CUNO
a 3M company

3M

Bioprocess, Biologicals, & Pharmaceutical

CUNO Application Brief

Retrofit of Sparkler® Filter Presses with CUNO® Zeta Plus® Depth Filter Cartridges

Introduction

Sparkler-style plate filters have been employed in polishing, clarification, and particle removal filtration in the pharmaceutical and fine chemical industries for a number of years. They are also a common method to trap carbon fines used in upstream decolorization processes. They were originally the method of choice for these applications because they were relatively inexpensive to operate.

However, operators have become increasingly apprehensive of growing labor and safety concerns related to set up, plate removal, and cleaning of this style filter, where workers are exposed to potentially hazardous product or solvents, as well as suspended filter aids, such as diatomaceous earth (D.E.) or carbon powder used in the filter operation. Increased costs associated with the labor required to properly change-out the units and maintain them, costs associated with disposal of used D.E. or carbon, and the time consuming recirculation required for proper operation have led many to seek alternative methods of filtration.

This CUNO Application Brief details an alternative solution that employs Zeta Plus depth cartridge filters, installed in a separate Zeta Plus filter housing or in the existing Sparkler-style plate filter by means of a retrofit kit.

The Zeta Plus cartridge system:

- Provides rapid filter change-out, drastically reducing the time and labor required to prepare the filter for the next filtration run,
- Ensures proper sealing of the filter, greatly reducing (or even eliminating) the need to re-filter product, and
- Greatly limits user contact with hazardous product and filter aids.

Sparkler Filter Construction and Operation

Sparkler-style plate filters are typically composed of a pressure vessel containing a number of horizontal plates, each with an overlay of filter paper or fabric. The plates are unitized with tie rods in the center and periphery of the stack. Fluid flow is from the outside of the plate stack, through the spacing between the plates, and then through the filter paper to the core of the assembly. Figure 1 shows a common duplex plate filter arrangement.

Figure 1. - Common duplex plate filter arrangement.

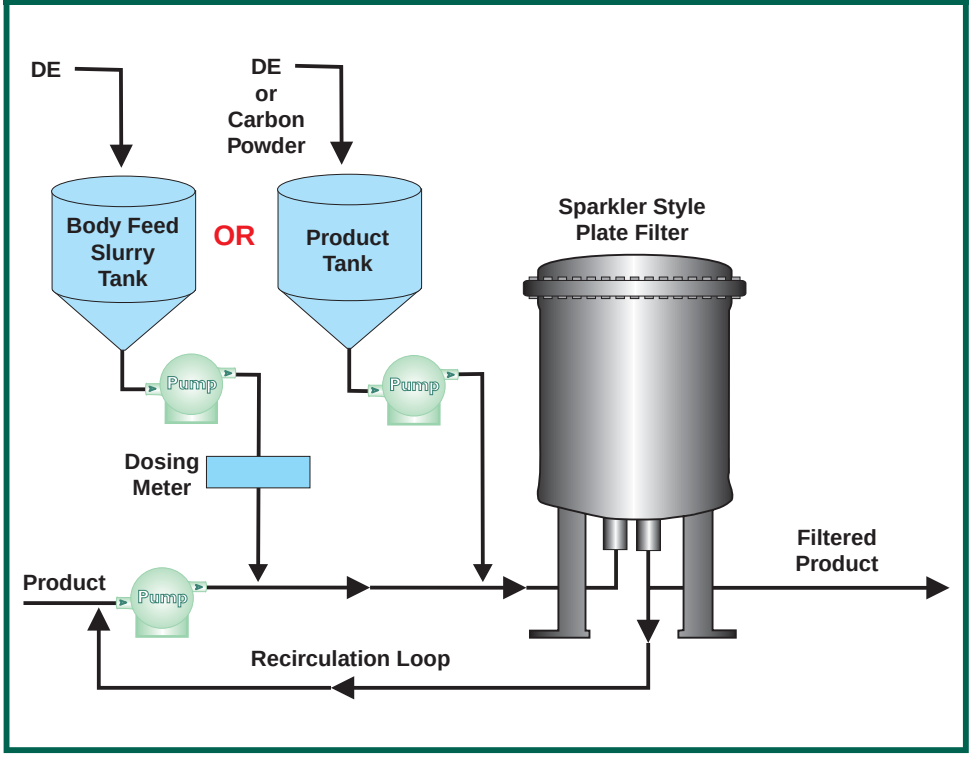
Depending on the separations goal, filter aids (diatomaceous earth, perlite) or carbon powder can be added to the fluid prior to filtration through the plate filter. As these filter aids flow through the system, they form a “cake” on the filter paper, aiding the separation of undesirable particles, microorganisms, or removal of color bodies.

Sparkler is a registered trademark of Sparkler Manufacturing Company.

Typical Process:

The diagram (Figure 2) is a general guide to a common Sparkler filter installation. Deposition of filter aids onto the filter paper in the Sparkler filter can be achieved by two different methods. The first method, usually referred to as body feed, is accomplished by blending a small, measured amount of a filter aid slurry with the product just prior to filtration. Contaminants are trapped in the filter aid mixture and retained on the filter paper as the fluid passes through the filter.

Figure 2. - Common Sparkler filter installation



The second method mixes the filter aid directly with the product in a mixing tank. This solution is then passed through the filter. This method is more common when carbon powder is being used to reduce color or adsorb unwanted compounds from a product. The carbon fines are then retained on the filter paper as the product passes through the filter.

Deficiencies Related to Sparkler Filter Press Operation:

Many users of Sparkler-style horizontal plate filters have identified deficiencies in the design and operation of the units. These deficiencies generally are related to filtration performance and ease-of use.

Proper Filter Sealing - Many Sparkler-style plate filters lack a positive seal between the filter paper, the support screen and the filter plate stack. Typically, the seal is formed either by the weight of the plates, or by a sealing nut at the top of the plate stack. Either arrangement makes the filter susceptible to bypass of unfiltered product, filter aids or both. This is particularly common with older filters where seals have been compromised, or in operations where variations in flow occur, allowing pressure shocks to disturb the filter cake resulting in poor filtrate quality.

Filter Change-out - Sparkler-style plate filters are either used in a batch process or in a continuous process. In a batch process, the filter must be drained of unfiltered product, disassembled, cleaned of filter-aids and filter paper, maintenance conducted, new filter paper reinstalled, and the unit reassembled, for each batch of product. In a continuous process, this procedure is performed only when the filter becomes fouled (reduction in flow, or terminal increase in differential pressure across the filter) or when the filtrate exceeds an established quality parameter such as turbidity, color, particulate level, or other measure.

In both cases, filter change-out is a cumbersome, time consuming activity, often requiring two operators a total of 8 man-hours or more to properly disassemble, perform routine maintenance, and repack

the unit. Additionally, during this change-out period, the filter is not in operation, reducing plant capacity.

Safety - During the change-out processes outlined above, operators are exposed to the process fluid, filter aids, and trapped contaminants in the filter. Exposure to filter aids, particularly powdered dry, diatomaceous earth during body feed operations, is of great concern to health officials. Diatomaceous earth contains crystalline silica, a possible carcinogen and cause of silicosis. Proper ventilation and operator protection efforts must be made for safe handling of the unused and the used powder. Additionally, many filters are employed to filter solvent based fluids that can be hazardous if not handled properly. The contaminants retained in the filter can also be of concern from a safety standpoint, since the filter operation by design, will concentrate these contaminants in the filter bed to a point where operator exposure may be an issue.

Product Quality - Sparkler-style plate filters often require recirculation of the product fluid through the filter to meet the intended separation goal. This is primarily due to the nature of the filter itself. Most filter operations rely on a thin paper filter sheet as a septum on which a filter aid is deposited. The filter aid builds a cake which traps contaminants, in the case of D.E., or adsorbs color bodies, in the case of carbon. The performance of this cake is highly dependent on certain process parameters such as flux (flow per unit area) and differential pressure across the cake. Furthermore, a filter cake composed of D.E. does not provide a fixed pore structure in which to retain particulates. Particles are trapped between the successive layers of D.E. fines as they are deposited during the filtration, resulting in partial particle release if the cake is disturbed. This disturbance is usually in the form of an uneven flux rate, a change in process speed, or due to the build up of differential pressure across the filter cake, compressing and shifting the cake itself. It can also occur at the end of the filtration cycle when the filter is "blown-down" to remove any unfiltered product.

Disposal - Spent D.E. requires proper disposal since airborne dispersal of the powder (if dried) is considered a health hazard. Additionally, the D.E. or carbon used in a separation step may also contain hazardous active product, or hazardous contaminants. The loose nature of these filter aids pose their own disposal problems, particularly in regards to operator exposure and work area contamination.

Product loss - Unfiltered product can be recovered from Sparkler-style plate filters through drain ports located in the bottom of the filter housings. However, unfiltered product remaining in the filter cake is usually not recoverable, and is disposed of along with the spent filter cake. Unprocessed and unrecoverable product in the filter cake can be as great as 1 l/Kg of filter aid or more. In operations where the product fluid is of great value, this loss can be a compelling concern. Also, filter cake material commonly falls onto the base and outlet pipe during removal, contaminating the "clean-side" of the filter.

The CUNO Solution

Zeta Plus Depth Filter Cartridges

Zeta Plus is a family of advanced cellulose–based depth filtration media designed to retain contaminants by both mechanical entrapment and electrokinetic adsorption. Zeta Plus filter media is composed of high surface area filter aids, such as diatomaceous earth and perlite, embedded in a cellulose fiber matrix. During the manufacturing process, molecules carrying a positive charge are chemically bonded to the filter matrix permanently forming an interconnected filtration structure with positively charged electrokinetic capture sites. The resulting porous depth filter is a tortuous network of charge-enhanced flow channels capable of removing microorganisms, color bodies, cellular debris and fine particulate to a level that mechanical screening alone cannot achieve. An alternative formulation is also available for

applications where activated carbon is required. This formulation, ZetaCarbon® (Figure 3), replaces filter aids with activated carbon impregnating the media.

Zeta Plus filter media are available in sheet form suitable for most filter presses and Sparkler style presses, as well as easy to use filter cartridges of various sizes (Figure 4). These cartridges can be installed in sanitary design stainless steel filter housings engineered for this purpose. However, they can also be installed in Sparkler-style plate filters by using a kit designed to retrofit the housing to accept the cartridges. The Zeta Plus cartridges effectively replace the internal plates, screen, and filter paper of the Sparker press, allowing for greatly simplified operation.

Figure 3. - ZetaCarbon Filter

Figure 4. - Zeta Plus Filter Cartridges

Body Feed Construction

For operations that require the addition of filter aids such as D.E. and carbon, special Zeta Plus cartridges are available with additional spacing to allow for deposition of the filter aid cake between the "cells" of the cartridges.

Sparkler Press Conversion Kit

CUNO has designed a conversion kit that can be used to convert Sparkler-style plate filters to accept Zeta Plus or ZetaCarbon depth filter cartridges. The Press Retrofit Kit (PRK) is comprised of three main components: a new seal plate, a center post, and a spring loaded sealing system (Figure 5). The sealing plate and center post can be manufactured in either stainless steel or Hastelloy. The spring loaded sealing system can be manufactured in either polypropylene (standard applications), stainless steel (high temperature or solvent applications) or Hastelloy (applications limiting stainless steel contact).

Figure 5. - Press Retrofit Kit (PRK)

To retrofit an existing housing, the internal plates and tie-down rods are removed. A cartridge center post and sealing plate from a PRK kit are then installed in the base of the housing (Figure 6). Next, Zeta Plus or ZetaCarbon filters are installed in the housings and the system is sealed with the spring loaded sealing system (Figure 7).

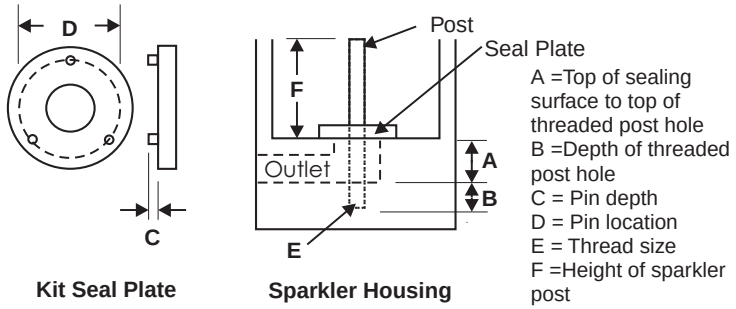
Figure 6. - PRK Center Post/Sealing Plate Installed

Figure 7. - Zeta Plus Cartridge Installed

Standard PRK units are available for common Sparkler filter models (refer to CUNO literature LITZPPRK). However, the wide variety of models available from Sparkler and other manufactures may require the construction of a custom PRK unit. The measurements depicted in Figure 8 are needed to provide a proper fitting PRK unit.

Consult CUNO for information regarding proper measurements of internal Sparkler-style dimensions.

Figure 8. - Required Measurements



Benefits of the Zeta Plus Cartridge System

The Zeta Plus cartridge system, installed in its own filter housing, or installed in an existing Sparkler-style housing modified with a retrofit kit, offers a number of benefits. Among them are the following.

Proper Filter Sealing - Zeta Plus and ZetaCarbon cartridges are sealed in two modes: intra-cartridge (within the cells of the filter cartridge) and inter-cartridge (between the filter cartridges themselves and between the filter cartridges and the filter housing.)

Zeta Plus "cells" (discs of filter media) are joined to each other to form a cartridge in the manufacturing process. This operation utilizes stainless steel (or optional Hastelloy) bands in the center of the cartridge. This design creates a strong intra-cartridge seal that cannot be bypassed by product fluid when used in conjunction with the spring loaded sealing system. It also makes the finished cartridge very easy to handle during installation and removal.

Zeta Plus cartridges are then installed over a center post in the housing and sealed via a spring loaded sealing nut attached to the top of the center post, compressing and sealing the cartridge stack in the housing. With the internal spring, this sealing nut maintains a positive pressure on the filter stack, ensuring an effective seal over the life of the filter operation. The seal is maintained even in circumstances that would ordinarily result in by-pass in a Sparkler-style plate filter, such as sudden changes in system pressure or flow. The Sparkler seal is a static seal that cannot adjust to process system variations, while the Zeta Plus seal is an active seal that adjusts to variations in the process.

Easy Filter Change-out - Since Zeta Plus filters are in cartridge form, they are much easier to install and remove between process batches. Typical installation of Zeta Plus cartridges into a Sparkler housing require only a fraction of the time needed previously. Considerable savings have been noted in reduced labor costs (reduced by 50-75%) and maintenance. Also, since cartridge change-out requires only a fraction of the time necessary for a conventional Sparkler filter change-out, a cartridge operation can be ready for production sooner, potentially increasing plant capacity.

Figure 9. - Optional Zeta Lift® handles

Greater Safety - Even when filter aids are employed, Zeta Plus cartridges are easier and safer to handle during change-outs than Sparkler-style plate filters. Since cartridges are unitized, they can be removed easily and quickly with very little exposure to the filter aid, trapped contaminants or product fluids. Optional Zeta Lift® cartridge handles (Figure 9) are also available to further ease installation/removal and reduce operator exposure. Also

available is a device, ZetaGrip™, that when attached to a hoist, can easily remove spent filter cartridges without operator contact.

Improved Product Quality - The filter media incorporated into a Zeta Plus cartridge forms a durable substrate on which to deposit filter aids (if required). Additionally, the filter media itself is typically 3 - 5 mm thick, with a void volume of approximately 70%. Zeta Plus filter media alone is a substantial improvement over the filtration qualities of the filter paper typically installed in Sparkler filters.

During evaluation, some operators have determined that the filtration capacity of Zeta Plus filter media alone (or ZetaCarbon filter media) is sufficient to accomplish a separations goal, where with the previous operation, the addition of bulk filter aids or carbon was required. Also, operators may determine that by employing Zeta Plus cartridges, the need for recirculation to meet product standards is greatly reduced or eliminated altogether. This advantage is provided by 1.) the greater depth of the filter media compared to ordinary filter paper, 2.) the composition of the Zeta Plus filter media itself, and 3.) the superior sealing design of the cartridge style system.

These determinations vary from operation to operation and are proven through small scale pilot tests.

Reduced Disposal - Disposal of spent Zeta Plus cartridges is easier, faster and less costly than a comparable Sparkler-style plate filter. Zeta Plus cartridges can be easily removed via the cartridge handles, greatly limiting operator contact. If filter aids are employed, the cake tends to remain in the inter-cell spaces of the cartridge filter, again limiting contact and spread of contamination, as well as easing disposal.

Minimized Product Loss - In systems where Zeta Plus cartridge filter media efficiency alone (without additional filter aid deposition) is sufficient to provide filtrate within the target quality specification, product hold up within the media itself is minimized. Typical product hold up is 2.7 l/m^2 of filter media. This can be minimized further through procedures that push product out of the filter with compatible fluids (water or solvent) or by "blowing-down" the filter with 5 psid of clean compressed air or nitrogen.

Example - Table 1 provides a description of relative costs that can be used to assess the total cost of a Sparkler-style system compared to a Zeta Plus cartridge filter system.

Table 1. - Cost Analysis of Sparkler-Style System Compared to a Zeta Plus Cartridge Filter System

Cost	Sparkler-style Filters	CUNO Depth Filters
Initial Capital Cost		
Slurry tank	High	—-
Filter cost	High	Low
Subtotal	**High**	**Low**
Operational Labor Cost		
Setup	High	Low
Operation	Low	Low
Slurry tank cleanup	Medium	—-
Filter cleanup	High	Low
Subtotal	**Medium-High**	**Low**
Disposable Costs		
Bulk carbon	Low	—-
CUNO Zeta Plus filters	—-	Medium
Subtotal	**Low**	**Medium**
Grand Total	**Medium to High**	**Low**

Conclusion and Summary

There is a growing safety concern related to set up and disassembly of Sparkler-style plate filters. Increased costs associated with the labor required to properly change-out the units and maintain them, costs associated with disposal of used D.E. or carbon, and the time consuming recirculation required for proper operation have led many to seek alternative methods of filtration.

This CUNO Application Brief details an alternative solution that employs Zeta Plus depth cartridge filters and ZetaCarbon activated carbon filters installed in a separate Zeta Plus filter housing, or in the existing Sparkler-style plate filter by means of a retrofit kit.

The Zeta Plus cartridge system:

- Provides rapid filter change-out, drastically reducing the time and labor required to prepare the filter for the next filtration run.
- Ensures proper sealing of the filter, greatly reducing (or even eliminating) recirculation of product.
- Greatly limits user contact with hazardous product and filter aids.

CUNO Literature References

Description	Literature Identification
Zeta Plus PRK	LITZPPRK
ZetaCarbon Cartridges	LITAC1
ZetaGrip	LITZGR
Zeta Plus Maximizer Filter Cartridges	LITCZPMAX1
Zeta Plus S Series Filter Media and Cartridges	LITZPS01
Zeta Plus A Series Filter Media and Cartridges	LITZPA01
Zeta Plus ZPC/ZPB Model Filter Housings	LITHSZPBC

Scientific Applications Support Services

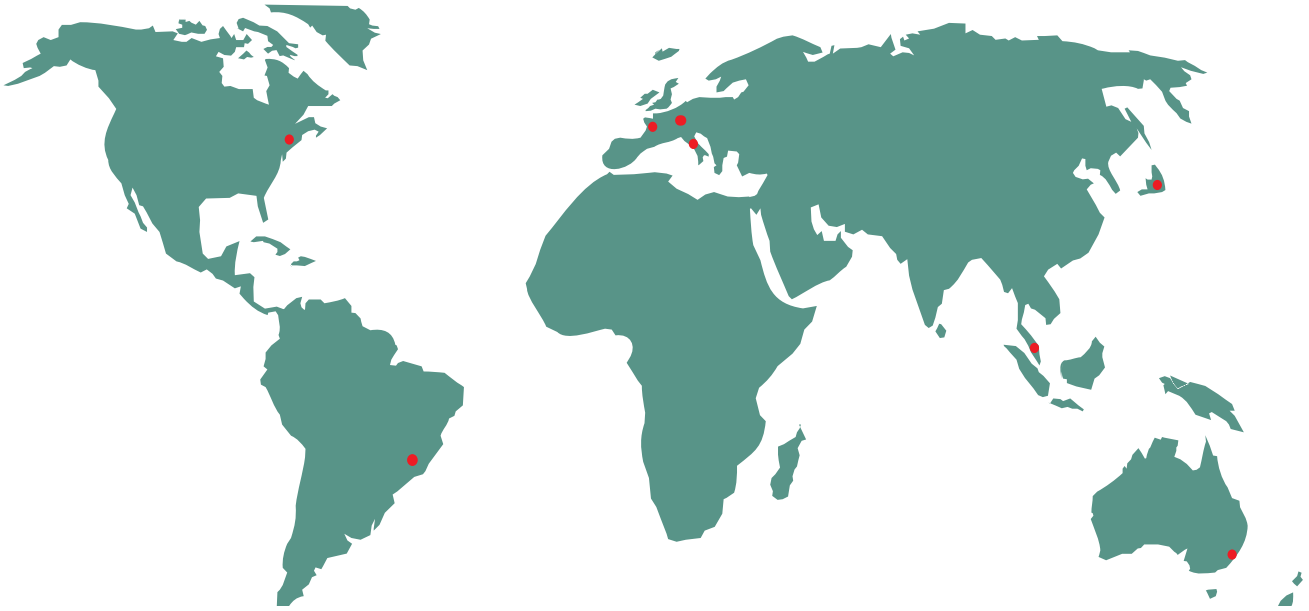
The cornerstone of CUNO's philosophy is service to customers, not only in product quality and prompt service, but also in problem solving, application support and in the sharing of scientific information. CUNO's **Scientific Applications Support Services** (SASS) group is a market-oriented group of scientists and engineers who work closely with customers to solve difficult separation problems and aid in the selection of the most effective and economical filtration systems. CUNO offers specialized support to the pharmaceutical and biotechnology industry through our **Validation Support Services Program**. SASS routinely provides end-users with:

- Validation And Regulatory Support
- Extractable And Compatibility Analysis
- Filter System Optimization Studies
- CUNOCheck® 2 Integrity Tester Validation.

For more information regarding CUNO's Validation Support Services, please contact CUNO Technical Services or your local CUNO Distributor.

CUNO ... A World Leader in Fluid Purification

CUNO's manufacturing sites have ISO 9001 registered quality systems. Global manufacturing together with trained stocking distributors and state-of-the-art laboratory support bring quality solutions to existing and challenging filtration applications.



CUNO®

a 3M company

CUNO Filtration Asia Pte Ltd
18 Tuas Link 1 (3rd Floor)
Singapore 638599

Cuno Filtration Shanghai Co, Ltd
No. 2 Xin Miao San Rd,
Xin Miao Town,
Song Jiang District,
Shanghai. China. 201612

CUNO Pacific Pty Ltd
140 Sunnyholt Road
Blacktown, NSW 2148
Australia

CUNO K.K.
Hodogaya Station
Building 6F
1-7 Iwai-cho, Hodogaya-ku
Yokohama 240 Japan

CUNO Latina Ltda
Rua Amf Do Brasil 251
18120 Mairinque-Sp
Brazil

CUNO Ltd
21 Woking Business Park
Albert Drive
Woking, Surrey GU215JY
United Kingdom

Cuno Incorporated
400 Research Parkway
Meriden, CT 06450, U.S.A.
Tel: (800) 243-6894
(203) 237-5541
Fax: (203) 630-4530
www.cuno.com

LITCABPRK1.1101