Ion Exchange Decolorization Applications Using Fractal Shallow Bed Equipment

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Applicability of Available Information And Challenges For Beet Sugar Applications

• Most information is about low color (less than a 1000 IU) cane syrups
• Resin bed depth – 6-13 feet (flowrates, pressure drop issues)
• Irreversible fouling with high MW colorants (the composition is different for beet extract / thick juice)
• Amount of regenerant waste is proportional to color removal (high color syrups will generate larger amount of waste - needs to be addressed)
• Different pH, Brix, etc.

Old style equipment is expensive, new approaches required
Group Consortium Trials

- Amalgamated Sugar
- American Crystal
- Michigan Sugar
- Rogers Sugar
Pilot Equipment
Effect of Brix on Decolorization

(30 and 70 BX extract, 16 Bx Thin Juice - 3 ft resin bed)
Study Highlights

• Decolorization can be accomplished in relatively short beds that minimizes the capital investment.
• Decolorization on dilute juices is more efficient. Additionally, the overall resin loading is higher due to accessibility of resin active sites.
• As a result, the amount of regenerant can be reduced. Regenerant use can be optimized by partial recycle and nanofiltration.
• Regeneration can be accomplished at higher flowrates.
• Fractal Shallow Bed equipment design allow to bring both capital and operating cost to a reasonable level.
Escon / ARi Fractal Shallow Bed Softener Installation In a European Sugar Plant
Two Consecutive White Boilings in the Beet Sugar Industry

Underlying Concept - Reduce Negative Impact of Recycles
Reasons for Recycle

• Higher product recovery
• Improved quality of the product,
• Minimized environmental impact through the reduction waste streams
• Improved heat recovery
• Etc.
Effect of Recycle on Sugar Inventory

100 150

50

100 120 100

20

Recycles Require Larger Equipment
## Sugars™ Estimates for Two White Boilings

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Existing</th>
<th>White Two White Products</th>
<th>Existing</th>
<th>High Raw Two White Products</th>
<th>Existing</th>
<th>Low Raw Two White Products</th>
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<tbody>
<tr>
<td>M/Cuite Flow (cu. ft./hr)</td>
<td></td>
<td>2,286</td>
<td>1,672</td>
<td>1,089</td>
<td>785</td>
<td>462</td>
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<tr>
<td>% Sugar Recycle</td>
<td></td>
<td>42.1</td>
<td>18.3%</td>
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<tr>
<td>Sugar Color (ICUMSA)</td>
<td>23</td>
<td>17</td>
<td>2855</td>
<td>34</td>
<td>7444</td>
<td>3817</td>
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<tr>
<td>Pan Purity (%Sug/DS)</td>
<td>94.0</td>
<td>93.1</td>
<td>87.7</td>
<td>85.4</td>
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<td>76.3</td>
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<tr>
<td>Molasses Purity (%Sug/DS)</td>
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<td>59.1</td>
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<tr>
<td>Steam Flow (lb/hr)</td>
<td>50,305</td>
<td>52,843</td>
<td>20,786</td>
<td>10,145</td>
<td>6,789</td>
<td>5,869</td>
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<tr>
<td>Molasses Color (ICUMSA)</td>
<td></td>
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<td>43,778</td>
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</table>
### Estimated Percent Reduction

<p>| | |</p>
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<tr>
<td>Total massecuite Flow</td>
<td>24</td>
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<tr>
<td>Percent of Sugar Recycle</td>
<td>57</td>
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<tr>
<td>Exhaust steam usage</td>
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<tr>
<td>Molasses color</td>
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<tr>
<td>Flowrate, BV/hr</td>
<td>Bed length, Ft.</td>
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<tr>
<td>----------------</td>
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<tr>
<td>20</td>
<td>2</td>
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<tr>
<td>33</td>
<td>2</td>
</tr>
<tr>
<td>42</td>
<td>2</td>
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<tr>
<td>30</td>
<td>3</td>
</tr>
<tr>
<td>36</td>
<td>3</td>
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</table>
Remaining Questions for Large Scale Trials

- Ash content and crystal size in the second boiling
- Variability of thin juice color during the crop
- New purity profile with two white products
- Utilization of continuous machines be used after the second boiling (crystal uniformity)
- Longer term resin studies (regenerations efficiency and sustainability, etc.)
Conclusions

• Decolorization with Fractal Shallow Bed Approach makes projects more attractive due to lower capital and operating cost

• Use of innovative technologies and approaches is required to support the new vision
Acknowledgements

• Robert Howe and his team- British Sugar plc

• Amalgamated Sugar LLC  Nampa factory team