AN INNOVATIVE PROCESS FOR PLANTATION-WHITE SUGAR OF ULTRA-LOW SO2 CONTENT

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• Demand of domestic market of Sudan is for white sugar of **100 ICUMSA** of negligible SO2 content i.e. less than **10 ppm**.

• Most of the factories in **Sudan including the 25000 TCD capacity Kenana Sugar**, produce white sugar of **100 ICUMSA** by **Defco-remelt phosphation (DRP)** process with following parameters:

  - Higher chemical consumption.
  - Higher steam consumption at level of **60 % on cane**
  - Higher **power consumption** of process house more than **12 kW/t of cane**.
STUDY OBJECTIVE

- White Nile Sugar Company (WNSC) from Sudan, while setting up a green field 24000 TCD capacity sugar plant, set the target to produce 100 ICUMSA white sugar having less than 10 ppm sulphur content with following prime objectives:

  - Minimum capital cost
  - Minimum requirement of bulk chemicals viz lime and sulphur, that are not locally available in Sudan and expensive to import.
  - Minimum process energy requirement
In order to circumvent these limitation, a process was developed, which eliminates the intermediate stage of raw sugar melting, yet limit the SO2 content in sugar, to reduce:

- The capital cost
- Process steam and power consumption.
- Bulk chemicals i.e. lime and sulphur

Named as ‘S-Pro Isgec’ Process.

Successfully adopted in 24,000 TCD sugar plant at WNSC Sudan.
PROCESS FLOW DIAGRAM: PLANTATION WHITE SUGAR OF ULTRA LOW SO2 CONTENT

3-1/2 MASSECUITE BOILING AND CURING SYSTEM

RAW JUICE FROM MILLING → MILK OF LIME → DEFECATOR → RJ HEATER → MELT CLARIFICATION SYSTEM

JUICE CLARIFICATION SYSTEM

SYRUP SULPHITIOR → MULTI BED FILTER → SYRUP HEATER → FILTRATE CLARIFICATION SYSTEM

MUDY JUICE → CLARIFIER → VACUUM FILTER → CLEAR JUICE

FILTRATE → MICRO FILTER → CLEAR FILTRATE

5th → 4th → 3rd → 2nd → 1st

SO2 GAS

MELT CLARIFICATION SYSTEM


SYRUP A-HEAVY → CLARIFIED MELT → PAN SUPPLY TANK → WHITE SUGAR FOR PACKING

SYRUP A-HEAVY

MELT+SYRUP

SUGAR C-D Marketing

B-HEAVY C-LIGHT

C AFTER C/CONT.PAN

C FORE C/CONT.PAN

WASTE MOLASSES
‘S-Pro Isgec’ PROCESS

• Raw juice is clarified by hot liming to 7.7 pH followed by settling in a continuous clarifier. Clear juice is concentrated in quintuple effect evap. to 67° Bx, called raw syrup.

• Clarifier underflow is clarified by phospho-flotation followed by micro-filtration. The clear filtrate is directly sent to evaporator along with clear juice.

• The scum from syrup clarification & melt clarification is de-sweetened through filtrate clarification system.
‘S-Pro Isgec’ PROCESS

• Raw syrup is clarified with phospho-flotation followed by deep bed filtration then lightly sulphited to 5.7 pH.

• 3½ massecuite boiling incorporating an intermediate A1-massecuite.

• A1-massecuite is boiled in continuous pans. Its purity and quantity is adjusted to maintain melt color below 3000 IU. The A1 grain is prepared in clarified syrup using seed slurry.

• About 70% of the total feed to the A1 continuous pan is clarified syrup and 30 % is A heavy molasses.
‘A’ PAN STATION
AT WNSC
‘S-Pro Isgec’ PROCESS

• Whenever the purity of B-massecuite goes up, footing ratio is changed i.e. then grain is made in 50% syrup and 50% A heavy molasses.

• A1 single-cured sugar, B single-cured sugar and C double-cured sugar are melted. The melt is clarified with phospho-flotation process.

• A-massecuite footing is done by clarified melt and then filling by clarified syrup. It is then centrifuged to get 100 IU white sugar with negligible SO2 content i.e.<10 ppm.

• B and C massecuites are boiled in continuous pans as per normal procedure.

'S-Pro Isgec' PROCESS
‘A1’, ‘B’ AND ‘C’ PAN STATION AT WNSC
Clear juice is heated to 118°C and then concentrated to 67±1° Bx in 5-effect evaporator set consisting of:

1st Effect: (4w+1s) x 3380 m², Semi-Kestner

2nd Effect: (4w+1s) x 3340 m², Falling Film

3rd Effect: (4w+1s) x 3340 m², Falling Film

4th Effect: (4w+1s) x 1200 m², Falling Film

5th Effect: (4w+1s) x 1000 m², Robert type
EVAPORATOR STATION AT WNSC SUDAN
The S-pro Isgec process has been adopted in the **24,000 TCD** sugar plant of WNSC, Sudan.

Plant has **4 streams, each of 6000 TCD**. Each stream has been successfully commissioned.

Plant has regularly produced plantation white sugar of **100 ICUMSA with less than 10 ppm SO2**.

About **1.0 kg lime & 2 kg sulphur** is consumed per tonne cane. Small quantities of fine chemicals were also consumed for phospho-flotation.
PERFORMANCE TEST RESULTS AT WNSC

• The performance test of one stream of the process plant, i.e. at 6000 tonnes of cane per day capacity, was conducted for a continuous period of 3 days from 16-18 February 2015.

• The average results of these 3 days in respect of analysis of intermediate products, sugar quality, color balance and heat and mass balances are given on next slides.
### PG TEST RESULTS: BRIX / POL / PURITY

<table>
<thead>
<tr>
<th>Stage</th>
<th>Brix (°Bx)</th>
<th>Pol (%)</th>
<th>Purity (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Raw syrup</td>
<td>67.12</td>
<td>55.19</td>
<td>82.23</td>
</tr>
<tr>
<td>A massecuite</td>
<td>89.77</td>
<td>79.67</td>
<td>88.75</td>
</tr>
<tr>
<td>A1 massecuite</td>
<td>92.71</td>
<td>74.25</td>
<td>80.09</td>
</tr>
<tr>
<td>B massecuite</td>
<td>92.53</td>
<td>69.67</td>
<td>75.29</td>
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<tr>
<td>C massecuite</td>
<td>96.12</td>
<td>55.24</td>
<td>57.47</td>
</tr>
<tr>
<td>Raw melt</td>
<td>65.00</td>
<td>62.33</td>
<td>95.89</td>
</tr>
</tbody>
</table>

Pol / Brix by method 6.1 of SASTA laboratory manual. Figures are average of 3 days i.e. 16-18 Feb 2015.
PG TEST RESULTS: COLOUR PROFILE

- Raw Syrup
- Clear Syrup
- Sulphited Syrup
- Raw Melt
- Clear Melt
- Sugar

Colors:
- 16-02-15
- 17-02-15
- 18-02-15
- Average
<table>
<thead>
<tr>
<th>Date</th>
<th>Colour</th>
<th>SO2 Content</th>
</tr>
</thead>
<tbody>
<tr>
<td>16 Feb, 2015</td>
<td>98 IU</td>
<td>9.0 ppm</td>
</tr>
<tr>
<td>17 Feb, 2015</td>
<td>96 IU</td>
<td>7.0 ppm</td>
</tr>
<tr>
<td>18 Feb, 2015</td>
<td>101 IU</td>
<td>8.0 ppm</td>
</tr>
</tbody>
</table>

ICUMSA method GS9/1/2/3-8 (2011) used for color.
ICUMSA method GS2/1/7/9-33 (2011) used for SO2
HMBD FOR PG TEST PERIOD:

JUICE CLARIFICATION

RAW JUICE
277.00 t/h
30.0 °C
14.84% DS

V5
11.70 t/h
67.8 °C (Sat.)

V4
7.79 t/h
95.1 °C (Sat.)

277.00 t/h
72.0 °C

Milk of Lime
4.35 t/h

55.5 °C

Juice Defecator

Defecated Juice Heaters (DJ1+DJ2+DJ3)

85.0 °C

V3
6.28 t/h
101.5 °C (Sat.)

V2
4.91 t/h
108.0 °C (Sat.)

281.35 t/h
95.0 °C

285.25 t/h
103.0 °C

Continuous Clarifier
444 Design

Under flow
40.25 t/h

Clean Juice Tank

Clear Juice to Evap.
302.36 t/h
91.3 °C
13.53% DS
14,367 CU

57.75 t/h
85.0 °C

Filtrate heater

57.19 t/h
68.2 °C

58.75 t/h
84.0 °C

Clarified filtrate

Filtrate clarification system

Scum from syrup and melt clarifiers

Wash Water
23.06 t/h
94.1 °C

Rotary Vacuum Filter

Cake
8.72 t/h
1.93% Sugar

V2
1.56 t/h

Bagacillo
2.61 t/h
HMBD FOR PG TEST PERIOD:
EVAPORATOR SECTION

LP Steam 91.76 t/h 250.0 kPa 127.4 °C (Sat.)

1st body 3380 m³
LP condensate
heat recovery PHE

CJ1 cond.
C/F Wash Water

CJ2 cond.

87.79 t/h 120.0 °C

Hot Surplus Condensate to recirculation

87.79 t/h 94.1 °C

Clear Juice 302.36 t/h 91.3 °C 13.53% DS 14,367 CU

C/ F condensate

82.32 t/h 116.5 °C (Sat.)

Loss

To sugar dryer

LP steam

V1

Vent losses

4.93 t/h, CJ-I

2.60 t/h

Hot Surplus Condensate to Cooling Tower

4.89 t/h, C Pans

5.87 t/h, DJ-I

2.13 t/h, DJ-III

1.66 t/h, Filterate

Loss

1.00 t/h, Syrup

5.05 t/h, DJ-II

0.53 t/h, Melt

0.57 t/h, Melter

4.91 t/h, DJ-III

Boiler Feedwater 82.81 t/h 100.0 °C

87.79 t/h 94.1 °C

Cooled Surplus Condensate to Cold water Tank 68.89 t/h 36.0 °C

76.75 t/h 94.1 °C

Hot Surplus Condensate to Cooling Tower

Boiler Feedwater 82.81 t/h 100.0 °C

To Melter 450 t/h

To seed 450 t/h

To magma mixer 430 t/h

To pans 416 t/h

To Imbition, 102.43 t/h

To Vacuum Filter 470 t/h

9.53 t/h, CJ-I

9.53 t/h, Melt

9.53 t/h, Melt

V2 74.99 t/h 108.0 °C (Sat.)

V3 61.28 t/h 101.5 °C (Sat.)

V4 18.51 t/h 95.1 °C (Sat.)

V5 12.98 t/h 67.8 °C (Sat.)

A, A1 & B Pans 40.52 t/h 6.28 t/h, DJ-I

Loss

RJ-I 11.70 t/h

RJ-II

Cold Water In

tail pipe water
46.0 °C

Raw Syrup 61.06 t/h 72.1 °C 67.03% DS 15,761 CU

3rd body

3340 m³

C Pan Cond.

DJ2 cond.

'A' + B + A1 Pan Condensate

DJ1 cond.

Syrup Heater cond.

3.41 t/h

10.72 t/h

14.46 t/h

27.6 t/h

Hot Surplus Condensate to recirculation

118.0 °C

LP steam

V1

Clear Juice heaters (CJ1+CJ2)
HMBD FOR PG TEST PERIOD: SYRUP CLARIFICATION

Raw Syrup
- 61.06 t/h
- 72.1 °C
- 67.03% DS
- 15,761 CU

Syrup heater

V2: 1.00 t/h

Lime

Sodium succinate

Phosphoric Acid

Color precipitant

Flocculent

Water

Filtered Syrup: 59.46 t/h

SO₂

Clarified Syrup to pan
- 69.66 t/h
- 8.331 CU
- 5.7 pH

Scum to filtrate clarifier

Filtered Syrup: 59.46 t/h
- 72.9 °C
- 66.10% DS
- 12,357 CU
<table>
<thead>
<tr>
<th>Parameter</th>
<th>S-Pro ISGEC Process</th>
<th>Double sulphitation</th>
<th>DRP process</th>
</tr>
</thead>
<tbody>
<tr>
<td>Steam consumption</td>
<td>33.5% on mixed juice</td>
<td>34% on mixed juice</td>
<td>37% on mixed juice</td>
</tr>
<tr>
<td>Power consumption</td>
<td>8.5 kW/t cane</td>
<td>9.0 kW/t cane</td>
<td>10.0 kW/t cane</td>
</tr>
</tbody>
</table>
CONCLUSION

• S-Pro Isgec Process is simple and reliable. It has lower capital, operation and maintenance costs as compared to any other process for producing white sugar.

• It consumes **50% less lime, 5% less steam on cane and 10% less power consumption** as compared DRP process to produce white sugar of 100 ICUMSA.

• It results in softer scale in juice heater and evaporator tubes that can be removed by CIP (chemical cleaning) during the season, thus avoiding the need for expensive and time consuming mechanical de-scaling.
Thank You

Presented By
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