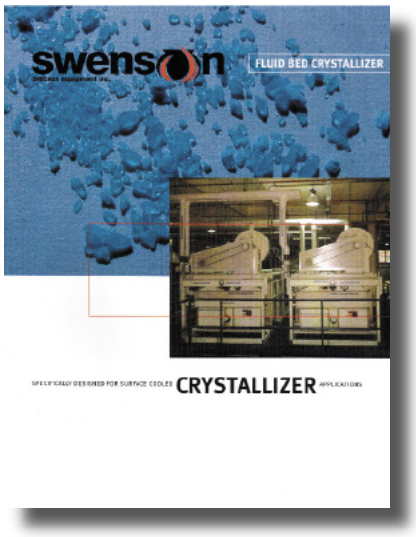
Whiting Equipment Canada Inc.
Swenson Fluid Bed Crystallizer



What Makes the Fluidized Bed Crystallizer So Unique?

The fluid bed crystallizer is a patented new type of crystallizer (pat. No. 5,523,064) specifically designed for surface cooled crystallization applications. In applications where crystals can be formed simply by cooling the feed solution, (no evaporation required) the fluid bed crystallizer should be considered.

MECHANICAL DESIGN

- **Small physical size.** All the separate items in a conventional shell and tube surface cooled crystallizer (crystallizer body, shell & tube heat exchanger, circulating pump, interconnecting ductwork) are combined into a single piece of equipment, eliminating the need for circulating piping; the heat exchanger and the crystallizer are combined into a single compact unit. The slurry pump is eliminated and replaced by a conventional fan.
- **Low elevation requirements.** Typically 9 to 12 feet compared to 30 feet for conventional shell and tube crystallizers, little or no structural steel required.
- **Low maintenance.** The only moving part is an air blower and an air damper, no pump seals which might leak.

PROCESS DESIGN

- **Larger crystals are produced** because of the reduction in mechanical attrition and formation of neculation of new seed crystals by eliminating the circulating pump and using air for agitation.
- **Higher liquid heat transfer coefficients** are achieved with air agitation, because the liquor flow at the tube surface is more turbulent.
- **Operates at larger temperature differences** between cooling medium and liquor temperature without crystal formation on the heat transfer surface. Higher temperature differences can be used because of the high turbulence at the tube surface caused by the bubbles rising through the slurry.
- **Less heat transfer surface required** Depending on the application, the effects of higher heat transfer coefficients combined with operating at larger temperature differences, can reduce the required heat transfer by as much as 60%.

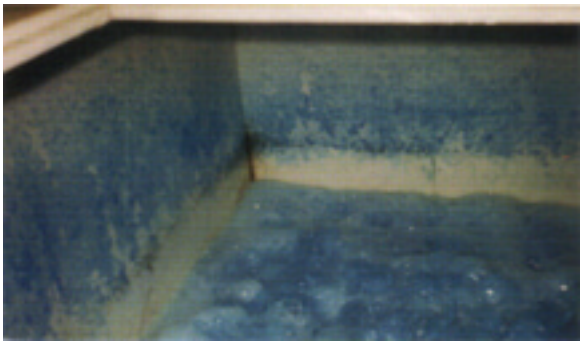
OTHER ADVANTAGES

- Can successfully operate at low slurry densities.
- Heat transfer surfaces are accessible.
- Easy to start up and shut down the fluid bed crystallizer.
- While air is typically used to keep the crystals suspended, other gases can also be used.

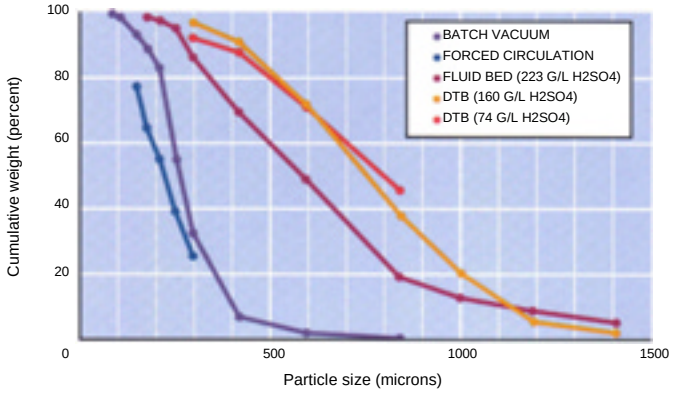
THE KEY TO THE FLUID BED CRYSTALLIZER DESIGN

The key to the design is the air distribution tubes that supply a continuous stream of air bubbles over the submerged coolant surfaces. The gas bubbles increase localized velocity around the heat transfer surfaces to effectively provide for continual surface renewal to improve heat transfer efficiency. The scrubbing action reduces crystallization on the coolant surfaces. Cooling is accomplished without an external circulation loop and pump minimizing unwanted contact nucleation which reduces crystal size. The air stream fluidizes the crystals in the slurry providing for a well mixed solids phase resulting in a narrow crystal size distribution.

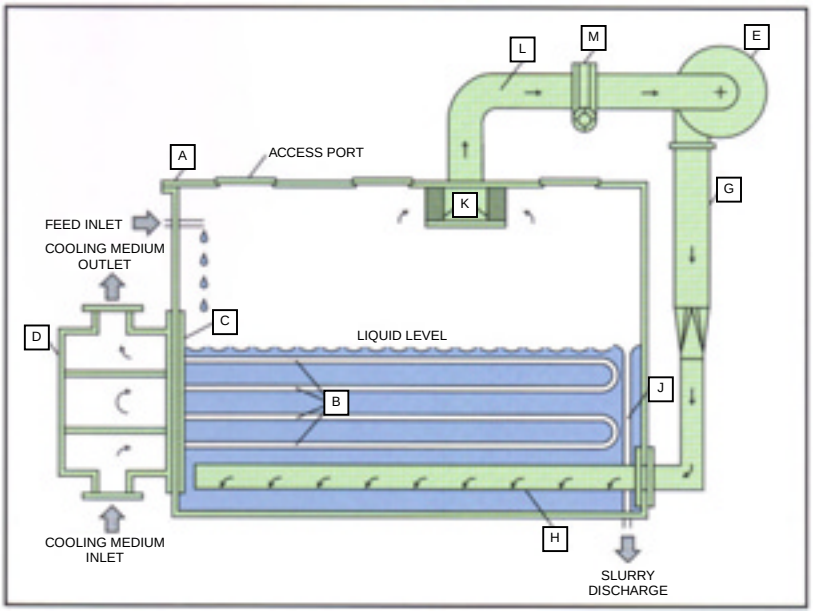
The following graph shows a comparison of the crystal size distribution for copper sulfate pentabydrate obtained from various commercial scale crystallizers. Note that the distribution obtained in the fluid bed unit is very nearly as large as that in the growth type (DTB) units and significantly larger than that obtained either in batch vacuum or forced circulation crystallizers. It should be pointed out that SWENSON'S experience indicates that sulfuric acid levels tend to decrease particle size, which makes the fluid bed results even more favorable.



Comparison of Crystal Size Distributions



DESCRIPTION OF THE FLUID BED CRYSTALLIZER



The crystallizer body [A] is supplied with liquor from a feed tank (not shown) through e feed inlet, cooling medium is supplied to water box [D] and through the tubesheet [C] through the cooling tubes [B] and out the water box for coolant regeneration. Air is supplied by blower [E] through duct [G] to the air distributor tubes [H]. The air distributor tubes are supplied with many holes through which the air is discharged as bubbles which travel upwards through the magma and around the coolant tubes. An overflow discharge weir [J] maintains the slurry level within the crystallizer. Product is recovered through the discharge outlet, The saturated air from the bed of slurry passes through a mesh type de-entrainment separator [K] through duct [L] and through damper [M] before returning to the air blower [E] through duct [G] and recycled to the air distributor tube [H].

SWENSON® EQUIPMENTFOR THE PROCESS INDUSTRIES:

- **CONDENSERS**
  - Direct Contact Type
  - Digester Blow
  - Surface Type
- **COOLERS**
  - Flash
  - Fluidized Bed
  - Rotary
  - Spray
- **CRYSTALLIZERS**
  - Batch
  - Direct Contact Refrigeration
  - Draft Tube
  - Draft Tube Baffle
  - Forced-Circulation
  - Surface Cooled
  - Reaction
  - Decomposition
  - Recompression
  - Teflon Tube
  - Multi-Stage Horizontal
  - Spray Evaporators
- **DRYERS: FLUIDIZED**
  - Closed Cycle
  - Direct Fired
  - Indirect Heated
- **DRYERS: ROTARY**
  - Countercurrent
  - Direct Fired
  - Indirect Heated
  - Parallel Flow
  - Steam Tube
- **DRYERS: SPRAY**
  - Closed Cycle
  - Countercurrent
  - Mixed Flow
  - Parallel Flow
  - Research
  - Reverse Flow
- **DRYERS: FLASH**
  - Direct Fired
  - Indirect Heated
- **LABORATORY FACILITIES**
  - Bench Scale Tests
  - Crystallization
  - Evaporation
  - Flash Dryers
  - Fluidized Bed Crystallizers
  - Fluidized Bed Dryers - Coolers
  - Rotary Dryers - Coolers
  - Spray Dryers
  - Steam Tube Dryers
- **EVAPORATORS**
  - Calandria
  - Forced-Circulation
  - LIV Falling-Film
  - LIV Rising-Film
  - Natural Circulation
  - Recompression
- **FILTERS**
  - Top Feed
- **HEAT EXCHANGERS**
  - Direct Contact
  - Shell and Tube
- **PROCESSING AND PROJECT ENGINEERING**
  - Ammonium Sulfate Crystallization & Drying
  - Caustic Soda Systems
  - Citric Acid Systems
  - Fluorine Recovery
  - Salt Crystallization & Drying
  - Sodium Sulfate Recovery & Drying
  - Sodium Chlorate System
  - Wet Process Phosphoric Acid
  - Potash Crystallization & Drying
  - Soda Ash Calcining,Crystallization & Drying
  - Others

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WHITING
www.whiting.ca

Dave Neville, P. Eng.
350 Alexander Street
Welland, Ontario L3B 2R2 CDN
Tel (+1) 905-732-7585 ext. 265
Fax (+1) 905-732-2366
Cell (+1) 905-733-0116
E-Mail dneville@whiting.ca