Replacing Filter Presses and Manual Plate Filters for Removing Trace Solids from Chemical Slurries with Thin-Cake Candle Filter Technology

The BHS technologies of Vertical Candle Filters provide improved product quality with more efficient operations compared with filter presses and manual plate filters. Fully automatic operations provide for complete containment of the solids and liquids for reduced maintenance costs and overall project savings.

By
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INTRODUCTION

As the chemical industry has changed and grown since the mid-1980's, there are increasing concerns about the safe handling of solids and slurries. To meet these requirements, with less operator interaction, the industry's need for new technologies has expanded.

One area of importance is now the efficient removal of activated carbon, metal catalysts and trace insolubles, such as diatomaceous earth, from slurries. Currently, most slurries are clarified with the use of filter presses and manual plate filters, bag filters, cartridge filters and other conventional filter equipment or, in some cases, a combination of equipment. All of these units require manual operations for cake discharge and cleaning between batches or campaigns as well as suffer from high labor and maintenance costs, high disposal costs and the exposure of the operators and the environment to toxic and hazardous solvents and solids as well as used and contaminated filter cloth, bag filters and filter cartridges.

This article discusses the use of thin-cake vertical candle filters as alternatives to manual and conventional filter equipment. These new technologies are described as well as the selection process. The article includes test data and case histories.

CLARIFICATION & RECOVERY OF SLURRIES

Candle Filters are installed for clarification and recovery applications from liquids with low solids content. The candle filters are vertical candles.

Description and Operation of the Candle Filter

The BHS Candle Filter provides for thin-cake pressure filtration, cake washing, drying, reslurry and automatic discharge as well as heel filtration in an enclosed, pressure vessel. Units are available up to 100m^2 of filter area per vessel.

Filter Candles & Media

The filter candles, as shown in Figure 1, consist of three components: single-piece dip pipe for filtrates and gas, perforated core with outer support tie rods and filter sock media. The filtrate pipe is the full length of the candle and ensures high liquid flow as well as maximum distribution of the gas during cake discharge. The perforated core can be a synthetic material, stainless steel or Hastelloy and is designed for the full pressure of the vessel. The outer support rods provide for an annular space between the media and the core for a low pressure drop operation and efficient gas blowback for cake discharge. Finally, the filter media is synthetic or metallic with removal efficiency to less than 0.5 microns.

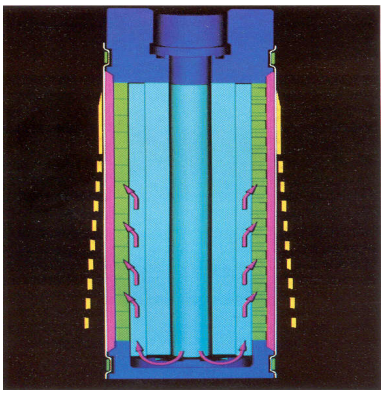


Figure 1: BHS Candle

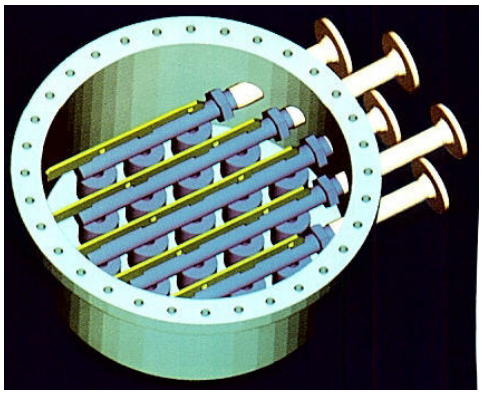


Figure 2: BHS Candle Filter

Filter Vessel & Candle Registers

Vessel is constructed of stainless steel, Hastelloy or carbon steel lined. Within the vessel are candle registers. Each candle is connected to a register with a positive seal to prevent bypass. Each register may contain from 1-20 candles depending upon the filter size. The registers convey the liquid filtrate as well as the pressure gas for filter media expansion. Each register is controlled with automated valves to ensure optimum flow in both directions. Figure 2 illustrates the candle filter vessel.

Automatic Process Cycles

Filling: The slurry feed enters the bottom of the filter vessel.

Filtration: The slurry is pumped under pressure into the vessel. Cake will deposit on the outside of the candle; the separated filtrate will flow through the filtrate pipe and the registers. This process continues to a maximum pressure drop, the maximum cake thickness, or the minimum flow.

Washing: Displacement washing or recirculation washing.

Drying: Blowing gas, steam or "shock" drying.

Heel Filtration: The liquid remaining in the vessel cone after filtration or washing is completely filtered.

Cake Discharge: Gas flows through the register pipes, and down the filtrate pipe. The filter media gently expands allowing for cake discharge. Alternatively, the cake can be discharged as a slurry.

SELECTION OF CANDLE FILTER TECHNOLOGY

Cake Thickness and Filtration: The candle filter is limited to cake structures that can be formed to about 5 – 25 mm with and can conduct filtration up to 150 psig.

Filter Media: The candle filter uses only synthetic media and use media with a clean removal efficiency to less than 0.5 microns.

Cake Washing: If the process requires washing, displacement washing can be conducted.

Heel Filtration: The remaining liquid in the vessel, liquid heel, can be removed from the candle filter by circulation or heel filters in the cone of the vessel. .

Cake Drying: The candle filter can produce cakes as low as 10 – 15% moisture. This moisture level depends upon the specific cake but the moisture lower limit is that moisture just above the cake cracking point.

Cake Discharge: Complete cake discharge with no residual heel by gentle gas expansion of the filter sock.

Sock Cleaning after Cake Discharge: If necessary, sock cleaning is accomplished by filling and circulating cleaning fluids while blowing gas in the reverse direction to the filtration direction, which crates a turbulent mixture or a quasi-ultrasonic cleaning effect.

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.

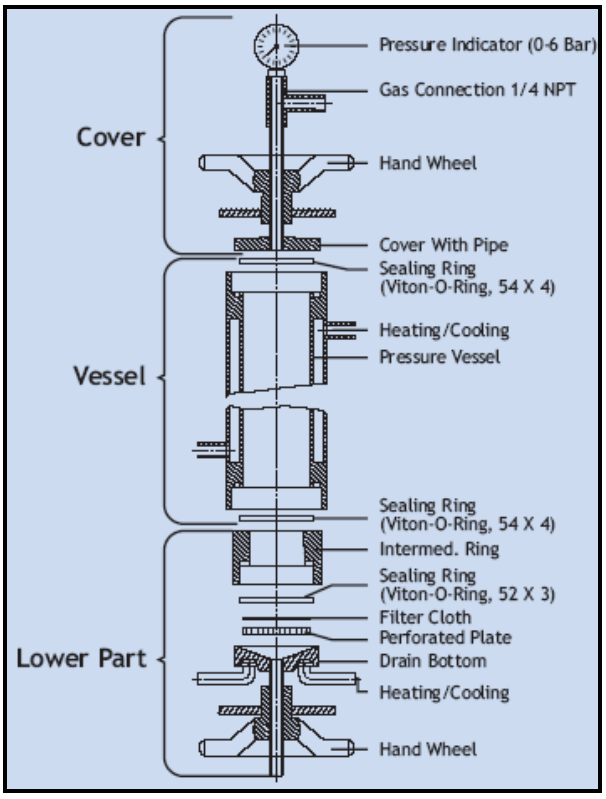


Figure 3: BHS Pocket Leaf Filter (PLF)

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 Manual Plate Filter and Bag Filter Combination

This specialty chemicals manufacturer produces various resins that require filtration. Current production includes a neutralization step which yields metal salts. These salts are filtered out with a manual plate filter followed by a bag filter for polishing. Two solvent washes follow the filtration step to recover as much resin as possible. After washing, the filters are steamed out and opened up. The solids are disposed manually for each batch and the filter paper is replaced. The goals are to eliminate exposure to heptane, reduce the maintenance and operation on the two filters and to recover a dry, as possible, catalyst. Current production is 3000 gallons in 4 – 5 hours.

Results & Conclusions

The filtration flux rate from the BHS laboratory tests ranged between 10-30 L/m^2min at approximately 20 psi feed pressure. The filter cloth for the sock is polyester with an air permeability of 1.0 cfm/ft^2.

The tests showed that one BHS candle filter with 10 m^2 of filter area can complete the cycle in a time of 4.3 hours and replace the manual plate filter and bag filter. The cycle time is as follows:

Typical Cycle Times		
Filling	5	min
Filtration	10	min
Wash	4	min
Drain	10	min
Dry	5	min
Vent	2	min
Discharge	5	min
Reserve	9	min
TOTAL	**50**	**min**

Figure 5: Dry Cake After Discharge

Application 2: Replacing a Filter Press for a Hot Slurry Filtration

This specialty chemicals manufacturer produces various grades of polyols from ethylene glycols that require filtration of small particles in the 1 – 2 micron range. Current production includes a manually-operated filter press at 200 – 250 degrees F. The goals are to eliminate operator exposure, reduce the maintenance and operating costs for the filter press and to increase the polyols yield. Current batch sizes are 45000 pounds of slurry.

Results & Conclusions

BHS conducted the lab tests in the BHS laboratory in Charlotte, North Carolina. The slurry temperature was between 200 – 250 degrees F at a pressure of 90 psig. The filter cloth for the sock was successful using PTFE or PEEK material.

The tests showed that one BHS candle filter with 27 m² of filter area can complete the required batch is three (3) cycles, each of 6-hours. The cycle time is as follows:

Typical Cycle Times		
Filling	12	min
Precoat	8	min
Filtration	60	min
Drain	15	min
Dry	3	min
Vent	2	min
Discharge	15	min
Reserve	5	min
TOTAL	**120**	**min**

Figure 6: Jacketed Candle Filter with Register-Filtrate Piping & Junction Box

SUMMARY

Thin-cake filtration operations provide many benefits to the production / clarification process. By selecting the optimum thin-cake candle filter technology, engineers can realize a more efficient process approach including solids handling with minimal operator involvement for improved safety and environmental concerns.

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:

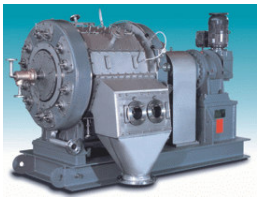
- Rotary Pressure Filter
- Continuous-Indexing Vacuum Belt Filter
- Candle Filter
- Pressure Plate Filters
- Autopress, an Automated/Contained Specialized Filter Press

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