Automatic screen changers are used in continuous processes where contamination can clog normal screen packs in a relatively short time compared to the production run time. Generally, if a production run can be completed without requiring a screen pack change, an automatic screen changer is not required. There are three basic screen holders:

- Part of sealing system between the extruder and die
- A hydraulic system that switches breaker plates when the extruder is stopped
- An automatic screen changer that supplies fresh filtering media during normal operation

The screen changer or filtering system chosen depends on the process, the throughput rate, the run length, the contamination, and the extruder size. Filtration systems available include

- Breaker plate with screen pack
- Hydraulic slide plate, either fast or slow movement
- Double bolt
- Ribbon-type screen or continuous breaker plates
- Rotary disk filter

Each of these screen changing systems are discussed in this chapter with their advantages and disadvantages.

There are many designs and sizes for wire mesh screens. Most screens are made from steel wire, with stainless steel available for special high-pressure or corrosive applications. A 20-mesh screen has 20 holes or wires per inch, while an 80-mesh screen has 80 holes or wires per inch. As the mesh increases, the hole size decreases, providing more filtration capacity and higher pressure drop, which reduces the extruder output per rpm. Finer filtration is accomplished with smaller screen openings, such as 300 or higher mesh. The screen pack normally consists of more than one screen. If a 120-mesh screen is used by itself, the pressure build-up in front of the screen will blow holes through the screen pack at the breaker plate holes. To prevent polymer from blowing holes in the screen, coarse screens are placed between the fine screen and the breaker plate holes to support the fine screen. Assuming the polymer has to be filtered through a 120-mesh screen, it is common to use a 20/60/120/60/20 screen pack, where the first 20- and 60-mesh screens filter coarse particles, preventing them from accumulating on the 120-mesh screen, and the back 60- and 20-mesh support the 120-mesh screen.

Many screen designs along with mesh sizes are available for different filtration requirements. Some screen weaves are shown in Fig. 35.1. Using the appropriate mesh, a square (A) or twill weave (B) can provide filtration down to 100 microns (μ). Dutch weave (C) filters out particles between 40 and 80 μ in diameter, while a Dutch twill weave (D) filters particles between 8 and 35 μ in diameter. The advantage of Dutch weave is the precise wire separation, minimizing the pressure drop across the screen pack while removing smaller particle sizes from the melt.

In filtration applications, more than one type of screen may be used to provide better filtration. Haver and Boecker\[1\] recommend up to five filtration layers to make up a given screen pack in Gneuss automatic screen changers. Depending on the screen type and mesh size, one can remove particles from 500 μ to 5 μ.

As screen packs become fouled, the pressure drop increases, the extruder throughput decreases, and the melt temperature increases. Figure 35.2 shows this relationship for a slide plate screen changer. The throughput is at its operating rate with the new screen pack. As the screen pack becomes contaminated, the head pressure

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**Figure 35.1.** Types of weaves for filtration screens.

**Figure 35.2.** Pressure, temperature, and throughput relationship in discontinuous screen changer.
increases, and the throughput starts to decrease. This creates more pressure flowback into the extruder, creating more work, which increases the melt temperature. As the screen pack plugs, the pressure builds rapidly, further decreasing the throughput and increasing the melt temperature. After a new screen pack is inserted, the throughput and pressure return to normal. The melt temperature takes longer to recover, as the extruder barrel needs more time to equilibrate.

Figure 35.3 shows actual pressure increase versus time as highly contaminated material is extruded through an automatic screen changer. The melt pressure versus time shows the rapid pressure increase as the filter becomes contaminated. This extruded material is recycled oil bottles that contained paper and metal. A coarse mesh, square weave screen (12 mesh) clogged in approximately 12 minutes.

The screen changing system required depends on the contamination level. If it takes approximately 10 minutes to plug a screen pack a continuous screen changer is required or the extruder operation will never reach equilibrium and throughput rates will not meet expectations. Screens that clog in 10 minutes are either too fine or the extruded polymer has too much contamination. This operation definitely requires a continuous screen changing system. Screens that plug between 2 and 16 hours can benefit from automatic screen changers. However, if the screen clogs in 12 hours and a normal production run is less than 12 hours with cleanup between runs, then a discontinuous screen changer will meet the process requirements. An economic study is required to determine the value of the downtime saved versus the screen changer costs. If the feedstock is clean with long runs and minimal screen plugging, the payback period will probably not justify a continuous screen changer. However, depending on the extruder size and the downtime required to change screen packs, using a continuous screen changer may be justifiable.

### 35.1 Breaker Plate with Screens

A breaker plate's function in single and twin screw extrusion is to hold the screens while providing a seal between the extruder and die. Scratches, dents, or marred surfaces on the breaker plate can lead to leakage. If the breaker plate has been machined to remove defects, verify that it is still thick enough to act as a seal. Figure 35.4 shows a breaker plate with and without screens. To change a screen pack in a breaker plate, it is necessary to remove the die, the breaker plate, and screens. After new screens are inserted in the breaker plate, the extruder piping is reassembled. This is the most time-consuming screen pack system. Depending on the extruder size and the die removal difficulty, downtime can range from 15 minutes to an hour or more.

![Figure 35.3. Melt filtration of recycled oil bottles with automatic screen changer.](image-url)
35.2 Manual Screen Changer

Manual screen changers are available with two breaker plates mounted in a metal plate close to one another. With a long handle, one breaker plate and screen pack is moved out of the melt stream while the second one is inserted into the melt flow path. This system is inexpensive and works very well in a discontinuous operation. Figure 35.5 shows a Berringer screen changer with a clean breaker plate out of the melt stream and the handle to move it in line with the extruder.

35.3 Hydraulic Screen Changer

A hydraulic screen changer can function as either a continuous or discontinuous changer, depending on the transfer time from one breaker plate and screen to the other. In a slow transfer operation, the extruder has to be shut down while the slide plate is moving between positions, creating a discontinuous operation. The dead space between the two breaker plates during slow transfer could generate high head pressure and blow the rupture disk if the extruder ran during transfer. If the transfer is rapid from one position to the next and the distance between the breaker plates is less than the breaker plate diameter, the process can continue to run in a continuous, non-steady-state operation. When the dead space between the breaker plates is small, the clean breaker plate starts into the melt stream before the dirty one is completely removed. This prevents rapid pressure rise in the extruder. Figure 35.6 shows a hydraulic screen changer with a clean screen and breaker plate next to the hydraulic piston. When the active screen becomes contaminated, the hydraulic cylinder is activated. It pushes the clean screen breaker plate into the melt stream, and the dirty one exits from the other side. The dirty screen pack and breaker plate are removed and replaced with a clean screen pack and breaker plate. The configuration in Fig. 35.6 shows a horizontal hydraulic cylinder moving from side to side. Depending on the extruder configuration and downstream equipment, the hydraulic screen changer can be installed vertically. The melt stream is free from any dead space that might cause resin degradation over time. All adapters and flanges have to be heated and securely tightened to the extruder and die to prevent polymer leakage. The screen changer body is heated with cartridge heaters to maintain temperature. It is possible to use a liquid heat transfer medium if required.

Figure 35.7 shows a rapid transfer, continuous operation hydraulic screen changer made by Dynisco. The large cylinder is necessary to supply the hydraulic fluid to rapidly move the slide plate from position 1 to position 2. The entrance to the screen changer is the same diameter.
as the extruder. The exit side is normally smaller than the extruder bore to maintain the resin velocity in the transfer pipe to the die. Figure 35.8 shows a reduced bore diameter on the downstream side of the screen changer.

### 35.4 Double Bolt Screen Changer

A double bolt continuous screen changer has two round bolts or hydraulic cylinders with breaker plates and screen packs that move in and out of the melt stream. Options are available for the melt to flow through both bolts simultaneously or individually. Figure 35.9 shows a double bolt screen changer.[3] In both pictures the cylinders are completely retracted with no flow through either bolt. The breaker plate opening and screens are visible. The melt flows through the adapter and into the flow channel in the double bolt housing. The melt passes through the screen and into another adapter connected to the die. The screen changer housing is heated to maintain the polymer temperature and prevent freeze-off if the extruder stops. A pressure transducer, mounted in the adapter between the extruder and screen changer, indicates when the screens are contaminated and need to be replaced. In Fig. 35.10 both screens are in the polymer flow path.

Two operation modes are available. In the first mode, one filter is used while keeping the second as a spare to replace the first when it becomes dirty. The second operational mode uses both screens simultaneously. In the first operational mode, there is less filtration area, leading to more rapid screen plugging. One filter becomes dirty; the second bolt with a clean screen is slowly brought in line, allowing the air to escape from the bolt along with some polymer melt. This provides continuous operation and prevents trapped air in the bolt from exiting the die. The dirty screen is removed from bolt one and replaced with a new screen pack. Melt is pumped through the second screen and bolt until that screen becomes dirty. Once the second screen is dirty, the first bolt with a new screen is slowly transferred back into line and the second one removed and cleaned.

In the second operational mode, both screens become clogged simultaneously. Through the use of a back flush operation, screens can be cleaned one at a time by forcing polymer back through the screen to remove contaminants. As the first screen is transferred to the back flush position, polymer from the second slide bolt flushes contaminants from the screen. The first screen is transferred to its normal operation position while the second screen is back flushed to remove contaminants. The advantage of using both filters simultaneously is having twice the filtration area.

During the transfer operation, excess polymer is cleaned off the slide bolt. This is usually done with copper gauze. As the bolt is transferred back on line, it is stopped before complete engagement to allow the air to escape. Polymer fills the breaker plate cavity, forcing the air out. After some polymer weeps out, the cavity is completely filled and the slide can be completely engaged. If this procedure is not followed, air flows to the die, where holes form in the extrudate and possibly cause material breaks.

In a continuous operation, an option is available to back flush the screen pack to remove contamination. This procedure is
used in applications requiring long life or in recycle applications where the screens foul rapidly (see Fig. 35.3). With the slide in the back flush position, polymer flows through the screen from the back side, loosening the contamination and conveying it out of the cavity. After the back flush operation is complete, the cleaned screen goes back on line. Back flushing can be done many times and it uses little material. Typical material loss in a back flush operation is 1 to 1.5 times the slide cavity volume. Programmable controls are available to let the operator know when the back flush is complete and approximately how many back flushes can be done.

Figure 35.11 shows the double bolt screen changer slide positions as the screens are changed and reengaged. Positions 2 and 3 allow for venting of air and the polymer
to prevent any air from passing through the die. Figure 35.12 shows the slide bolt position in a back flush operation. In the back flush operation, both slide bolts are used simultaneously, with polymer from one flushing the other. Figure 35.13 shows the process for changing screens with a slide bolt designed for a back flush operation.

### 35.5 Ribbon-Type Screens

Ribbon-type screen changers use long or continuous screen material that moves through the polymer flow channel. The screen is pulled by a hydraulic clamp or pushed through the melt by the melt pressure. As the melt pressure increases, it pushes the screen forward to provide clean screen for filtering. This is a semicontinuous process, with the melt pressure acting as the driving force to provide fresh screen. The screen is a continuous ribbon that is sealed to prevent polymer leakage by cooling the ribbon where it enters and exits to form a polymer seal. These systems provide continuous filtration with minimal moving parts and a simplified system. Figure 35.14 shows a ribbon-type screen system. Throughput, pressure, and melt temperature variations are less than shown in Fig. 35.2, which is more typical of hydraulic breaker plate units.

Disadvantages of these systems are that a contamination surge can clog the filter and, if the seals fail, large amounts of material will flow onto the floor.

### 35.6 Rotary Disk Screen Changer

A rotating disk has 10 to 12 screens in a ring pattern around the disk; they are indexed in steps as small as one degree as screens become contaminated. The indexing

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**Figure 35.12.** Back flush operation—polymer is fed from second bolt.

**Figure 35.13.** Changing screens in a back flush slide bolt screen changer.
sequence is very rapid. Figure 35.15 shows a rotary disk screen changer.[4] Constant melt pressure is obtained during operation, through indexing the rotary disk to supplying clean screens. The microprocessor control determines the index rate by monitoring either the pressure before the screens or the pressure differential across the screens. With a continuous rotary screen changer and microprocessor control, the graph shown in Fig. 35.2 produces three flat lines for throughput, pressure, and melt temperature, resulting in a stable process.

In operation the melt passes directly from the extruder through the screens to the die or adapter in the shortest possible path. The flow path is uninterrupted as the screens index. Screen packs are fitted over breaker plates in the rotary disk to provide filtration down to 6–8 μ. As new cavities in the rotary disk move into the melt stream, the air is vented as the screen cavities are filled to prevent air getting into the polymer melt, which would create downstream extrudate interruptions. A back flush channel forces small amounts of filtered melt back through the screen to purge contaminants from previously used screens. The purging valve stays open for a short time (1–2 seconds per stroke), minimizing the lost polymer while keeping the screens clean. The screen area purged is equal to the contaminated screen indexed forward. Rotary screen changers without a back flush require the dirty screens to be removed and replaced as the screen rotates.

Heating the screen changer is accomplished with cast heaters and heater cartridges strategically located around the screen changer. Individual heater zones provide better heating efficiency and uniformity. Heat-transfer fluids can be used if required for the application. Disk indexing is accomplished through either a hydraulic or a pneumatic drive. Machining precision prevents these units from leaking, even at high pressures.

While the rotary disk screen changer, shown in Fig. 35.15, has continuous screens and cavities around the circumference of the disk, some disks contain distinct breaker plates with dead spaces between them and are indexed at discrete distances to provide a completely new filter medium for each index step. In this scenario, the throughput, pressure, and melt temperature curves depend on the dead space between the breaker plates.

Continuous rotary disk screen changers are used in high-quality applications requiring gentle treatment of the melt. Potential application areas include foam sheet extrusion, fibers, compounding and PVC processing, tight tolerance finished parts, and processes requiring only limited pressure drops, such as resin polymerization and fiber production.

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2. Dynisco®, Franklin, MA.
3. Kreyenborg GmbH Maschinenfabrik Coermühle 1-5 48157 Münster/Germany.
4. Gneuss Inc., 921-A Matthews Mint Hill Road, Matthews, NC.
Review Questions

1. What is the difference between a continuous and a discontinuous screen changer?
2. What are some types of continuous screen changers?
3. What types of continuous screen changers produce changes in melt temperature, melt pressure, and throughput as the screens become clogged?
4. Why do some rotary disk screen changers show no increase in melt temperature or melt pressure or decrease in throughput as screens become dirty?
5. How does a double bolt screen changer work?
6. What is the purpose of the back flush in double bolt and rotary disk screen changers?
7. What are some different screens and how do the weaves differ?
8. What is a ribbon-type screen changer and how does it operate?