Polymer Filtration Options: Screen Changers or Large Area

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TYPES OF FILTRATION

Manual and hydraulic type screen changers are the most common found in extrusion and polymer production, with both causing an interruption in the melt flow during screen change. Continuous belt, single and dual piston, and multi-segment rotary disc types comprise the majority of continuous screen changers. Large area or candle type filtration systems are available in single vessel-discontinuous, or dual vessel-continuous configurations. Continuous systems are able to change screens/filtration media on the fly, with no process interruptions or negative effects on the end product.

Manual Screen Changers (see Figure 1)

Limited size ranges up to 150 mm, with low capital and operating costs. Compact in size, with streamlined flow passages for minimum residence time. Major process interruption, requiring line shutdown to change screen. Use pressure activated seals, which require maintenance and occasional replacement to avoid leakage.

Hydraulic Screen Changers (see Figure 2)

High level of industry acceptance, with a wide range of available sizes up to 450 mm. Low operating and capital costs, with streamlined flow passages. Momentary process interruption and air entrapment when clean screen moves quickly into production. Heated standby screen in atmosphere can cause material degradation. Single screen operation limits filtration area and use of seals adds to maintenance and the likelihood of leakage. Use of complicated, high volume hydraulic system leads to additional safety and operational issues.

Belt Type Screen Changers (see Figure 3)

Able to maintain close to constant, but relatively high differential pressure by incrementing small amounts of clean screen into the process. Streamlined flow path for short residence time. Low operator intervention levels, with up to a 50 meter rolled screen being automatically fed, via the process pressure. Limited size ranges and relatively high capital/operational costs. Requires a sophisticated control system to manage movement of the screen belt and the melt temperature dependent sealing. Varying contamination level and melt viscosity can cause problems with screen belt movement and system leakage.

Piston Type Screen Changers (see Figure 4)

Very wide range of sizes, with two, four and eight screen systems, and diameters up to 450 mm. Continuous operation and a sealless design combined with the highest available open filtration area of any screen changer. Suitable for a variety of extrusion and polymer applications at a cost

higher, but still competitive with hydraulic slide plate systems. Some pressure variations at screen change and increased residence time, with individual flow channels for each screen cavity. Backflush capable for high automation and very low operator intervention.

Rotary Disc Screen Changers (see Figure 5)

Sizes to 250 mm offer constant pressure operation, but relatively high pressure drop, with a minimum residence time. Highly automated, with sophisticated controls and low operator intervention, with backflush option. Leakage and disc lockup concerns are related to clamping force of housing plates, material viscosity and system pressure, and these systems can require excessive amounts of attention and system setup.
Large Area filtration Systems (see Figure 6)

Filtration capacities of 2000 kph and up, with filtration levels as low as 5 micron and gel retention using depth media. Continuous, dual vessel systems take up considerable floor space, but handle the most difficult applications. High capital and operational costs, with safety concerns associated with handling and cleaning dirty vessels and candle elements.

APPLICATION FACTORS AND SYSTEM SIZING

Many factors decide what style of filtration system would be most suitable for a given application. Total throughput and final filtration levels for the most part will determine whether a screen changer can do the job, or if a large area system will be required. Production rates of 7,500 kph and higher, and/or filtration levels of 25 micron and lower will usually indicate a large area system. Screen change frequency or desired on-stream life, frequency of normal line shutdowns and material waste and downtime during restart will determine if a continuous system is warranted. The need for automation and the effects of pressure variations on the process will further define the style of screen changer and such options as backflush capability.

Once a style of screen changer or large area system is selected, then the required filtration area must be determined. The type of application or process, along with material viscosity and thermal stability, filtration levels, production rate, contamination levels and system pressures all combine to determine the correct size system for the application.

THE PISTON TYPE SCREEN CHANGER

Piston type screen changers are the most accepted and widely used continuous systems on the market, and will be looked at in detail here. One, two or more screen bearing pistons in a common housing, with one or more breaker plates per piston comprise a typical system. Leakage is controlled by a close tolerance, clearance fit between the piston and housing bore, which is maintained over a sealing length between the screen cavity and atmosphere. One or more flow channels split the flow to multiple screens, where at least one screen is in the melt flow at all times. A control system is not required, however if automatic positioning or backflush is desired, a simple PLC system with piston position indication and control is used.

Continuous Production

During normal production, all screens are in operation and only during screen changer are one or more screens removed from the melt flow, which is diverted through the remaining screens. As the shear increases, the material viscosity decreases, minimizing the pressure increase across the

screen changer. Pressure variations at screen change can be minimized by changing screens early, before they are totally clogged and differential pressures have reached a high level.

Venting of the Screen Cavity

The second element of an uninterrupted process is complete de-aeration of the screen cavity prior to going back into production. An entrance groove allows a small amount of material to fill the cavity, where front, top and back venting grooves allow all the air to escape to atmosphere. Either positioned manually or by an optional control system, venting can take anywhere from 20 - 30 seconds to several minutes, depending on the material and process. Automatic positioning for fine control of the venting process will remove human error and minimize any loss of die pressure.

Support Plates and Breaker Plates

Breaker plates with up to 56% open area and support plates with 98% open area are the heart of the piston screen changer. A special plate using vertical ribs support the screen pack off the breaker plate allowing full utilization of the screen surface and enabling use of larger holes in the breaker plate for lower pressure drop. Convex shape on the backside of the breaker plate promotes plug flow of material by forcing uniform material flow across the entire surface of the breaker plate. Optional candle breaker plates can increase the total area 4 to 5 times that of a flat screen pack allowing higher through puts and/or finer filtration.

DUAL VESSEL, LARGE AREA SYSTEM

Run Mode

The filter system runs on one vessel until elements fill up with dirt. At this point (when the pressure differential set point is reached), vessel changeover is started to direct flow to the clean vessel.

Vessel Changeover

The vent valve is first opened to allow gasses to escape while filling. The inlet valve is positioned to allow polymer to flow into both the dirty and clean vessel. Once the clean vessel is full and vented, the vent valve is closed and the outlet valve is moved to the same position as the inlet valve, allowing the clean vessel to come on stream with the dirty one. Both the inlet and outlet valves are moved together to full on stream position for the clean vessel. The dirty vessel is now off stream and ready for cleaning, and the system is back in run mode.

APPLICATIONS

Single Piston Systems

<u>6500 PPH, PET</u> resin production with a one screen 250 mm, dis-continuous system. Batch polymerization process for bottle resin, stainless steel, oil heated, with 325 mesh screens.

<u>500 PPH, HDPE</u> strand pelletizing extrusion line with a two screen 78 mm, continuous system. Low cost unit to eliminate dropped strands at change and with 250 mesh screens.

1500 PPH, PS inline thermoforming line with a two screen 176 mm, continuous system, with automatic positioning control. Replaced a slide plate and eliminated production losses at screen changer for a 12.5% increase in productivity.

Dual Piston Systems

3000 PPH, HIPS/PET inline sheet thermoforming with a two screen 176 mm, continuous system. Replaced slide plate to increase production and finer filtration of 150 mesh.

18,000 PPH, SAN polystyrene production with a two screen, oval 270 mm, continuous system. Increase production and filtration levels, while lowering maintenance costs by replacing slide plate with candles.

3500 PPH, PP bail wrap recycling with a backflush, two screen 230 mm, continuous system. 200 mesh filtration, with reduced screen costs and up to 80 backflushes per screen pack.

2000 PPH, PET continuous polymerization fiber production with a four screen 176 mm, continuous system. High IV polymer and explosion proof design to improve overall filtration and extend pack life.

3500 PPH, PCR PET staple fiber line with a four screen 230 mm, continuous system. Increase production and filtration levels, while extending spin pack life.

Large Area Systems

10,000 PPH, PET oligomer filtration with a single vessel system. Backflush capable for reduced maintenance. Increased filtration levels and improves downstream filter life.

25,000 PPH, PET production with a 42 square meter, vertical dual vessel system. Bekaert 40-micron fiber metal felt and 100 mm slide valves.

SUMMARY

Most efficient and highly profitable production lines will require continuous, uninterrupted filtration, with a minimum of pressure variation at change over. De-aeration must be precise, complete and automated to insure on specification production. Automatic backflush of the filtration media for highest automation and reuse of filtration media, especially for high contamination levels as found in recycling. Screen changers should be reliable and leak free, with virtually no need for maintenance, other than routine cleaning. Large area filtration for highest outputs and finest filtration levels, including gels. Screen changers whenever possible for lower costs, and reduced maintenance and safety concerns.

FIGURES

Figure 1, Manual Screen Changer.

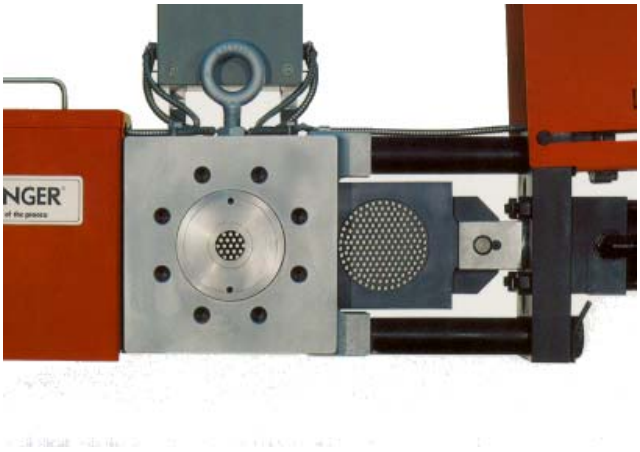

Figure 2, Hydraulic Slide Plate.

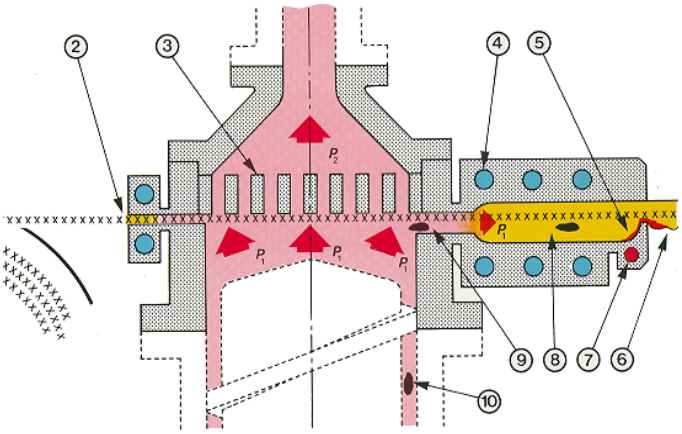

Figure 3, Belt Type Screen Changer.

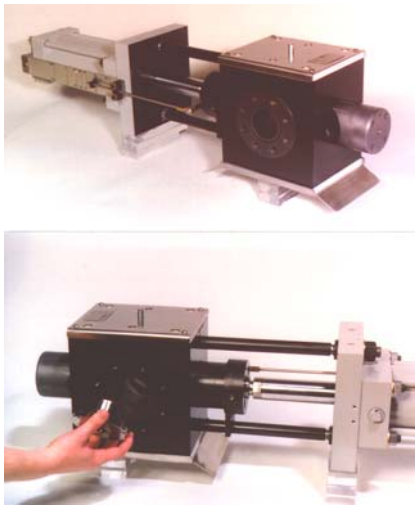

Figure 4, Piston Screen Changer

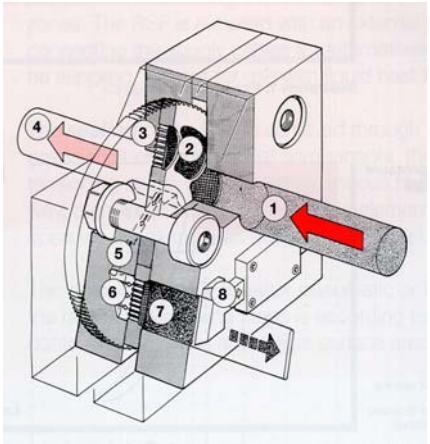

Figure 5, Rotary Disc Type.

Figure 6, Large Area System.