

Filtration for Parts Washers

Introduction

Parts, when manufactured and before assembly into finished products, often require cleaning to reduce manufacturing debris to meet product quality specifications. This results in the ability to use these components in equipment with increasingly tighter manufacturing tolerances. In the past, solvent systems were quite common, but the EPA has instituted guidelines restricting solvent usage in the parts cleaning marketplaces. The search for alternatives to solvent cleaning technologies resulted in new solutions for high technology critical cleaning applications. Today, parts cleaning applications continue to increase, with most of the applications being water-based detergent processes.

Manufacturers in all industries want to know how the cleaning process can be improved... made faster, more effective, and less expensive. To achieve the required improvements and effectively increase both efficiencies and yields, parts washing systems must:

- Maintain clean wash and rinse tank fluids through appropriate filtration,
- Provide the degree of cleanliness required to reduce scrap or cleaning rework, while decreasing system maintenance.

Selection of the correct filters for these applications has proven to reduce the overall manufacturing costs...rework, scrap, customer rejects and help to extend the life of washing and rinsing fluids. Inadequate or no filtration at all will increase the number of off specification parts produced while maintaining a cleanliness level exceeding the required specification will consume resources unnecessarily. This Customer Application Brief (CAB) is focused on aqueous parts cleaning fluids and the positive impact of appropriate filtration on the cleaning process.

The Process

Most, if not all, parts washing equipment is custom designed for the intended application. This includes peripheral equipment such as a filtration system. The level of filtration or cleanliness requirement of the part is dictated by where and how the part will be used. Parts being cleaned are typically transported to the cleaning system by an overhead conveyor or placed on a conveyor belt. Small parts or components are either: 1.) placed in an enclosed basket and immersed into a bath, 2.) or nested, in a tray or fixture, and sprayed. The cleaning process consists of a series of stations each having dedicated tanks for washing and rinsing. The first stations in the cleaning process, Figure 1, are dedicated to washing. The parts, if immersed, may undergo a very rigorous cleaning cycle. Often an immersed basket of small parts will be lowered and raised in the bath several times, tumbled, undergo ultrasonic cleaning, or a combination of the above methods. Exiting the first wash station, the parts will pass to the second wash station. The process is similar to the first but conducted in a “cleaner tank”. The parts will eventually leave the wash area and enter the first of two or more rinse stations. The rinse process is generally limited to a spray rinse or to immersion and tumbling of the parts. The final rinse is the cleanest water the parts will encounter and this will determine the cleanliness of the part. Each wash and rinse tank has a dedicated filtration system for reduction of contaminants. The water is pumped from the tank, through a filter, and

| Industries Currently Using 3M Purification Inc. Filter Products for Parts Cleaning Operations |
|---|
| Aerospace & Aircraft Components |
| Coatings & Finishes |
| Computer & Storage Equipment |
| Defense / Military |
| Electrical Equipment |
| Fabricated Metal |
| Industrial Machinery |
| Medical Devices |
| Metalworking Machinery |
| Motor Vehicle Body & Parts |
| Non-Metal Products (ceramics, glass, composites) |
| Original Equipment Manufacturers |
| Optical & Photographic Equipment |
| Plastics & Rubber Manufacturing |
| Semiconductor & Electronic Components |

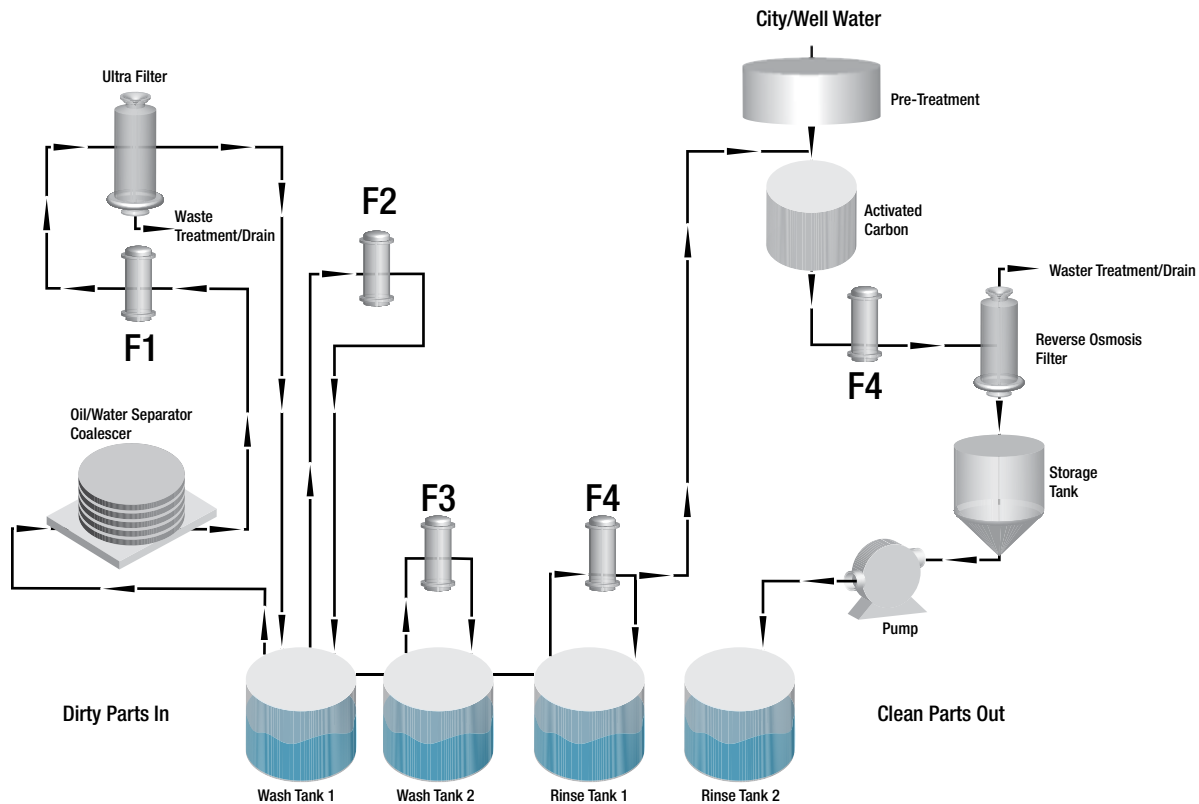


Figure 1 — General Parts Washing Schematic

returned to the tank. Common contaminants carried into the system along with the part being cleaned are oils, emulsified oils and solid particulate.

The Potential Problems

The parts cleaning operation is effectively a closed loop system where the goal is to regenerate constantly and reuse the wash and rinse tank fluids. This is often the most cost effective process to use, avoiding constant bath change and chemical addition. The problem in maintaining such a system is that particulate, oils and surfactants are constantly being introduced into the wash and rinse fluids as the parts being cleaned are moved from tank to tank being sprayed or dipped. These contaminants and manufacturing debris, if not effectively reduced, will build up over time, changing the chemistry of the parts cleaning solutions, and inhibit the solution's ability to clean the parts effectively and, therefore, meet cleanliness specifications. These contaminants also have a significant impact on the fluid treating equipment - used to maintain appropriate hardness, pH, and other critical water chemistry requirements - as follows:

Wash/Rinse tanks

If the fluid in the wash and rinse tanks do not maintain the specified cleanliness levels, often measured in mg/l or ppm, the parts, as they are passed from tank to tank, will not be adequately cleaned of particles and debris. The result is:

- parts will not meet specification, will be rejected and have to be cleaned again. This results in reduced productivity and increased inventory levels.
- defective (poorly cleaned) parts are shipped to customers, or used in equipment. The resulting machine debris may cause unnecessary wear to the finished products, reducing equipment life or simply creating poorly performing equipment and potential rework on a warranty.

To maintain the bath cleanliness specifications, parts cleaners will often change the bath fluids, causing disposal and waste problems. The cost of disposal, including labor and washing fluid replacement, combined with the lost production can have a

significant impact on the parts cleaning operations profitability.

Beyond the direct costs of maintaining the bath cleanliness ancillary equipment must be protected from particulate contamination. These can include:

Ultrafiltration (UF system)

The purpose of the UF system is to reduce emulsified oils that are introduced into the wash bath by the parts undergoing the washing. The UF system works on the principle of passing a stream of contaminated water over a micro porous membrane which often has pore sizes smaller than 0.1 micron in order to separate the unwanted contaminants from the feed stream. As the fluid passes over the membrane, two streams are ejected. Purified water, virtually free of oils and particles, preferentially permeates through the membrane and returns to the wash tank to be reused. Emulsified oils and particles can not permeate through the membrane and are ejected in the concentrate stream. UF membranes are very expensive, typically costing thousands of dollars each, and are expected to be in service for years. If not properly protected, the membrane will plug with solid particles resulting in reduced fluid output, higher operating pressure drops, and higher energy costs. Eventually, the membrane will become completely plugged and require replacement.

Reverse Osmosis System (RO System).

RO systems reduce dissolved salts and minerals from the incoming rinse water, which, in turn, provides a spot free finish on the washed parts. Like the UF system, this is accomplished by passing the water over a micro porous membrane where the water molecules will preferentially pass through the membrane while the dissolved ionic contaminants will not. Particles in the feed water must be reduced from the water or the membrane will plug prematurely resulting in unnecessary change-out and expense.

The Solution

Filtration for a parts cleaning system can range from simple to complex depending on the cleanliness requirement. In complex systems, where requirements dictate finer reduction efficiencies, relatively coarse reduction of large particles occurs at the wash tanks, while finer reduction efficiencies are required at the final rinse tanks. This, along with providing sufficient protection for the ancillary water treatment systems, means that filters with different micron ratings and potentially materials of construction must be used. The filters of choice will be those that:

- are chemically compatible with the various additives and detergents added to the wash and rinse fluids to meet specifications
- have high dirt holding capacity to provide long on stream life and reduced filter change-out for reduced disposal and maintenance costs
- are absolute-rated for the rinse stages to reduce all particles larger than the stated rating therefore providing reproducible and defined system protection

Since no one filter is ideal for all applications it is very important to review the requirements to obtain a cost effective system. The listing below is a guideline to aid when reviewing the filtration requirements of the system.

- 1.) The initial wash stages have a significant amount of manufacturing debris that must be reduced from the wash water. Likewise, when reducing the filter from the housing, it is ideal to reduce the debris with the filter. This reduces the need to clean the filter housing during filter change-out. 3M™ DF series filtration systems provide excellent contaminant reduction, service life up to 4 times that of bag filters and reduces the captured debris with the filter cartridge.
- 2.) The secondary wash and initial rinse station are designed to provide an improvement in the level of filtration. Absolute rated filters are ideal for this application. This assures that the desired particles are reduced from the wash and rinse water. The Betapure™ NT-T filter cartridge is an absolute rated polypropylene depth filter with a unique design typically provides up to 2 times the life of similar depth filters.
- 3.) Chemical compatibility and temperature may also limit the filter selection and it is important that the wash and rinse quality is not compromised by these constraints. The Betapure™ BK series filter, also an absolute rated filter, can meet the more stringent process conditions without sacrificing the filtration efficiency.
- 4.) The final rinse station will dictate the part cleanliness and the part can only be as clean as the rinse solution. It is therefore



3M™ DF Series Filter Systems

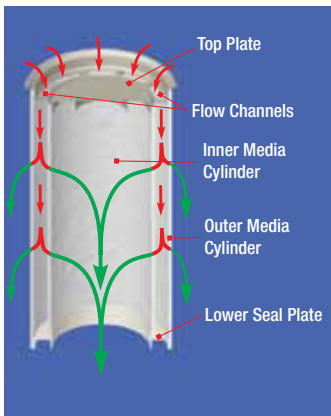


Figure 2 — 3M™ DF Series Flow

imperative that the filter provides the utmost quality while still being cost effective. The LifeASSURE™ cartridge, a high efficiency pleated filter, provides excellent service life and is ideal for applications where the fluid cleanliness is mandatory.

The following 3M Purification Inc. products meet these requirements, are available in a range of reduction efficiencies and are effective in each stage of the parts washing system:

The 3M™ DF series filter element is manufactured using a graded porosity structure combined with a unique construction with 62% increase in filter surface area. Combined, these provide up to 4 times the service life of typical needle felt bags while providing equivalent or better contaminant reduction efficiency. 3M DF series will reduce filter costs while minimizing production downtime, disposal and labor costs. The 3M DF series design utilizes a filter element geometry that reduces fluid holdup volume by 67%. As a result, fluid loss is minimized and worker exposure to process fluids is reduced. The design of the 3M DF series restrainer basket provides 100%, three dimensional support of the 3M DF series element. This reduces the potential for filter element rupture and the resulting gross contamination of the downstream effluent with previously reduced particles. The added area also reduces the flow rate per square inch, commonly referred to as flux, which in turn improves the overall filtration efficiency. The contaminant, contained within the 3M DF series filter, is reduced with the filter thus reducing the need to clean the filter housing.

3M Purification Inc. utilizes a technology in the production and assembly of the 3M DF series filter to optimize performance and filtrate quality to assure customer satisfaction. The 3M DF series filter element is sized to replace conventional #1 and #2 bag filters with ratings from 1 to 100 micron and is available in polypropylene or polyester.

The 3M DF series filter will easily retrofit most existing bag filter housings. To take advantage of the 3M DF series system in applications where bag filter housings currently exist simply reduce the existing support basket and replace it with a 3M DF series basket and insert the 3M DF series filter. For new installations, 3M Purification Inc. offers a 3M DF series single filter housing that can be installed as a single unit or is easily installed in series or parallel depending on the application requirement. Since the 3M DF series has more surface area and better flow characteristics the number of filter elements require will be reduced thereby lowering the housing capital expenditure.

Betapure™ NT-T filter cartridges are 3M Purification Inc.'s latest advance in depth filtration technology. The all-polypropylene filter is constructed using a process that uses flow enhancing filter media and an innovative flow pattern. The result is an absolute-rated filter, available in ratings from 0.5 µm to 70 µm, with vastly superior on-stream life that provides more cost effective filtration than conventional filter technologies.

Betapure NT-T filter construction combines a unique polypropylene filter media with fluid distribution netting to form multiple layers. Critically positioned media flow channels allow greater movement of fluid from layer to layer (Figure 3). Three distinct media sections, made from multiple media/netting layers, are combined to form a filter cartridge (Figure 4). The outer and middle sections contain multiple layers of interleaved filter media and fluid distribution netting. Within each media layer, a portion of the fluid travels through the media while the balance of fluid is delivered directly to the next distribution layer through the flow channels. The fluid distribution netting provides longitudinal and latitudinal flow paths to evenly distribute fluid flow across the surface of each successive filter media layer. The inner-most layers of media, equal to one third of the filter's depth, is supported by a rigid polypropylene core. It contains no flow channels and is the final qualifying section ensuring absolute rated performance.



Betapure™ NT-T Filter Cartridge Configurations



Figure 4 — Betapure™ NT-T Filter Construction

Betapure™ NT-T Filter Advantages

- Superior Service Life - as much as 4 times greater dirt holding capacity than competitive filters
- All polypropylene depth filter cartridges for broad chemical and temperature compatibility
- Ratings from 0.5 - 70 micron to suit a wide range of applications
- Absolute-Rated Performance for consistent filtration quality
- Exhibits superior particle retention under increasing differential pressure

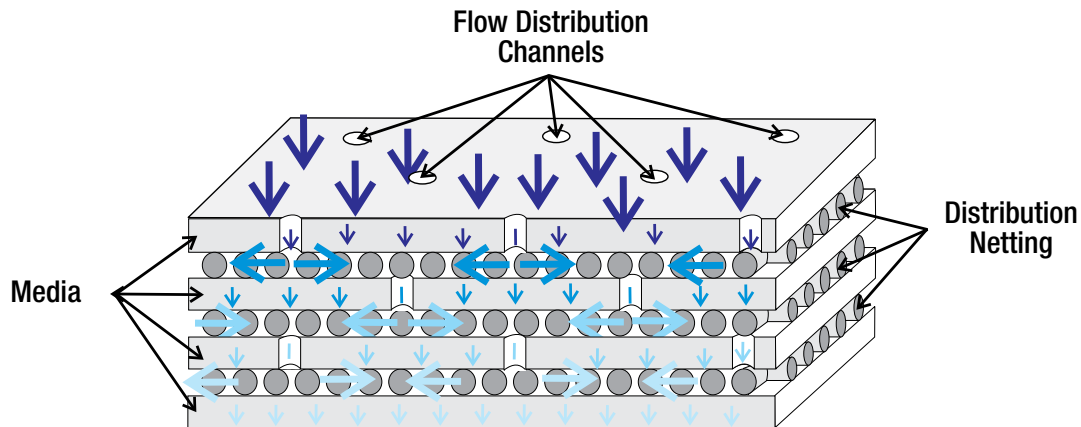


Figure 3 — Betapure™ NT-T Filter Construction

Betapure™ BK Series Filter Cartridges - Betapure BK series filters are absolute rated, rigid (non-compressible) resin bonded cartridges featuring a graded-porosity structure for reduction of contaminants with a wide range of particle sizes. Consistent quality and performance at absolute ratings from 5 to 70 micron make Betapure BK series the clear choice for economical parts washing. Absolute-rated Betapure BK series depth filter cartridges are very effective at reducing large quantities of contaminants. The combination of high efficiency and rigid media construction ensures effective particle reduction and high dirt holding capacity without the danger of particle unloading during operation. A high temperature cartridge is available for applications operating between 250 - 300°F.



Betapure BK series filter cartridges are manufactured using a process that achieves a true graded pore structure with a clean and smooth inside diameter reducing the need for a center core. Figure 5 illustrates that the openings between the fibers become progressively smaller as the fluid flows from the outer surface to the inner core of a graded porosity structure. Each fiber is locked in this arrangement by a thermosetting binder to create a rigid structure. The overall effect is to sort, classify and stop particles by size as they progress through the cartridge. Larger particles are trapped in the upstream region of the filter and finer particles towards the inner core of the filter. Contaminants at or near the filter's absolute rating are reduced in the inner section of the filter cartridge.

Betapure BK series cartridges also feature an optimized groove pattern that increases the surface area by over 65% when compared to smooth cylindrical cartridges (Figure 6). The grooved surface prevents premature blinding of the outer surface by large particles and allows full utilization of the depth structure.

Betapure™ BK Series Filter Cartridges

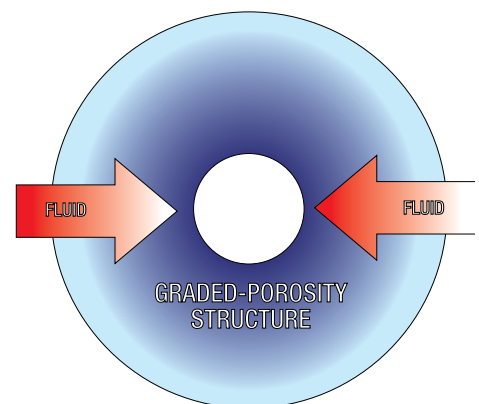


Figure 5 — Graded Pore Structure

Maximum surface area with a true graded pore structure means that Betapure™ BK series can provide greater service life of three times or more than competitive filter cartridges of comparable efficiency.

LifeASSURE™ filter cartridges are 3M Purification Inc.'s latest advance in membrane filter technology. Encompassing two leading-edge processes, FlexN membrane manufacture and MaxMedia pleating construction, the LifeASSURE series of filters offers unmatched performance, as well as exceptionally long service life. Designed with pleated Nylon 66 membrane in an all- polypropylene cartridge construction, LifeASSURE filters are ideally suited for a wide range of filtration applications in the parts washing process where final polishing or protection of an RO membrane is a consideration.

As the SEM photo of the LifeASSURE membrane cross section demonstrates (Figure 7), the membrane is constructed with a single layer of membrane consisting of an “open” zone on the upstream side of the membrane and a “tighter” zone on the downstream side. In effect, the upstream zone acts as a prefilter, capturing larger particles and bacteria, while the tighter downstream zone provides retention of smaller particles and bacteria. This multi-zone structure results in greater contaminant capacity, while maintaining high flow rates. The combination provides the end-user with the security and reliability of consistently high reduction efficiencies at low differential pressures along with the enhanced economics of longer lasting, faster flowing filter assemblies.

LifeASSURE™ Filter Advantages

- Superior downstream membrane protection - ideal for RO pre-filtration
- Offers the maximum in contaminant holding capacity to decrease filter change-outs
- Designed with pleated Nylon 66 membrane in an all- polypropylene cartridge construction for durability and a wide range of fluid compatibility

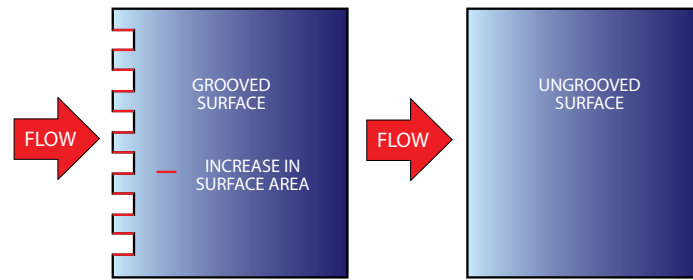


Figure 6 —Betapure™ BK Series Increased Surface Area



LifeASSURE™ Filter Cartridges

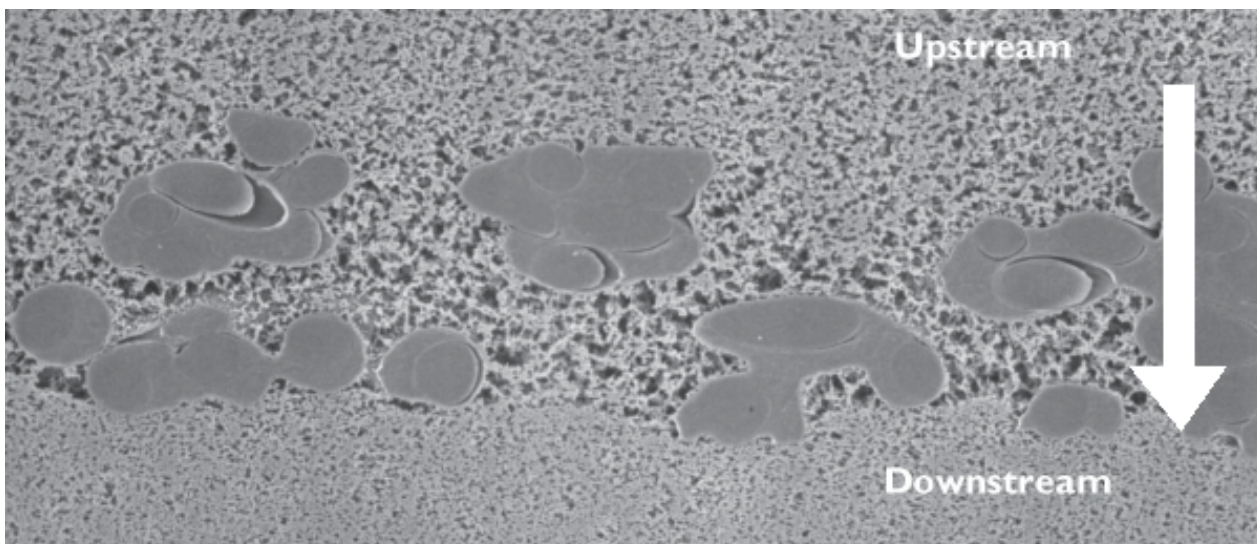


Figure 7 — LifeASSURE™ Filter Media Construction

These products are recommended to be used in the following locations shown in Figure 1.

Table 1 — Typical Filter recommendations

| Filter Position | Application | Goal of Filtration | Contaminant | Filter Cartridge | | Filter Housing* | |
|-----------------|---|--|---------------------------------------|---|---|-----------------|---------------|
| | | | | Construction | Recommendation | 1 to 15 gpm | 15 to 100 gpm |
| F1 | Wash Tank 1 Pre- Ultrafilter (UF) | Protection of UF system | Narrow particle distribution | Absolute rated, rigid, depth filter | Betapure™ NT-T Filters 20 micron | CT | DC |
| F2 | Wash Tank 1 Recirculation Loop | Reduction of solid contaminants and oils | Broad particle distribution | Absolute rated, rigid, graded porosity depth filter | Betapure™ BK Series Filters 5 - 70 micron | CT | DC |
| | | | | Nominally rated, graded porosity, high flow filter | 3M™ DF Series 1 to 100 micron | 3M™ DF Series | 3M™ DF Series |
| F3 | Wash Tank 2 Recirculation Loop | Reduction of solid contaminants and oils | Broad to narrow particle distribution | Absolute rated, rigid, graded porosity depth filter | Betapure™ BK Series Filters 5 - 70 micron | CT | DC |
| | | | | Absolute rated, rigid, depth filter | Betapure™ NT-T Filters 1 - 70 micron | | |
| | | | | Nominally rated, graded porosity, high flow filter | 3M™ DF Series 1 to 100 micron | 3M™ DF Series | 3M™ DF Series |
| F4 | Rinse Tank 1 Recirculation Loop | Reduction of solid contaminants | Narrow particle distribution | Absolute rated, rigid, depth filter | Betapure™ NT-T Filters 1 - 70 micron | CT | DC |
| F5 | Rinse Tank 2 Recirculation and Make-up Water Loop | Protection of reverse osmosis system | Narrow particle distribution | Absolute rated, rigid, depth filter | Betapure™ NT-T Filter 20 micron | CT | DC |
| | Rinse Tank 2 Recirculation Loop | Reduction of solid contaminants | Narrow particle distribution | Absolute rated, pleated membrane filter | LifeASSURE™ 0.2 - 0.8 micron | 1ZMO | SD |
| | | | | Absolute rated, rigid, depth filter | Betapure™ NT-T Filters 1 - 70 micron | CT | DC |

Recommendations/Conclusions

Parts cleaning processes depend upon effective filtration to reduce machine debris and other contaminants to meet manufacturing and quality requirements. Proper filtration in each step of the parts cleaning system will reduce operating costs and improve efficiencies. 3M™ DF series, Betapure™ NT-T, Betapure™ BK series, and LifeASSURE™ have been evaluated and recommended for use in the filtration of wash and rinse tank fluids. Contact your local 3M Purification Inc. Distributor for more information.

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