Total Solutions from

Semi-Bulk Systems, Inc.

The Paint Plant for the 21st Century

Processes for all Pigments & Extenders
Incorporate Process XstreamLining℠
in your Paint Plant

The VACUCAM® Dynamic Continuous Steady State Slurry Process for all Pigments and Extenders: The Continuous Steady State Process is available in a number of capacity designs. Properly sized, a typical unit can handle multiple pigments or extenders to handle the plants total demand. The Unit can be fed from either bulk bags or bulk silo.

The VACUCAM® Powder Handling and Mixing Systems have been successfully validated for:

- **Gums, Thickeners, Starches, Stabilizers – Rapid and total hydration of dry functionalizing ingredients.**
  See additional brochure Process for Mixing of Thickeners
- **Paint Pigments and Fillers for paint formulations and/or master slurry production.**
  This brochure describes processes for slurry manufacture

Semi-Bulk Systems has standardized, modular, skidded processes to easily provide the appropriate solution to meet your plant requirements.

For description of Powder Handling, see the Powder Options Brochure.

PROCESS XSTREAMLINING℠

Semi-Bulk Systems is ISO 9001 REGISTERED COMPANY

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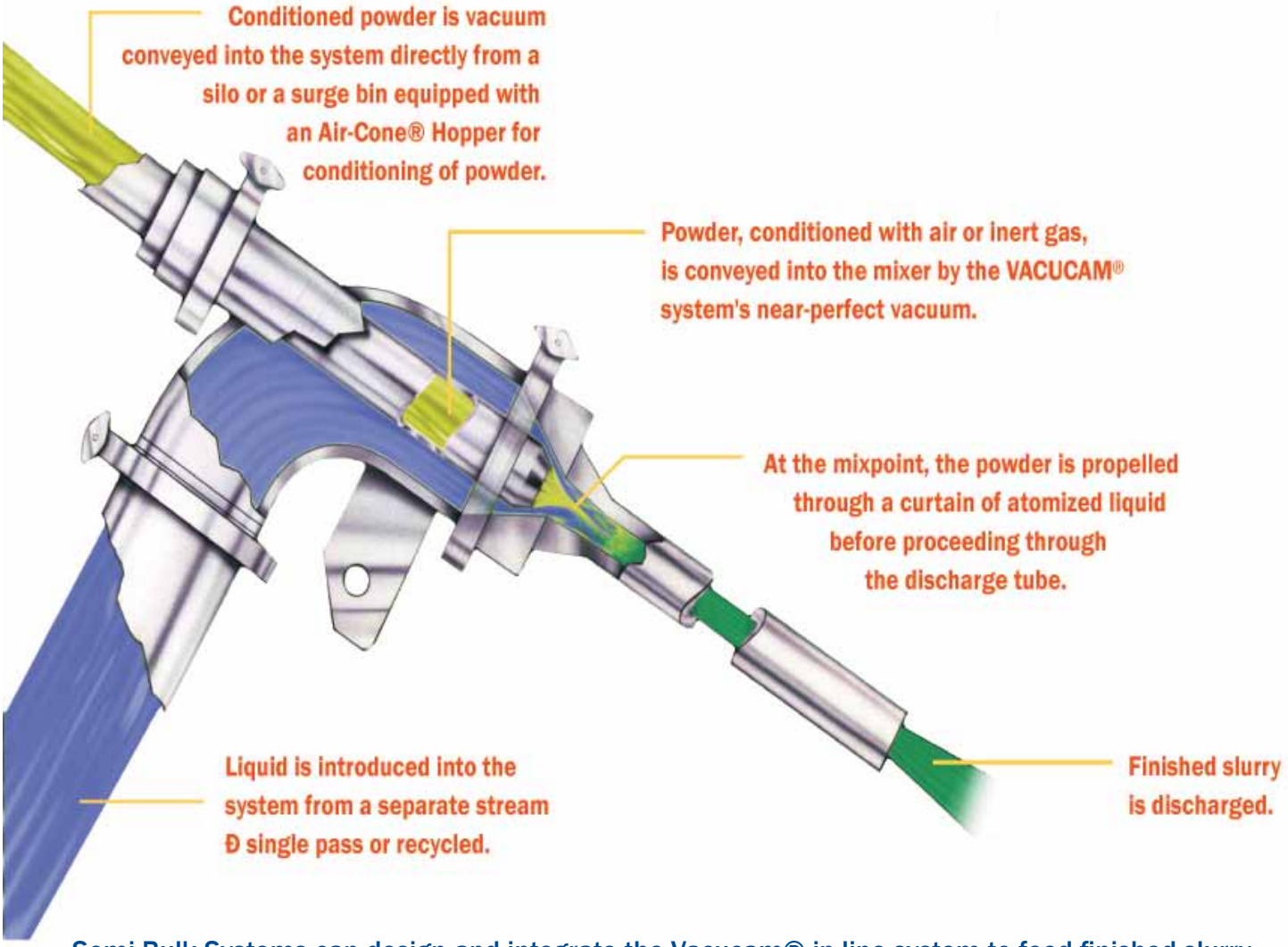
VACUCAM® EJECTOR MIXER:

The VACUCAM® Ejector Mixer is the most effective system available for conveying, wetting and dispersing powders into liquids. Here's how it works.

CONDITIONED POWDER IS CONVEYED INTO THE MIXER BY A NEAR-PERFECT vacuum, which is created when pressurized fluid is forced through the Ejector Mixer's unique, patented annular nozzle. The fluid is discharged as a high-velocity, hollow jet into which the powder is drawn.

The VACUCAM® system achieves high-speed, instantaneous and complete wetting by bringing together conditioned powder and highly atomized liquid from two separate streams, incorporating particles of liquid with particles of powder. The reactive surface areas of both the powder and the liquid are maximized before intimate contact is actually made. The result is consistently uniform, superior wetting without the agglomeration or "clumping" usually associated with conventional mixing methods. On subsequent recirculation through the orifice, solids concentration increases and powders are dispersed at a shear rate approaching 20,000 sec-1... about twice the level of a high speed disperser.



Semi-Bulk Systems can design and integrate the Vacucam® in-line system to feed finished slurry into multiple locations of your preference, such as storage or mix tanks.

Process XstreamLining[sm] starts with the **VACUCAM® Ejector Mixer Processes**

for all powder/liquid mixing requirements....

Powder and Liquid Mixing systems are utilized in many industries to manufacture totally different end products -- Food, beverage, dairy, pharmaceutical, paint, industrial products, chemicals, etc. Although the final form of the end product will vary considerably, the issues of mixing the powders and liquids are basically identical regardless of the product application.

Thickening Agents, Functionalizing Ingredients and Stabilizers:

For purposes of this discussion, we will limit the family of dry powder ingredients to those normally referred to as Thickening Agents, Functionalizing Ingredients and Stabilizers. [Guar gums, xanthan gum, methylcellulose, pectin, starches, many polymer thickeners, etc.]. Their use in the product is to achieve a specific "function" – viscosity/thickening body affect, stabilizer for mixture, texture, etc.

These families of products are typically the most challenging to achieve the desired mix results because the process of combining the powder with the liquid requires a control of the rate of powder to available liquid so there is always excess liquid to fully hydrate the surface area of the powder as they are being combined. If the powder is added at a faster rate than it can find liquid for full hydration, it will from lumps with unwetted powder in the center [fish eye]. Once this damage is done, then considerable energy must be added to undo the damage resulting in considerable energy usage and degradation of the product which reduces its performance.

Mixing performance is typically discussed in the following terms:

"Dispersion" –the process of breaking down particle agglomerates to the ultimate particle and efficiently wetting the surface area of the particles to produce lump free slurry [no fisheye in the case of thickeners and/or functionalizing ingredients]. The VACUCAM® Mixing Process achieves the ultimate dispersion with a single pass (no shear) process through the mixer. The VACUCAM® Ejector Mixer generates huge liquid surface area under vacuum and conveys particles of powder, under vacuum, into the high velocity liquid surface to combine particles of powder with particles of liquid for optimum dispersion and hydration. For functionalizing ingredients, including starch, 95% + of the applications do not require a shear process and a single pass process through the Vacucam® Mixer produces the most efficient dispersions. Its efficiency is defined in the properties of the finished product generally allowing 10-30% reduction in ingredient addition to achieve the desired product functionality.

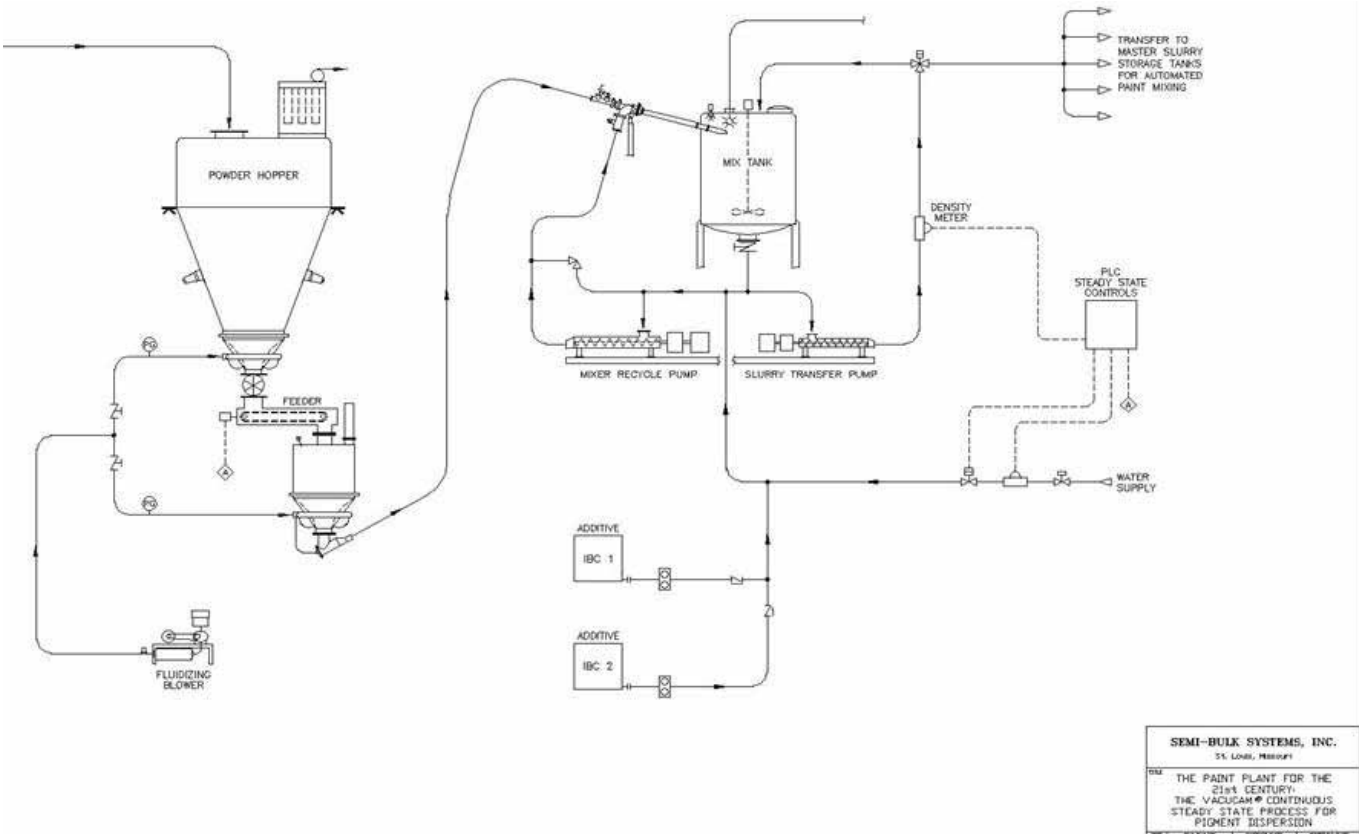
"Shear" - The process of applying considerable energy to slurry to expose the unwetted, undispersed agglomerates to achieve wetting of the ultimate particle. This process typically is required to correct the problem created by the use of an inefficient process to produce a dispersion. Many conventional mechanical processes including high shear dispersers and in-line mechanical shear devices will expend considerable energy and cost to achieve the desired end properties that could be achieved by utilizing more efficient "dispersing" processes. In the process of achieving an acceptable usable slurry, the product's functional structure is typically damaged by shear thereby reducing its efficiency and requiring an added amount to achieve the desired end product.

In some applications, additional "shear" is required to enhance the slurry properties of the finished slurry. HSD and other in-line shear devices accomplishes shear by bring the "metal" [the blade] through the slurry. The Vacucam® Ejector Mixer (batch recycle) achieves the most efficient shear by bringing the slurry through the metal [the orifice is designed for optimum shear requirements].

"Milling"- The process of applying considerable energy to a slurry to reduce [mill] the particles to a smaller size. When dry products are dry milled to the size of the particular product, a dispersion process or a shear process will be able to achieve wetting and dispersion up to that particle size. If further reduction of the particles is required in a slurry form, a wet milling process [ball mill, sand mill, other mechanical mill equipment] is typically used to further reduce the particle size in the slurry.
Wet milling is typically required for appearances [automotive paint finishes, appliance paint finishes, fine printing inks, etc.]

WET MILLING SHOULD NEVER BE REQUIRED FOR FUNCTIONALIZING INGREDIENTS since they are generally shear sensitive and its functional structure will be damaged.

Paint/Pigment Slurries



The In-Line VACUCAM® DYNAMIC CONTINUOUS STEADY STATE PROCESS

Paint/Pigment Slurries (TIO2, CaCO3, Clay, Silica, etc.) can be produced at very high capacities using the VACUCAM® Continuous Steady State Slurry Process. This process offers the Paint Industry the capability to increase slurry capacity by 300-400% with fewer personnel, with greater than 75% energy savings per ton of slurry, with consistent dispersion quality, and with significant reduction in COGS/gallon of paint. The Steady State process will disperse approximately 20 MTPH of pigment into 60-80% slurry (to within 1% of slurry dilatancy). This 21st Century Paint Process will allow a paint manufacturer to produce individual master batch slurries, at maximum concentration, of each individual pigment and continuously deliver each slurry to its respective slurry storage tank. To formulate a batch of paint, the operator selects the appropriate menu on the computer and the system will automatically pump the appropriate amounts of master slurries into a blend tank which will then deliver the finished formula to the canning line. This process has been demonstrated to increase plant capacity by 400%, reduce plant personnel by 30% and reduce manufacturing costs by $0.40/gallon of paint.

This Continuous Steady State Process is totally automated and is designed to recycle slurry through the VACUCAM® Ejector Mixer mounted tangentially into the top of a small de-aeration tank. The Mixer will convey and mix powder at a rate delivered and controlled by the continuous scale feeder. The water addition is automatically slaved to the dry powder addition and the multiple additive additions are slaved to the water addition to continuously deliver the design ratio of ingredients to produce finished slurry. The set-point slurry concentration is continuously maintained as the level set-point in the slurry tank controls the transfer pump to continuously deliver finished slurry to storage.

The dry side of the Continuous Steady State Process is designed to maintain the capacity feed of dry ingredients to the Ejector Mixer. The dry side can be fed from high capacity bulk bag unloading systems, from day bins or dry pigment silos.

Process Description:

The Vacucam® Continuous Dynamic Steady State Pigment Slurry Process is the most efficient process for rapidly making high capacities of quality pigment/extender slurries on a "continuous" run basis. The system is totally automated and does not require multiple batch tank changes. The Process incorporates the following modules:

Dry Side Module:

- Powder receiver hopper with load cells w/ pneumatic conveyor filter receiver. Hopper also incorporates an Air-Cone® Hopper bottom, with hopper cone vibrators and a rotary feeder.
- Continuous weigh belt feeder
- Receiving hopper with Air-Cone® hopper w/pick-up transition to deliver powder to suction convey hose of the Ejector Mixer.
- Fluidizing blower provides air to the Air-Cone hoppers to maintain fluid conditioned powder delivery to the mix station.

Vacucam® Dynamic Steady State Mix Station:

- The Vacucam® Ejector Mixer [sized for 150gpm or 250gpm system—larger units available]
- Mixer Recycle pump sized for 150 or 250gpm mixer utilizing a 30 or 60hp motor. Typically a progressive cavity style pump or other positive displacement types.
- Slurry Transfer Pump sized to transfer slurry to storage on a continuous basis at the rate that slurry is produced typically 30-120gpm.
- Mix tank, valve, piping are all stainless steel construction for easy cleanout. Tank is approximately 2000 liter size.
- Mass Flow density meter monitors slurry density, % solids and production quantity delivered to slurry storage.

Liquid Injection Module:

- Water supply manifold w/ water meter, rate control valve, isolation valve.
- Additive plastic storage tanks with metering pumps. Additives may include dispersants, anti-foam, biocide.

Process Controls provide total system automation, sequencing, graphical display of complete process, monitoring, communication with plant central controls and data logging.

Slurry Capacities vs. Mixer Model/Size for different pigments/extenders:

Example of Extender product capacities shown for two typical Mixer Model/Sizes. Specific convey/transfer and mix capacities will depend on specific product grades and can be confirmed in pilot plant testing – larger capacity units are available to meet any process requirements

	150 B/C Ejector Mixer				250 C Ejector Mixer			
Extender	**Powder Rt #/min**	**Powder Rt MT/hr**	**% Solids**	**Slurry Capacity MT/hr**	**Powder Rt #/min**	**Powder Rt MT/hr**	**% Solids**	**Slurry Capacity MT/hr**
TiO2	**300**	**8.2**	**76**	**10.8**	**500**	**13.6**	**76**	**17.9**
CaCO3, 10micron	**600**	**16.4**	**69**	**23.8**	**1000**	**27.3**	**69**	**39.6**
CaCO3, 4micron	**500**	**13.6**	**71**	**19.1**	**850**	**23.2**	**71**	**32.7**
CaCO3, ppt'd	**250**	**6.8**	**65**	**10.5**	**450**	**12.3**	**65**	**18.9**
Clay	**400**	**10.9**	**65**	**16.8**	**700**	**19.1**	**65**	**29.4**

Description of Operation:

The process is selected by the operator to make a specific slurry from a product menu. The product menu would include data specific for a given process including: the specific dry product grade, powder delivery rate to the mixer system, % solids concentration, additive percentage for a given formula, slurry density.

The source of the product is selected for transfer from a specific silo to the receiver hopper. The destination slurry tank is selected for delivery of the finished slurry product. The slurry production quantity required for that specific production run to be delivered to storage is selected.

After the operator has selected the process information, he initiates the start of the system:

- The convey cycle is initiated to deliver extender/pigment from the silo to the powder hopper. The load cells control the low set point and high set point in the hopper to maintain volume in the hopper to feed the mixer at capacity. When the hopper reaches high set point, the rotary under the silo stops and the line is purged.
- Mix tank is charged with enough water and additives to provide pump circulation. The pumps are turned on and the mixer recycle pump circulates water through the mixer with the vacuum break valve open. The slurry transfer pump circu lates water through the density meter and recycles to the mix tank until the slurry density is achieved.
- When the weigh feeder delivers the quantity of powder to match the set-point concentration for the initial start up water, the system goes into steady state mode. Based on the powder delivery rate, water addition is slaved to the powder rate to match set-point. The additive quantities are slaved to the water addition.
- When the density meter establishes the set-point solids, the divert transfer valve switches from recycle to transfer finished slurry direct to selected slurry storage tank.
- With the process in “steady state” mode, automatic adjustments continue to maintain quality on-spec slurry:
- The signal from the powder hopper load cells will maintain a surge capacity to feed the process by regulating the speed of the rotary valve below the silo.
- The rotary feeder will maintain the powder delivery rate to the process by controlling the RPM of the feeder.
- The Mixer recycle pump maintains the rate of slurry to the Ejector Mixer to optimize it’s convey and mixing rate.
- The level sensor in the mix tank will maintain the operating level in the mix tank by controlling the RPM of the transfer pump and the rate of slurry delivery to storage.
- The water rate of addition is slaved to the feeder delivery rate to maintain the slurry set-point control and the additive additions are slaved to the water addition.

System Halt –The operator can halt the system at any time and all equipment will sequence to an idle position. System restart can be initiated by operator at anytime for automatic restart to “continuous steady state mode”.

The PLC controls with color graphics display provide the operator a total status of the operation with data logging and communication with customer’s PCS via Profibus DP or other protocol.

- Data display include: operating status of all motors and valves and speeds of all VFDs; rate of powder delivery; rate of water delivery; rate of slurry produced and delivered to storage; percent of slurry solids; Mixer supply pressure and conveying vacuum and other data as desired.

Slurry Production Volume – can be selected from a short batch quantity to an extended production run to achieve a day or a week’s production requirements. Based on the selected production run, the density meter will record the finished slurry already delivered to storage; the volume in the mix tank will be added to that total and the powder hopper on load cells will stop conveying of material from the silo. The remaining powder in the powder hopper will be emptied and fed to the mixer. At the end of the production run the slurry in the mix tank will be delivered to storage.

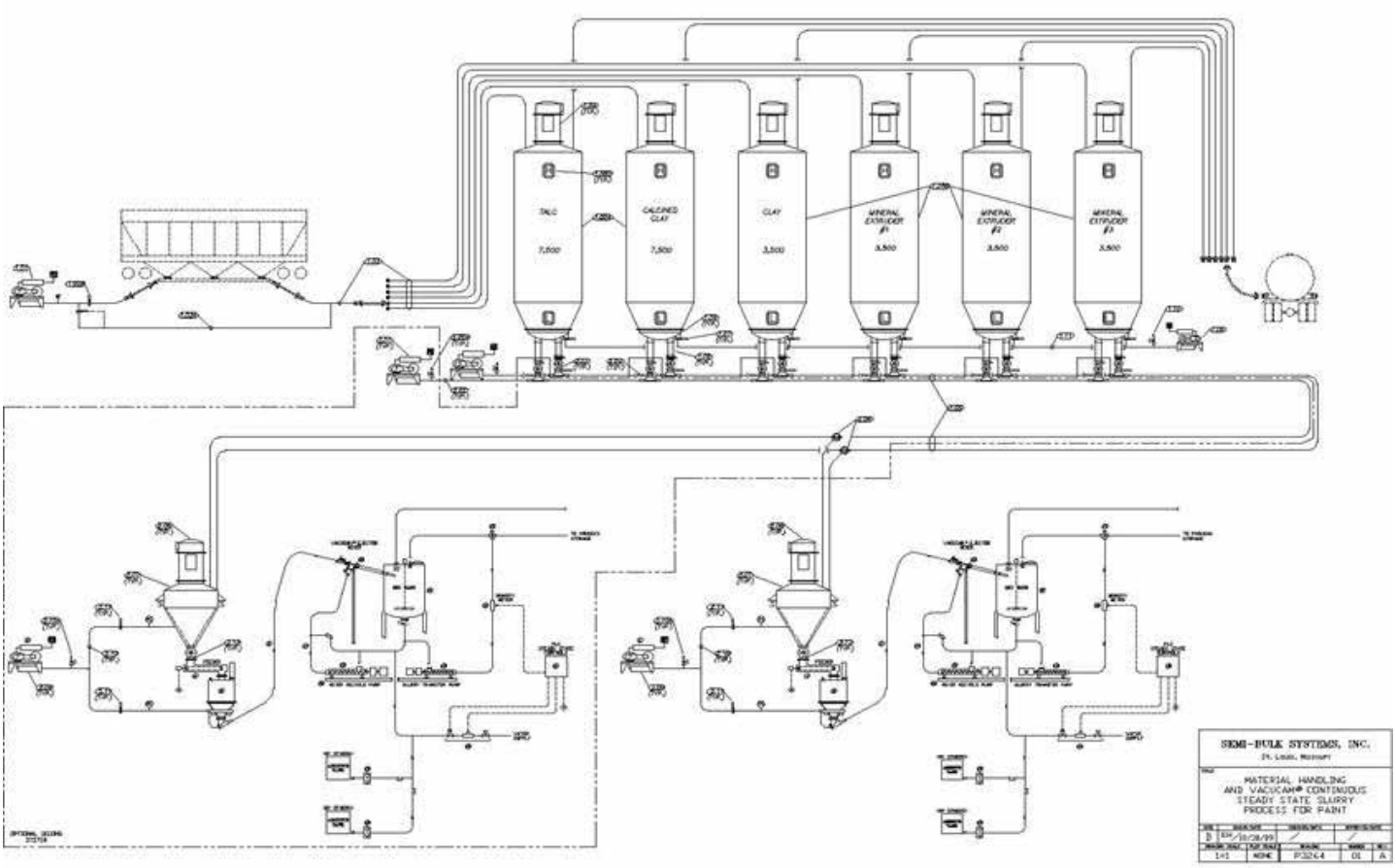
PLANT CAPACITY REQUIREMENTS / SYSTEM FLEXIBILITY — Due to the system capacity and versatility, one system process can be used to meet plant requirements for several or all slurry requirements. The dry side can be emptied and be ready to accept dry transfer of a different pigment/extender from a different selected silo. The mixing system can be emptied and be ready to make a different product slurry. Also based on the capacity of the process, labor is greatly reduced and production time can be reduced by complete shift operations to make slurry demands.

Powder Delivery Option:

Total bulk from Silo with automated pneumatic convey delivery to the Continuous Steady State feed hopper.

This Process Option represents the most efficient powder delivery system for high capacity plant requirements. The detailed description and operator sequence of the Vacucam® Dynamic Continuous State Slurry Process is fully described above illustrating the process being fed directly from bulk silos.

Process Flow Schematic



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Pigment Handling/Dispersion – Continuous Steady State, Batch Steady State or Batch for master batch slurry ingredients or total pigment slurries for paint batch.

Case study #3402: pigment dispersions
Semi-Bulk Systems Inc. achieves Process XstreamLiningsm
For a major Paint Manufacturer

Here are some of the Xstream Results: (Compared to the dry ingredient handling and dry/liquid mix technology that was previously used)

- **Provided production capacity and growth with existing real estate vs. building new facility saving millions of $$**
- **Increased plant capacity by 400% while reducing personnel by 30%**
- **Estimated labor savings vs. HSD = $0.0191/gal. Labor savings @15,000,000 gal/yr production =$287,086/yr savings.**
- **Capability to make excess sales needs in one shift/5 days vs. inability to meet sales needs in multiple shifts/7 days.**
- **99% batch consistency and elimination of batch adjustments**
- **Generated manufacturing cost savings of $0.40/ gallon**
- **90% Energy savings for pigment dispersion based on > 15million gallons/yr. Estimated power usage savings vs. HSD is approximately 0.403KWH/gal @ $0.08/kwh = $0.0322/gallon savings at 15,000,000 gal/yr paint plant = $484,132/yr SAVINGS [Energy only]**

These are just some of the Xstream results achieved when using our exclusive Process XstreamLining^{sm}

3-2011 Pigment Slurries

PROCESS XSTREAMLINING^{SM}

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