From tradition to automation: choosing the right filtration system for modern sulfur plants

By: Mathijs Sijpkes, Project Engineer, Elessent Clean Technologies

Selecting the appropriate filtration technology is critical to meeting today's safety, performance, and operational reliability requirements. While traditional pressure leaf filters have supported the sulfur industry for decades, many plants are now reassessing their filtration systems in response to increasing performance expectations, more stringent HSE standards, and a growing emphasis on automation and digitalization.

This article provides an overview of sulfur filtration technologies and presents a comparison between conventional pressure leaf filters and modern self-cleaning candle filters. Ultimately, the optimal choice depends on the specific process requirements and operational objectives of each facility.

Brief history of pressure leaf filters

Pressure leaf filters have been around for nearly a century and have understandably become the standard choice across a wide range of industrial processes. Their versatility, ease of adapting or replacing filtration elements, and flexibility in precoat and element selection make them a dependable solution for the consistent removal of suspended solids.

At the time of their introduction, pressure leaf filters dramatically increased the volume of liquid that could be filtered, compared with the gravity filtration methods in use at the time. They also enhanced work environment safety by closing the system, hence reducing operators' exposure to hazardous chemicals.

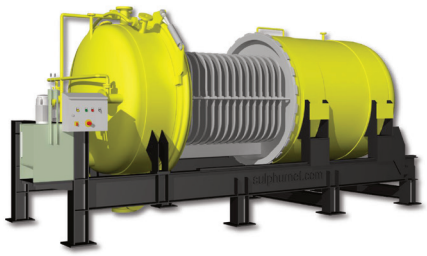
The process begins by feeding the process liquid into a vessel where multiple filter leaves are installed. Once the liquid reaches the top of the vessel, the outlet is opened and the system pressure pushes the liquid through the fine mesh or cloth on each leaf, which allows the filtered liquid through and into an outlet manifold, while the particles are retained on the filter leaf.

As these particles accumulate, they form a filter 'cake' which in itself acts as a filtration layer, sometimes in tandem with a filter aid. For application in sulfur, it is always required to apply such a layer of filter aid. This will continue until the maximum pressure drop or maximum cake thickness is reached.

Once filtration stops, the remaining liquid is drained, and the cake removal process begins. For the sulfur application, this can be done only by drying the cake layer and knocking it off the leaves manually.

How pressure leaf filters work: strengths and limitations

This system offers the significant advantage of handling relatively high solids concentrations (0.01-3%), which makes it suitable for heavy-duty industrial process streams. The robustness of the vessel and leaf structures enables long-term service and strong wear resistance. The fact that the leaves can be customized in both layer configuration and number makes this filter a good choice for a wide range of industries.



Liquid sulfur pressure filter.

Its global historical presence also translates into operational familiarity that plants can rely on, often reducing training requirements and providing a large base of industry know-how.

Finally, the standard pressure leaf filter is a competitive option on the market. While custom adaptations and technological enhancements may increase the initial investment, pressure leaf filters can significantly improve operational safety, efficiency, and long-term performance.

At Sulphurnet, for example, customizations include an improved design on the quick closing door mechanism, inversion of the traditional tank opening configuration, and a tailored drainage and filter leaf design, to name a few.

Of course, there is no single filtration system that completely fits all industrial needs. Like any system, the traditional pressure leaf filter has some disadvantages. To start, the cake-removal process requires a complete halt of operations, creating downtime. Also, even with mechanical systems to help loosen the cake from the leaves, cleaning still requires operator involvement, which sometimes involves handling hot liquids or hazardous materials. This step in the process is one of the primary areas that modern self-cleaning systems were designed to eliminate.

Depending on the industry and operation, pressure leaf filters can also require a large plot for installation, operation, and cleaning.

Lastly, the hydraulics and electronics maintenance intensity of each filter can quickly increase costs and labor investment. Periodically inspecting and replacing the leaves and mechanical or sluicing systems, to prevent leaks or mechanical failures, helps ensure durability but still entails ongoing costs.

Technical evolution: introduction of self-cleaning candle filters

The limitations of traditional pressure leaf filters, along with advancements in technologies, led to the development of the self-cleaning candle filter. This has brought significant safety, regulatory, and efficiency improvements, particularly in the sulfur industry, where high temperatures, hazardous fumes, and labor-intensive cleaning make manual interventions risky.

The first of these filters was patented by E.I. DuPont in 1942, reflecting the industry's early interest in automated cake discharge and more reliable continuous filtration. Over time, this drive for improved operability, combined with increasingly stringent HSE standards, contributed to the further development and refinement of this technology.

These filters are also pressure filters but use vertical candle elements to achieve fine solid-liquid separation. Technological advances enable candles to be produced

from polypropylene, PVC, or stainless steel, allowing this type of filter to be used in a variety of applications.

The filtration process essentially works the same way. The vessel is filled with liquid, which flows from the outside to the inside of the candle and into an internal manifold. The solids are trapped on the outer surface of the filter media, as in a traditional pressure leaf filter, forming a filter cake that, in turn, becomes a filtration layer.

Self-cleaning liquid sulfur candle filter.

The filtration cycles are also determined by the differential pressure or cake thickness; once these limits are reached, the vessel is drained, and the cake's discharge process begins. This is when the back flush—or reverse pressure—is applied. Pressured steam is applied from the inside of the candle to the outside, causing the filter media to expand and the cake to crack and detach from the candle. The cake is discharged into the bottom and then through a valve.

Even with the technical improvements, expanded material options, and the integration of stricter design codes, these filters are not the standard for the sulfur industry. Sulphurnet is the first and only player in the market to offer a fully automated configuration, having created a design that not only competes with traditional filters but also improves certain aspects of the operation.

Sulphurnet's self-cleaning candle filters can operate in manual, semiautomatic, or fully automatic modes and can be controlled by PLC control systems. This enables automatic filling, filtration, and back-flush cleaning cycles with virtually no manual intervention, resulting in continuous operation and reduced operator exposure.

Lastly, installing a closed system reduces exposure to dangerous vapors, high-temperature cakes, and iron sulfide-related fire risks; thereby facilitating compliance with modern HSE and labor condition requirements.

Why self-cleaning candle filters are becoming a new industry standard

With the growing shift of plant operations from manual on-site to automated and digital, having a reliable closed filtration system is imperative. Also, it is important to note that each application, process, and organization has different chemical requirements and operational challenges, which makes it even more important to invest in custom systems that will outlast the familiarity and expected durability of traditional one-size-fits-all solutions.

Investment decision: how plant owners can choose the right solution

At first glance, installing a traditional pressure leaf filter without an automation system and a standard opening configuration (moving the vessel head and its attached leaves) may result in lower CAPEX than installing the equivalent amount of self-cleaning candle filters to manage the same flow rate.

However, when considering the technical and digital implementations that can be added to the traditional pressure leaf filter, on top of a custom design tailored to the application's characteristics, plus the operational costs of manual cleaning and maintenance, the investment difference is not as large as initially estimated.

Another big budget consideration is the cost of the downtime between cycles for the pressure leaf filter. In comparison, a configuration of several self-cleaning candle filters operating in parallel, along with their back-flush cleaning system, will minimize production interruptions and reduce downtime-related losses.

Conclusion: matching technology to process needs

This comparative discussion demonstrates that both filters have advantages and disadvantages, and that an in-depth analysis of the needs and challenges of each plant is required to determine which filter system is most appropriate.

While self-cleaning candle filters are the more advanced solution, market realities, plant age, and the specifics of each process will determine whether the familiar and robust pressure leaf filter remains a viable filtration option.

Our recommendation when implementing a closed self-cleaning candle filter system is to analyze and custom-design a configuration of several filters working in parallel, which allows a higher flow if needed for the application.

If pressure leaf filters are determined to be the best fit for a plant, it is recommended to incorporate the latest technological advancements—such as improved opening configurations, quick-closing door designs, and optimized draining schemes—to ensure the highest possible level of operational safety.

At the end of the day, both systems have reliable results, and it will depend on individual conditions to determine which is the better fit.

For more information, please contact Mathijs Sijpkes, Project Engineer, Elessent Clean Technologies at Mathijs.Sijpkes@elessentct.com. ❑

Characteristic	Pressure Leaf Filter	Self-Cleaning Candle Filter
Throughput	Max. 100 MTP/h	Max. 30 MTP/h
Cake holding cap.	Higher	Lower
Filtration efficiency	10-15 ppm	10 ppm
Cleaning	Manual	Automatic
Cleaning cycle duration	2 hours	30 minutes
Weight	Two times 47.000 kg of equipment weight	Two times 32.000 kg of equipment weight
OPEX	Higher	Lower
CAPEX	Similar	

Comparative technical considerations