



BHS-FILTRATION INC.

BHS CANDLE FILTER TECHNOLOGY FOR REFINERY APPLICATIONS

- 1. Sodium Sulfate Removal from Make Up Buffer Solutions**
- 2. Specialty Amine Filtration**
 - a. Coker Unit**
 - b. Fluid Catalytic Cracker**
- 3. Wastewater Clarification from a Wet Scrubber Plant with FCC (Fluid Catalytic Cracker) Fines Downstream of a Clarifier**

BHS CANDLE FILTER TECHNOLOGY

Description, Benefits and Operation of the Candle Filter

Candle Filters provide 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 from 0.17 m² up to 100m² of filter area per vessel.

The Candle Filters are installed for clarification and recovery applications from liquids with low solids content. They are an ideal replacement for filter presses as well as for manual plate filters, bag filters, cartridges filters and other conventional-manual separation equipment where solids, solvents and hazardous materials are being handled.

Filter Vessel & Candle Registers

The candle filter vessel is constructed of stainless steel or higher alloys. Within the vessel are horizontal manifolds called 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 in the forward direction as well as the pressure gas in the reverse direction for filter media sock expansion. Each register is controlled with automated valves to ensure optimum flow in both directions. Figure 1 illustrates the candle filter vessel.

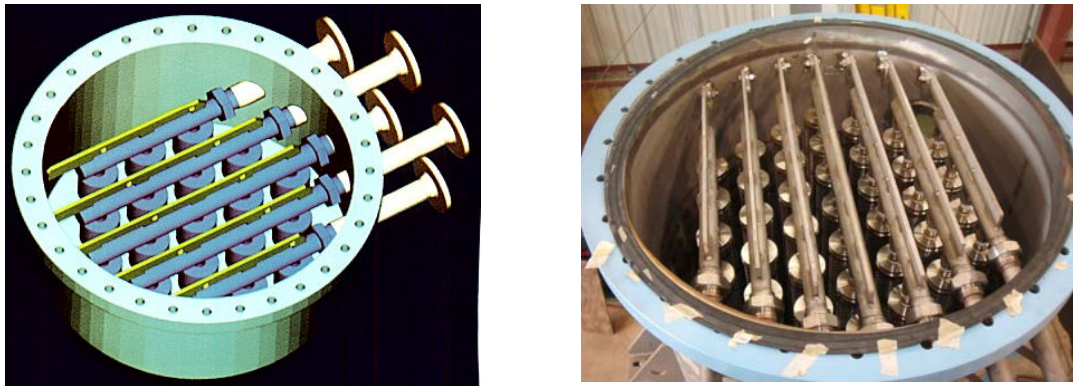


Figure 1: BHS Candle Filter

BHS CANDLE FILTER TECHNOLOGY

Filter Candles & Media

The filter candles, as shown in Figure 2, 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 higher alloys and is designed for the full pressure of the vessel. The outer support tie rods provide for an annular space between the media and the core for a low pressure drop operation and efficient gas expansion of the filter media sock for cake discharge. Finally, the filter media is a synthetic type with a clean removal efficiency to less than 1-3 microns. As the cake builds up, removal efficiencies improve to less than 1 micron.

Automatic Process Cycles

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

Filtration: The slurry is either pumped or pressurized from the reactor 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 until one of the following conditions is achieved: maximum pressure drop, maximum cake thickness, minimum flow or time.

Washing: Displacement washing or recirculation washing.

Drying: Blowing gas, steam or “shock” drying.

Heel (Falling-Film) Filtration: The liquid remaining in the vessel cone after filtration or washing is completely filtered.

Cake Discharge: Gas flows sequentially through each of the candle registers, down each of the filtrate pipes and then is distributed by the perforated core. The filter media sock gently expands by the gas flow and pressure allowing for cake discharge, as shown in Figure 1. Alternatively, the cake can be discharged as a slurry.

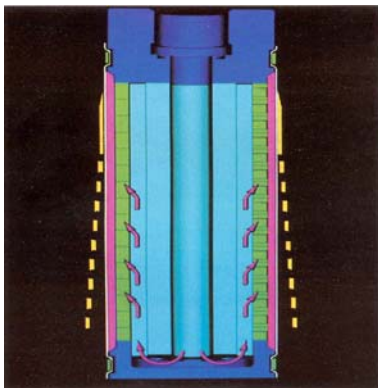


Figure 2: BHS Candle Showing Gas Flow to Expand the Filter Media Sock for Cake Discharge



REFINERY APPLICATIONS

1. Sodium Sulfate Removal from Make Up Buffer Solutions

A. Application Summary

- a. Sodium sulfate removal from a recirculating absorbing solution in a wet scrubber process.

B. BHS-Filtration Inc. Research Testwork

- a. In the absorbing process for scrubbing SO₂ from flue gases, there is an accumulation of Na₂SO₄ salt in the buffer solution. Bench top tests were conducted on the buffer solutions using a Rotovap evaporator and a BHS-Filtration Pocket Leaf Filter. The tests were conducted to demonstrate that the buffer solution could be concentrated by evaporation and then filtered. The evaporation process produces a supersaturated salt solution, and the excess salts are removed during the filtration process. This test indicates that thin- cake pressure filtration using the BHS-Filtration Candle Filter will provide the optimum filtration results for this application.

C. BHS-Filtration Inc. Installation

- a. Two candle filters
 - i. Each filter contains 37 candles
 - ii. Each filter has 19 m² of filter area
 - iii. BHS provided the PLC system to operate the filters and communicate to the DCS
 - iv. BHS provided all of the valves, instruments, piping, pneumatic tubing and wiring for the two candle filters
- b. Installation, Commissioning and Training
 - i. BHS provided supervision support for the installation
 - ii. BHS was involved in the commissioning and training of the operators

D. Photograph of the Two Candle Filters in the Fabrication Shop





REFINERY APPLICATIONS

2. Specialty Amine Filtration for a Coker Unit and Fluid Catalytic Cracker

A. Application Summary

- a. **Installation 1:** Removal of FCC Fines from a recirculating amine solution in a wet scrubber process. Fines are less than 2 microns.
- b. **Installation 2:** Removal of Coker Fines from a recirculating amine solution in a wet scrubber process. Fines are less than 2 microns.

B. BHS-Filtration Inc. Research Testwork

Bench top filtration tests were conducted using a BHS-Filtration Pocket Leaf Filter. The tests were conducted to produce a FCC Fines / Amine slurry and a Coker Fines / Amine slurry containing 2 micron and smaller particles. These slurries were then tested to demonstrate that the FCC Fines and Coker Fines could be removed from the Amine solution.

These tests indicated that thin-cake filtration using a BHS-Filtration Candle Filter will provide the optimum results for these products. It will be necessary to use a pre-coat for these products. Three Type KF-49/25 Filters with a total area of 74.7 m² will be required for the FCCU Fines / Amine slurry application and three Type KF-49/25 Filters with a total area of 74.7 m² will be required for the Coker Fines / Amine slurry application.

C. BHS-Filtration Inc. Installation

a. Two Complete Turnkey Filtration Systems (Trains)

- i. Each train contains three filters
- ii. Each filter contains 49 candles for a total of 147 candles per train
- iii. Each filter has 25 m² of filter area for a total of 75 m²
- iv. BHS provided the PLC system to operate three filters per train and to communicate to the DCS
- v. BHS provided all of the valves, instruments, piping, pneumatic tubing and wiring for the two trains

b. Additional Scope of Supply

- Two feed and two filtrate tanks
- Three (3) Feed pumps and Two (2) filtrate pumps
- Precoat Tank with agitator and Two (2) precoat pumps

c. Complete Skid System

- Skid engineering and design with piping, wiring, platforms, etc.

d. Installation, Commissioning and Training

- i. BHS provided supervision support for the installation
- ii. BHS was involved in the commissioning and training of the operators

D. Photograph of the Two Complete Turnkey Filtration Systems (Trains)





REFINERY APPLICATIONS

3. Wastewater Clarification from a Wet Scrubber Plant with FCC (Fluid Catalytic Cracker) Fines Downstream of a Clarifier

A. Application

1. The project is for candle filters for clarifying a wastewater stream from the Wet Scrubber Plant with FCC (Fluid Catalytic Cracker) fines downstream of a clarifier. This project is to replace filter presses and multi-bag filter systems.

B. Scope of Supply

1. Candle Filter System

Quantity: One Complete System with two (2) Candle Filter Vessels
Model: BHS Candle Filter KF 221-110
Each filter contains 221 candles
Each filter has 110 m² of filter area for a total of 220 m²

2. Precoat Tank System

Quantity: One Complete Precoat Tank System
Filter Precoat Tank
Filter Precoat Tank Agitator:
Filter Precoat Tank Pump:

3. PLC Controls

4. Valves & instruments

5. Air Receivers

6. Skid Package including engineering, piping, wiring, stairs and platforms



REFINERY APPLICATIONS

4. Process Benefits Realized From the Installation of the BHS Candle Filter Technology

- Automatic operation which eliminates the need for operator attention and manual efforts
- Full containment of solids, liquids and gases, which improves worker safety and eliminates environmental concerns.
- Candle and sock design is a positive seal, which eliminates bleed-through of solids, liquids or gases.
- Improved washing which may be beneficial for landfill purposes.
- Improved drying, no free liquids, which will reduce landfill costs.
- Discharge is automatic and 100% (no residual heel) and is from a 16-inch flange. Solids handling is easy as there is a chute from the discharge flange to the hopper or tote. The hopper / tote can easily be picked up by forklift or drive-in truck.
- Installation is easy as the candle filters are completely skid-mounted including piping, valves, instruments and PLC controls. Units can sit in an open structure and hard-piped to slurry, liquid and gas feed lines and filtrate and cake-discharge lines.
- There are no moving parts so the units are low maintenance and require a small inventory of spare parts.



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

BHS-Sonthofen GmbH, founded in 1563, is a leader in technology innovations. BHS worldwide specializes in thin-cake (3 mm up to 75 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, Wastewater and Others

Specialized Applications & Centres of Excellence:

BHS is organized both locally and globally. BHS-Filtration Inc., a subsidiary of BHS-Sonthofen, is responsible for North and South America. For these markets, equipment and systems are manufactured with as much local content as possible.

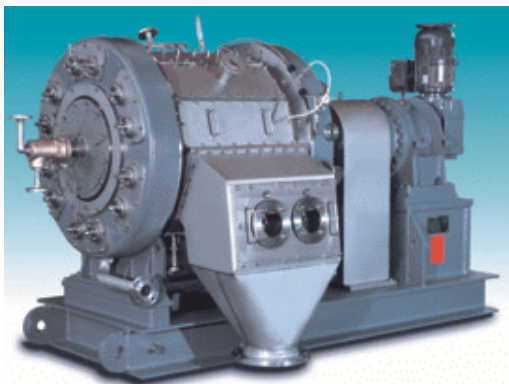
For specialized applications, BHS is organized globally with centres of excellence for these applications. For example, for power plant applications and the dewatering and drying of gypsum, this expertise resides at BHS-Sonthofen. For refinery and bio-energy applications, the expertise for process engineering, etc. resides at BHS-Filtration Inc.

Product Technologies & Capabilities

The BHS technologies and our expertise are thin-cake (3 mm - 25 mm) filtration, cake washing and drying. The five patented BHS technologies (rotary pressure filter, vacuum belt filter, candle and pressure plate filters and the Autopress, an Automated/Contained Specialized Filter press) are based upon pressure or vacuum filtration, for batch or continuous operations from high solids slurries (up to 50% solids) to clarification applications with solids to 1% and trace amounts.

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 and performance guarantees. Contact us today.

BHS Rotary Pressure Filter



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BHS Continuous – Indexing Vacuum Belt Filter



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