPS THANKS TO REGENERATION RECOVERY  François Rousset
Decolorization of Raw Cane Sugar syrup

Next steps?

- Further innovation for greener process, smaller Opex: Decolo/VAP/NF/RO?

- Projects for joint production of refined sugar and liquid sucrose/medium invert syrup in cane sugar refineries

- More new refinery projects in large sugar consumption areas for domestic market, or for re-export in EU market

- Decolorization needs for co-refining of cane raw sugar in beet sugar factories