PILOT TEST REPORT

Application:	**AMORPHOUS SUGAR COOLER**
Client:	**Sample**
Location:	**Sample Location**
Ref. Test No.:	**555-5555**
Report by:	**C. Richard, P. Eng.**
Date of Report:	**February 9, 20XX**

1. PROJECT DESCRIPTION

Sample Company is considering the use of a *Solex* Heat Exchanger for cooling amorphous sugar prior to bagging, storage or transportation. The objective is bringing down the temperature of the sugar, at a production rate of approximately 50 tons per hour, to avoid the problem of lump formation in storage or transportation and preserve final product quality and bulk characteristics. Pilot testing was conducted February 2-5, 20XX at the client's production facility.

The amorphous sugar from the process is currently bagged in totes at an average temperature of 65 to 70°C. The client would like to cool the sugar to a temperature below 40°C before bagging to stabilize product bulk properties.

Typical process conditions for the project are:

Product Flow:	50 tons/h	Bulk Density:	750-775 kg/m^3
Product Inlet Temp.:	70°C	Particle Size:	0.38 mm nominal
Product Outlet Temp.:	<40°C	Moisture Content:	0.2 % nominal
Cooling Water:	To be determined	Specific Heat:	0.31 kcal/kg·°C

2. TEST OBJECTIVES

The pilot testing provides on-site evaluation of the *Solex* Heat Exchanger for cooling amorphous sugar under typical process conditions at time of testing.

The test is configured to duplicate as closely as possible the conditions and operation of the production (full scale) equipment, at a pilot scale of approximately 200-400 kg/h depending on process conditions. A series of test runs are conducted at different selected conditions until steady state is achieved. Parameters such as cooling water temperature, feed rate, distance between plate coils and air injections will be adjusted to provide trouble-free operations and mass flow through the plate bank.

Hence, the objectives of the pilot test include:

1. Confirm that the product will flow at the selected heat exchanger plate spacing
2. Verify that no build-up or scaling forms on heat exchanger surfaces for selected operating conditions
3. Demonstrate empirical cooling capabilities for pilot conditions.
4. Confirm recommended discharge device type

3. TEST EQUIPMENT & SET-UP

- Solex Test Cooler

The pilot unit comprises of a plate bank with a maximum of nine stainless steel heat exchanger plates with an adjustable distance between the plates. The plates are the same type and construction as proposed for the production unit. A vibrating feeder is fitted below the plate bank and the speed of vibration is controlled with a variable frequency drive (VFD) to provide desired flow rate of product through the plate bank.

Fig. 1 – General Arrangement

Fig. 2 – Empty Plate bank

Fig. 3 – Plate Bank and Product

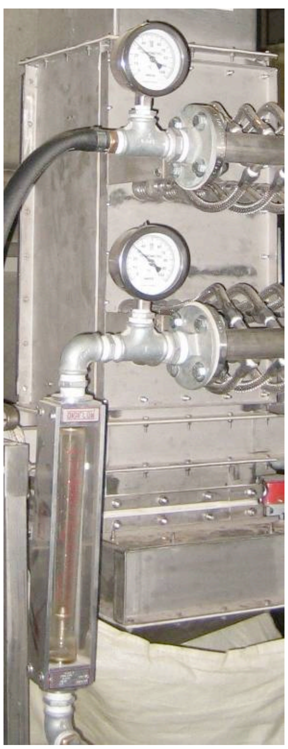


Fig. 4 – Water Manifolds and Instrumentation

Fig. 5 – Water Module

- Product

Product was drawn directly from bagging hopper. Cooled product at the discharge was collected into tote bags.

Motors were adjusted to experiment a range of feed rates between 400 and 800 kg/h.

- Cooling water:

A closed-loop water module was used to set and maintain desired cooling water temperature at the inlet manifold. Test runs were evaluated with set points of 30 and 25°C.

- Instruments

Temperature probes were located in the inlet hopper and at the inlet and outlet of the cooling water manifolds. Temperature was manually recorded at the discharge with a probe. Compressed treated air was injected in to the air manifold located at the top of the plate bank to purge ambient moisture in the bulk product.

4. RESULTS & OBSERVATIONS

A variety of scenarios were simulated to give an overview of experimental operation ranges.

Ambient conditions around the testing area were temperatures ranging from 30°C to 40°C with humidity levels from 30 to 55%.

Test conditions:

Product Type:	Amorphous	Cooling Water:	Water module used (@ 2300 L/h)
Moisture Content:	0.2%	Dry Air Purge:	Testing with and without air injection
Product Flow Rate:	400-800 kg/h	Plate Spacing:	32 mm (centers)

The following table gives a summary of the test conditions and findings. Pictures of test runs are included in the appendix.

Table 1 - RESULT SUMMARY**

Run No.	Cooling Water Temp °C	Purge Air Nm^3/h	Product Temp IN °C	Product Temp OUT °C	Product Feed Rate Kg/h	Run Time Min	Caking on Plates?	Notes
1	35	No	65	57	600-800	40	**Y**	Caking observed on top half of plates. Good mass flow
2	35	Yes	60	50	600	30	**N****	No caking, but sticky patches observed due to previous wash; Good mass flow. Unit washed with water hose and dried overnight.
3	30	Yes	55	42	500	45	**N**	No caking; good mass flow.
4	25	Yes	55	33	400	75	**N**	No caking; good mass flow.
3	25	Yes	65	31	200-300	60	**N**	No caking; good mass flow. Motors cycled to decrease flow rate and achieve more cooling.

Note 1: Average values shown for steady-state conditions only
Note 2: Amounts of air injected not measured and quality of air undetermined.

- Plate spacing

The selected distance of 32mm between the heat exchanger plates was adequate for the application. Consistent mass flow was observed through the plate bank at all conditions.

- Simulated Upset Conditions

Upset production condition (down time) was unintentionally simulated by allowing the pilot heat exchanger to fill while the motors were turned off and left in the unit for a long period of time (2-3 hours). This would have caused the product to settle and pack slightly as it would in a production shut down. The cooler was restarted next from its loaded condition and the product started flowing through the feeder immediately.

6. CONCLUSION & RECOMMENDATIONS

All the ***objectives*** for this pilot experiment were attained:

1. Plate spacing and Flow pattern:

The product exhibited good mass flow characteristics at the selected heat exchanger plate spacing of 32mm for all conditions. No signs of bridging or arching were observed.

2. Caking / Scaling on Plates:

It was demonstrated that air is essential to avoid caking on the surfaces of the heat exchanger due to condensation. The first run, performed without the use of air, showed a build-up of product on the top half of each plate.

Air was injected for all the subsequent runs and good results were observed. The pilot unit was emptied to inspect the plates at the end of each runs and no signs of accumulation were observed. The plates remained very clean.

A dry air injection system will be integrated as part of the proposed design for this application.

3. Demonstrate empirical cooling capabilities for pilot conditions.

Cooling capabilities were demonstrated within the scaled down limits of the pilot unit. We were able to achieve a reduction in temperature up to 40°C by increasing the residence time (product entering plate bank at 70°C and coming out the discharge at <30°C)

4. Confirm recommended discharge device type

A fixed louver vibrating feeder was used for testing and showed reliable product flow as well as good adjustment capabilities for through put and turn down ratios. This type of discharge device is recommended for this application.

Conclusion

The data and observations collected during the series of tests allow us to conclude that the use of a Solex Heat exchanger is a suitable method for cooling amorphous sugar at 0.2% moisture content, offering promising cooling capabilities, convenient operating conditions and utility savings.

APPENDIX:

- ***A – Pilot Test Pictures***
- ***B – Laboratory Analysis & Results***

APPENDIX: A – Pilot Test Pictures

Fig. 1 – Mass flow

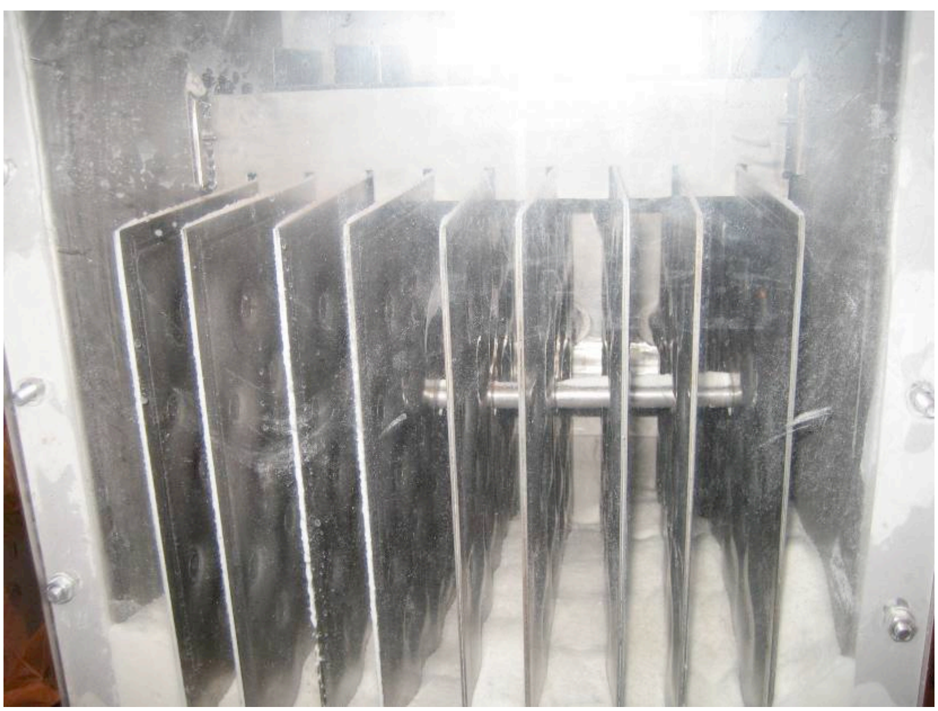


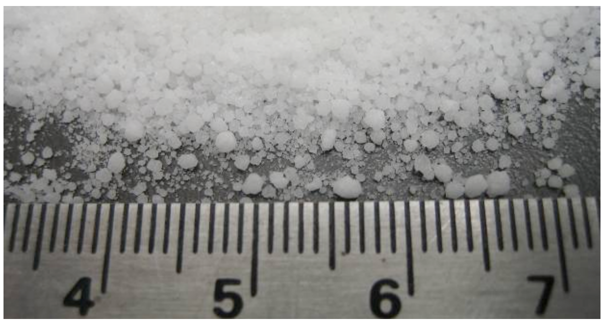
Fig. 2 – Air manifold through plate bank

APPENDIX: B – Laboratory Analysis & Results

LABORATORY TEST OBJECTIVES: Perform standard tests at *Solex Thermal* laboratory to determine physical and thermal properties of bulk material.

ANALYSIS & RESULTS:

Physical Properties



Color & Shape: White rounded granules

Density: 775 kg/m^3 *measured*

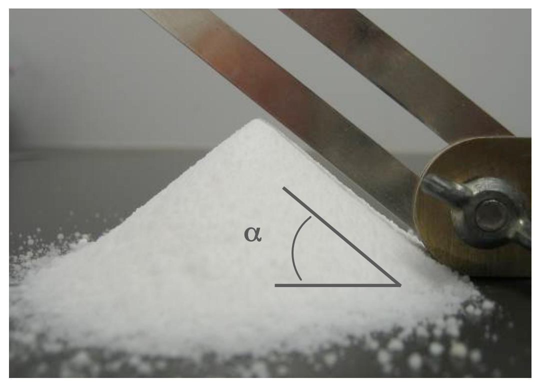
Angle of Repose α: 39°

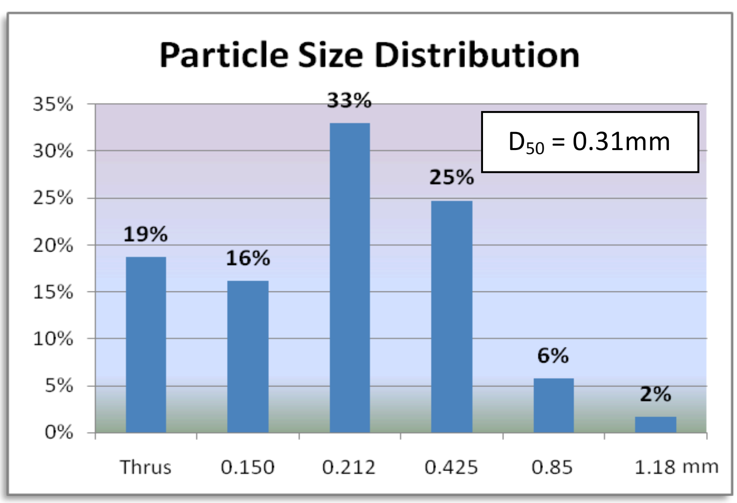
Moisture Content: 0.2 %

Size: 98% < 1.18 mm ; 0.31 mm nominal

Thermal Properties

Thermal Conductivity ***k***: 0.10 kcal/m·h·°C





LABORATORY TEST – Pictures

Fig. B1 & B2 – Appearance of Granules

Fig. B3 – Oven test for Moisture Content

Fig. B4 – Size Distribution & Granulometry