BHS-FILTRATION INC.

BHS VACUUM BELT FILTER, CANDLE & PRESSURE PLATE FILTER TECHNOLOGIES FOR BIO-ENERGY APPLICATIONS

1. **Crop Feedstocks for Bio-Ethanol**
2. **Cellulose Feedstocks for Bio-Ethanol**
3. **Wood Feedstocks for Bio-Diesel**

BHS CONTINUOUS–INDEXING
VACUUM BELT FILTER TECHNOLOGY

Figures 1 and 2 illustrate the operational features of the BHS Continuous – Indexing Vacuum Belt Filter. The operation is further described in the following paragraphs.

In the BHS vacuum belt filter, the slurry feed is continuous while the filter cloth is moved intermittently and the trays 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 but never touches the trays, which allows for long filter cloth life. The BHS filter eliminates the need for rubber carrier belts and motor to move the filter media. Compared with moving tray designs, the BHS unit requires no additional hardware such as rails, rollers or flexible pressure-vacuum rated hoses.

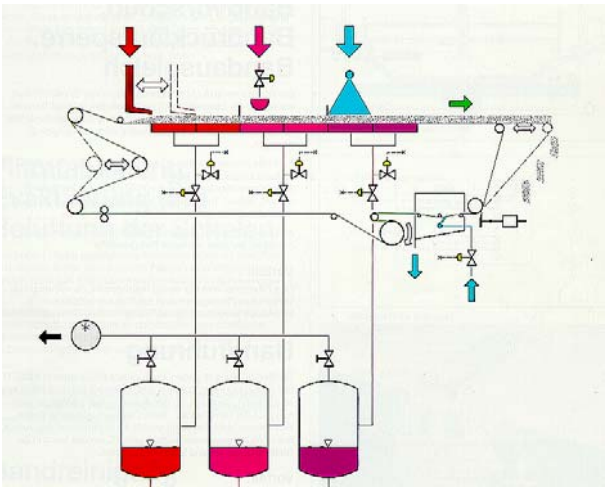

Figure 1: Process Flow Diagram Of the BHS Belt Filter Installation

Figure 2: BHS Belt Filter with 73.5 m^2 of Filter Area

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, shown in Figure 3, 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 media is then conveyed back to the slurry feed zone.

BHS CONTINUOUS–INDEXING
VACUUM BELT FILTER TECHNOLOGY

The entire operation is pneumatic and easily controlled by a PLC or customer DCS, which minimizes the installation, mechanical commission, water batching and process startup time. The 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. BHS completes the turnkey systems with 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.

Figure 3: Cake discharge from a BHS vacuum belt filter
The filter produces 10 tons/hour of dry solids with a cake depth of 50 mm.
The moisture < 10 % and the Chlorides are < 100 ppm from initially 20,000 ppm

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 m^2 up to 100m^2 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 4 illustrates the candle filter vessel.

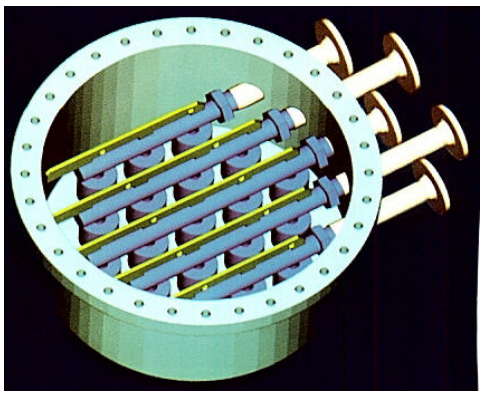

Figure 4: BHS Candle Filter

Filter Candles & Media

The filter candles, as shown in Figure 5, 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.

BHS CANDLE FILTER TECHNOLOGY

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.

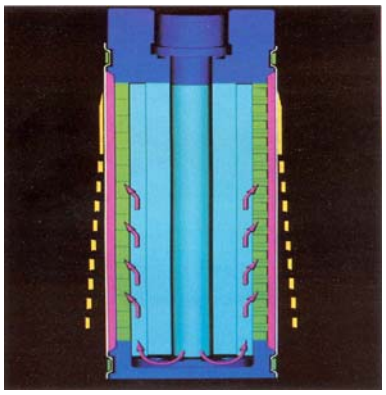

Figure 5: BHS Candle Showing Gas Flow to Expand the Filter Media Sock for Cake Discharge

BHS PRESSURE PLATE FILTER TECHNOLOGY

Description and Operation of the Pressure Plate Filter

The pressure plate filter has similar operating characteristics to the candle filter except that the cake structure is horizontal rather than vertical. The filter design is shown in Figure 6.

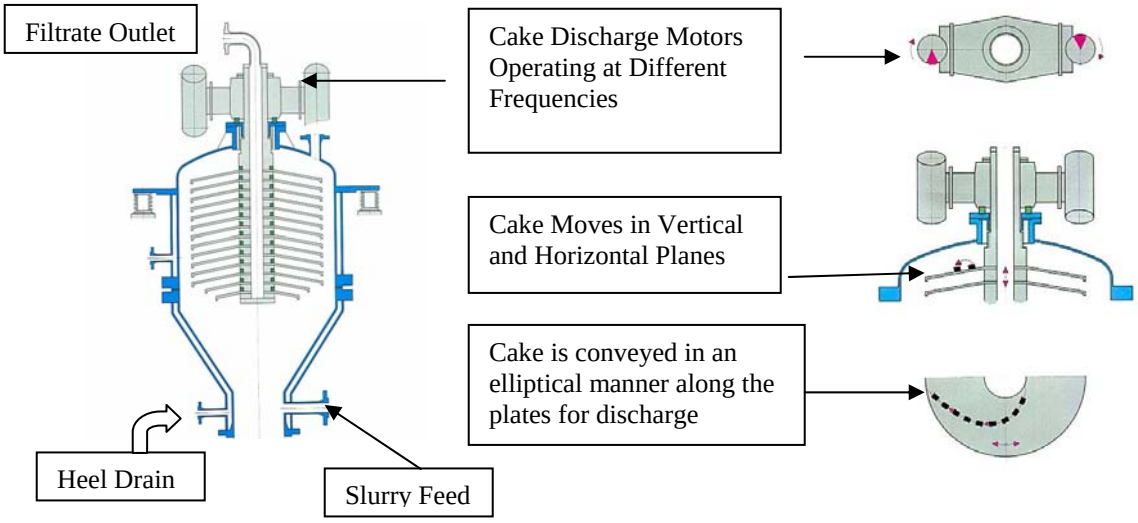

Figure 6: BHS Pressure Plate Filter

Figure 7: Vibrating Plates for Cake Discharge

Automatic Process Cycles

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

Filtration: The slurry is pumped under pressure into the vessel or via gas pressure through the reactor. Cake will deposit on the top of the plates. The separated filtrate will flow through the plates to the center main filtrate outlet. 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 Filtration: The liquid remaining in the vessel cone after filtration or washing is completely filtered.

Cake Discharge: As shown in Figure 7, the motors on the top of the filter operate at different frequencies and the plates gently vibrate for cake discharge. The plates vibrate in the vertical and horizontal planes and the solids are conveyed in an elliptical pattern to the outside of the vessel. Gas assist helps in the discharge process. There are no rotating plates, gears or bushings and mechanical seals are not required.

BIO-ENERGY APPLICATIONS

1. Crop Feedstocks for Bio-Ethanol

A. Application Summary

a. Crop feedstocks are to be filtered, washed and dried for further processing. The objective is to develop an alternative process to eliminate the membrane filter presses.

B. BHS-Filtration Inc. Research Testwork

a. The tests were conducted to determine the best filtration technology to separate the crop solids from the process fluid and conduct initial tests to evaluate counter-current washing.
b. BHS conducted vacuum filtration tests with different filter media, different water wash ratios, temperatures and sequences and various drying techniques including pressing, blowing, vacuum, steaming and combinations.
c. These tests indicates that thin-cake vacuum filtration using the BHS Continuous – Indexing Vacuum Belt Filter will provide the optimum filtration results for this application. The indexing design provides for maximum displacement washing efficiency and drying efficiency with pressing and gas blowing.
d. The BHS special oscillating feed device ensures an even cake structure for the process steps.

C. BHS-Filtration Inc. Installation

a. Complete Belt Filter Turnkey Installation
    i. BHS Vacuum Belt Filter
    ii. Liquid Ring Vacuum Pump System including recirculation
    iii. Filtrate Tanks (5) and Filtrate Pumps (5) for counter-current washing
    iv. Fully Automated with a PLC System
    v. Complete skid systems with piping and wiring and pneumatic tubing
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

BIO-ENERGY APPLICATIONS

2. Cellulose Feedstocks for Bio-Ethanol

A. Application Summary

a. Cellulose feedstocks are to be filtered, washed and dried for further processing. The objective is to develop an alternative process to eliminate the membrane filter presses.

B. BHS-Filtration Inc. Research Testwork

a. The tests were conducted to determine the best filtration technology to separate the cellulose fibers (solids) from the process fluid and conduct initial tests to evaluate counter current washing with water and/or caustic solutions.
b. BHS conducted vacuum filtration tests with different filter media.
c. Tests were also conducted using different water wash ratios and caustic ratios. Temperatures, pH and other parameters and sequences were evaluated.
d. Various drying techniques including pressing, blowing, vacuum, steaming and combinations were examined.
e. These tests indicates that thin-cake vacuum filtration using the BHS Continuous – Indexing Vacuum Belt Filter will provide the optimum filtration results for this application. The indexing design provides for maximum displacement washing efficiency and drying efficiency with pressing and gas blowing.
f. The BHS special oscillating feed device ensures an even cake structure for the process steps.

C. BHS-Filtration Inc. Installation

a. Complete Belt Filter Turnkey Installation
    i. BHS Vacuum Belt Filter
    ii. Liquid Ring Vacuum Pump System including recirculation
    iii. Filtrate Tanks (3) and Filtrate Pumps (3) for counter-current washing
    iv. Fully Automated Pneumatic Control System
    v. Complete skid systems with piping and wiring and pneumatic tubing
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

BIO-ENERGY APPLICATIONS

3. Wood Feedstocks for Bio-Diesel

A. Application Summary

a. The current process uses hydrocyclones and vapor-quench systems to produce bio-diesel (oil) and char. The process is energy intensive and there is carry-over of the char into the bio-oil.
b. The alternative process is to filter the slurry from the hydrocyclone to clarify the bio-oil and wash and dry the char.

B. BHS-Filtration Inc. Research Testwork

a. The tests were conducted to determine the best filtration technology to separate bio-oil from char.
b. Testing was conducted at elevated temperatures and pressures due to viscosity concerns.
c. Testing was also conducted using various ethanol wash ratios and concentrations.

C. BHS-Filtration Inc. Recommendations for Bio-Diesel Processes

a. BHS is in a unique position to provide three alternative solutions

i. BHS Candle Filter with reslurry washing with ethanol
ii. BHS Pressure Plate Filter with reslurry washing with ethanol and to produce a bone-dry cake
iii. BHS Vacuum Belt Filter for continuous operation with displacement washing with ethanol and vacuum drying

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 and innovation. 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

BHS Duplex Candle Filter