Continuous-Indexing Thin-Cake Vacuum Belt Filters Improve Process Operations by Replacing Conventional Vacuum Filters

The BHS technologies of Continuous-Indexing Vacuum Belt Filters provide improved product quality with more efficient washing and drying as compared with conventional vacuum pan and vacuum nutsche filters. Fully automatic operations provide for reduced maintenance costs and overall project savings.

By
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President and Managing Director

INTRODUCTION

The chemical industry faces unique challenges to increase process efficiencies and yields while improving the safe handling of solids and slurries. To meet these requirements, with less operator interaction, the industry's need for new technologies has expanded.

This article discusses the use of thin-cake Continuous-Indexing Vacuum Belt Filters as alternatives to manual vacuum nutsche and conventional vacuum pan equipment. This technology is described as well as the selection process. The article includes test data and case histories.

FILTRATION TECHNOLOGIES FOR HIGH-SOLIDS SLURRIES WITH CONTINUOUS VACUUM OPERATION

High-solids slurries can be defined as up to 50 – 55% solids in the slurry feed. The BHS technology is a Continuous – Indexing Vacuum Belt Filter (CI-VBF). This technology consists of fixed vacuum trays, continuously feeding slurry system and indexing or step-wise movement of the filter media. Figure 1 illustrates, in practical terms, the operational features of the CI-VBF, which, from a testing point of view, can be a series of Buchner funnels.

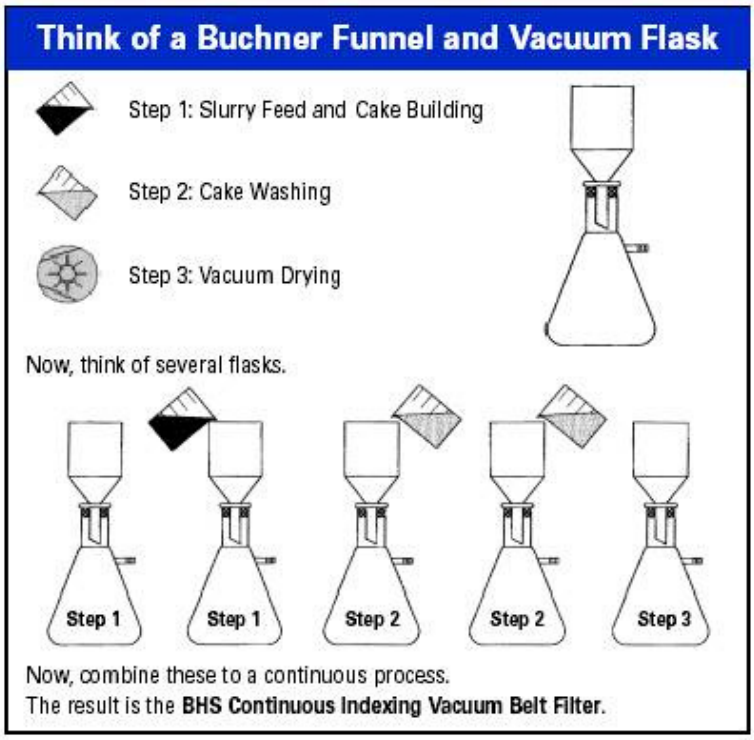


Figure 1: Series of Buchner Funnels Illustrating the BHS Continuous-Indexing Vacuum Belt Filter

The operation is further described in Figure 2 and in the following paragraphs.

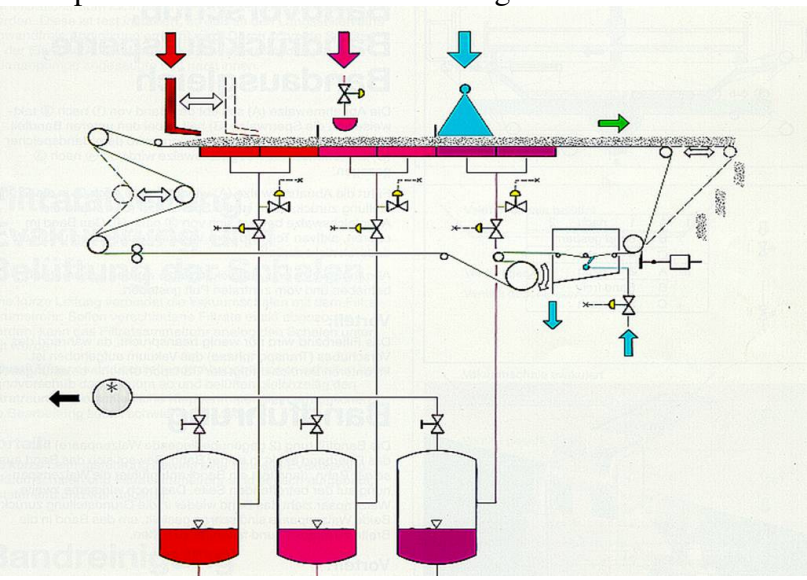


Figure 2: Schematic of the BHS Continuous-Indexing Vacuum Belt Filter

In the CI-VBF, the slurry feed is continuous while the filter cloth is moved intermittently; the trays are fixed in place. For cloth movement, the vacuum is broken by butterfly valves and the cloth moves (indexes), by pneumatic cylinders, in the space above the vacuum trays. The belt moves along and relaxes while indexing, which allows for long filter cloth life. The CI-VBF eliminates the need for rubber carrier belts and motor to move the filter media. Further, compared with moving tray designs, the CI-VBF requires no additional hardware such as rails, rollers and flexible pressure vacuum rated hoses that are within the belt filter frame.

For the process operation, due to the stepwise operation of the belt, washing and drying efficiencies are maximized, as the belt is stopped and the mechanism of "plug-flow" for gases and liquids is in effect. Finally, because the trays are fixed, the mother liquid and the wash filtrates can be recovered individually and recirculated and/or recovered and reused which allows for a more efficient overall operation.

After filtration, washing and drying, the cake is discharged and the filter media is cleaned. Cleaning occurs only when the filter belt is moving which ensures maximum cleaning with lower liquid usage. Automated valves control the washing. The clean filter media is then conveyed back to the slurry feed zone.

The entire operation is pneumatic and easily controlled by a PLC or customer distributed control system (DCS), which minimizes the installation, mechanical commission, water batching and process startup time. The CI-VBF units can be enclosed, dust-tight, or pressure tight for inerting or gas-blanket and are manufactured in stainless steel, Hastelloy, synthetic or reinforced- synthetic components depending upon the solvents, solids, temperatures, etc. The CI-VBF turnkey systems include feed pumps, liquid transfer and recirculation pumps, separator and receiver tanks, liquid ring vacuum pumps, instrumentation, pre-piped and pre-wired skids and PLC control systems. Heating and cooling packages for liquids and/or gases and solids handling can also be included.

TESTING TO DETERMINE THE OPTIMUM FILTRATION TECHNOLOGY OF VERTICAL CANDLE FILTER

Overview of Bench Top Testing in the BHS Laboratory

The BHS bench top testing is conducted using the BHS Pocket Leaf Filter, as shown in Figure 3. The testing will analyze cake depths, operating pressures, filter media, washing and drying efficiencies and qualitative cake discharge. The data collection sheets are shown in Figure 4.

FIGURES ON FOLLOWING PAGE

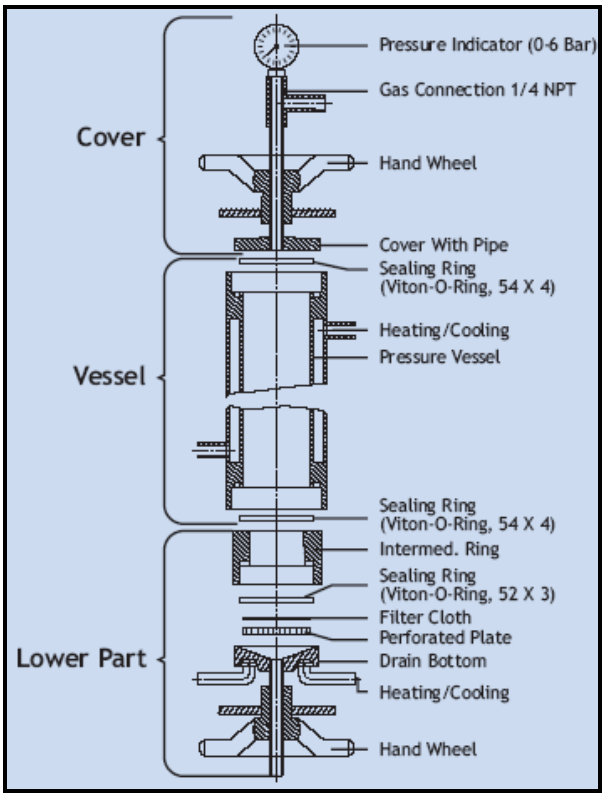


Figure 3: BHS Pocket Leaf Filter (PLF)

Customer:		Test Number:
Date :		Run #
	Filter Media	
	Suspension	
Filling	Volume of Slurry	
	Density of Slurry	
	% Solids in Feed	
	Temperature	
Filtration	Vacuum or Pressure	
	Volume of Filtrate	
	Time for Filtration	
	% Solids in Filtrate	
Wash 1	Wash Material	
	Pressure	
	Volume of Filtrate	
	Time for Filtration	
Wash 2	Wash Material	
	Pressure	
	Volume of Filtrate	
	Time for Filtration	
Drying	Pressure	
	Temperature	
	Flow Rate	
	Time for Drying	
	Pressing Pressure	
Cake	Weight	
	Thickness	
	% Residual Moisture	
	Dry Cake Weight	
	Cake Discharge OK?	

Figure 4: Data Collection Sheet for BHS Pocket Leaf Filter (PLF)

Application 1: Replacing a Vacuum Pan Table for Micro-Beads

This specialty chemicals manufacturer produces a micro-bead that requires filtration, washing and drying. Current production of 300 pounds/hour of slurry includes manual washing and manual cake discharge. The goals of the project are as follows:

1. Increase the filtration rate for higher production
2. Improve the washing of the solids with counter-current washing
3. Improve the drying to allow for the downstream dryer to operate in a more efficient manner (energy savings)
4. Reduce the maintenance and operation of the current operation

Results & Conclusions

The filtration flux rate from the BHS laboratory tests showed increased performance due to the higher vacuum that is possible on the BHS CI-VBF. Two stages of counter-current washing, with overall less wash liquid, was demonstrated. Cake drying was improved to 80%. The cake thickness was 15 mm.

The tests showed that a BHS Vacuum Belt Filter Type BF 100-035 with 3.5 m² of filter area will meet the customer's production requirements. BHS has also included an oscillating feed device to ensure an equal distribution of the slurry feed in the first zone. Finally, due to the indexing-design and unique cloth wash, the client was able to include two stages of cloth wash with different solvents to eliminate cloth blinding. The design of the CI-VBF is shown below.

Zone arrangement:	**Times**	**Number of Zones**
Filtration	80 seconds	2
Wash 1	80 seconds	2
Wash 2	40 seconds	1
Drying	80 seconds	2
Total Zones		**7**
Total Active Length		**3.5 meters**
Total Active Area		**3.5 m^2**

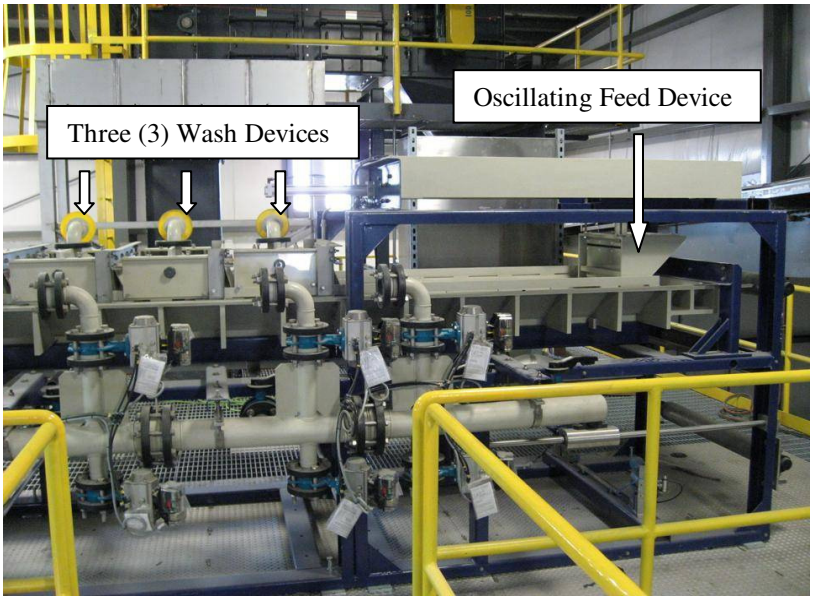


Figure 5: Oscillating Feed and Three (3) Wash Devices

Figure 6: Cake Discharge End & Pressing/Blowing/Drying Device

Application 2: Replacing a Manual Vacuum Nutsche for an Acid Slurry Filtration

This specialty chemicals manufacturer produces a very porous and fragile crystal that will turn "clay-like" if mechanically agitated or compressed. The slurry is acidic slurry at a 30% concentration. The goals are to eliminate operator exposure of the acid, efficient washing to reduce the acid concentration, and to isolate the mother liquor and wash filtrates so that they can be reused. Current production rate is 2500 Kg Dry Solids/hour.

Results & Conclusions

The filtration flux rate from the BHS laboratory tests showed increased performance at a cake thickness of 40 – 50 mm. Only one stage of washing was required to reduce the acid concentration to the specification.

The tests showed that a BHS Vacuum Belt Filter Type BF 100-045 with 4.5 m² of filter area will meet the customer's production requirements. BHS has also included a hood (box-design) to ensure no operator exposure to the acid slurry and no spillage during operation. The design of the CI-VBF is shown below.

Zone arrangement:	Number of Zones
Filtration	2
Washing	2
Drying	2
Total Zones	6
Total Active Area	**4.5 m²**

Figure 6: BHS Vacuum Belt Filter with Polypropylene Cover (Box-Design)

SUMMARY

Continuous thin-cake vacuum filtration operations provide many benefits to the production process. These include increased production rates, increased washing and drying as well as improved safety and environmental concerns. The process decision will then be the combined overall efficiency, total installed capital cost, operating cost, space requirements, ancillary equipment and above all the reliability and cost-effectiveness which will result in the optimum filter selection.

Ultimately, there is no substitute for accurate and professional test work under realistic conditions. For this, close cooperation is required between the plant operations and engineering staff and the filtration vendor along with detailed laboratory and pilot plant tests.

Barry A. Perlmutter is President and Managing Director of BHS-Filtration Inc., a subsidiary of BHS-Sonthofen GmbH. BHS is a manufacturer of thin-cake filtration, washing and drying technologies. Barry has over 28 years of engineering and technical business marketing experience in the field of solid-liquid separation including filtration and centrifugation and process drying. He has published and lectured extensively worldwide on the theory and applications for the chemical, pharmaceutical and energy / environmental industries and has been responsible for introducing and creating growth for many European companies and technologies into the marketplace. He received a BS degree in Chemistry from Albany State University, NY, MS degree from the School of Engineering, Washington University, St. Louis and an MBA from the University of Illinois. Barry served on the Board of Directors of the American Filtration and Separations Society (AFS) and is a member of several internationally recognized societies.

BHS Thin-Cake Pressure and Vacuum Filtration Technologies
For Batch or Continuous Operations From High Solids to Clarification

BHS-Sonthofen GmbH, founded in 1607, is a leader in technology and innovation. Among other areas of mechanical process engineering, BHS specializes in thin-cake (3 mm - 180 mm) filtration, cake washing and drying technologies.

BHS serves three major market segments as follows:

- Chemical: Fine, Specialty, Agricultural, and Others
- Pharmaceutical: Bulk and Final Products
- Energy / Environmental: Refinery, Power Plants, Bioenergy, and Wastewater

Specialized Applications & Centres of Excellence:

BHS is organized both locally and globally. BHS-Filtration Inc., headquartered in Charlotte, North Carolina is responsible for North America and Mexico.

For specialized applications, BHS is organized globally with centres of excellence. These centres include, for example, aromatic acids, cellulose derivates, pharmaceuticals, dewatering of gypsum, refinery and bio-energy applications.

Product Technologies & Capabilities

The BHS technologies and expertise are thin-cake (3 mm – 180 mm) filtration, cake washing and drying. The five-patented BHS technologies are as follows:

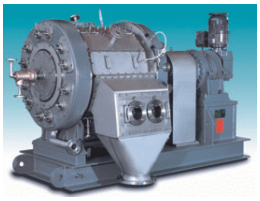
- Rotary Pressure Filter
- Continuous-Indexing Vacuum Belt Filter
- Candle Filter
- Pressure Plate Filters
- Autopress, an Automated/Contained Specialized Filter Press

These technologies are installed for pressure or vacuum filtration, for batch or continuous operations from high solids slurries (up to 60% solids) to clarification applications with solids to less than 0.5%.

Process Lab Testing & On-Site Pilot Testing

BHS conducts preliminary tests in our worldwide laboratories or at your facility. On-site tests with pilot rental units continue the process. Finally, BHS completes the project with a complete technical solution. Contact us today.

BHS Rotary Pressure Filter



BHS Duplex Candle Filter

BHS Vacuum Belt Filter