

BEST PRACTICES GUIDE FOR THE DAIRY INDUSTRY

FILTRATION SOLUTIONS





Operating a dairy plant requires balancing continuous production demands with the highest standards of food safety and compliance. Every decision - whether related to water quality, steam, or compressed air treatment - can directly help protect product integrity, shelf-life, and brand reputation. This guide provides dairy producers with practical, actionable insights on how to reduce risks and optimize filtration across all key utilities.

Inside, you'll discover:

- The role of water, steam, and air filtration in helping protect product quality and operational efficiency.
- Practical handling and maintenance steps that support long filter life and help manage downtime.
- Real-world examples of what can happen when utilities are overlooked.
- How robust solutions support both regulatory compliance and operational reliability.

Filtration may never appear on a label, but its role is present in every carton, cup and block leaving a dairy plant. By applying best practices for filtration management, dairies can help deliver consistency, support consumer safety, and assist in protecting brand reputation.

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INTRODUCTION

Dairy production is among the most demanding sectors in food manufacturing. From the moment raw milk enters the plant until the finished product reaches the shelf, every step must be carefully controlled to help protect product quality, support food safety, and promote consistency.

While recipes, equipment, and raw materials often take center stage, proper treatment of utilities, such as water, steam, and compressed air, is equally critical to help support process integrity and assist in smooth operations.

These utilities never appear on a product label, yet they play a role in nearly every stage of production - cooling, heating, sterilizing, mixing, packaging, and even direct product contact. Each represents a potential entry point for contamination if proper filtration and air treatment are not in place. Contaminated water, oil in compressed air, or poor-quality steam can disrupt production and help compromise product quality. In an industry built on trust and strict regulations, these are risks no dairy operation should overlook.

Regulators recognize this, which is why standards such as ISO 8573-1:2010, 3-A Sanitary Standards, International Featured Standards (IFS), and Codex Alimentarius set strict requirements for particle content, oil, particle content, oil, moisture levels, and sanitary standards. Yet compliance is only part of the picture. The true value of strong filtration practices lies in helping protect brand trust and supporting operational reliability.

Dairy consumers expect every carton of milk, cup of yogurt, or block of cheese to be safe, fresh, and consistent. Meeting that expectation requires more than clean equipment and good ingredients. Behind the scenes, correct management of the critical control points (CCP) of your utilities is essential - points where even small failures can have large consequences, from unplanned downtime to full-scale recalls. When handled properly, filtration is not just a quality requirement, but a driver of efficiency and confidence across the plant.



FILTRATION ACROSS THE DAIRY INDUSTRY



Looking at the dairy process, filtration plays a role in almost every step. For example:

- At reception, water quality helps determine how effectively raw milk can be cooled and handled.
- During pasteurization and fermentation, steam and sterile air influence product quality.
- In drying and packaging, sterile compressed air and sterile vents help protect powders, bottles, and cartons from contamination.

Every stage carries its own risks, but together they form a chain of critical control points. Break one link, and the entire process is exposed.

DONALDSON APPLICATIONS ACROSS DAIRY PROCESSES

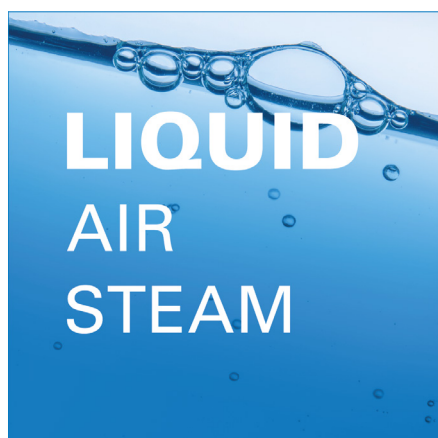
In the dairy industry, reliable filtration and air treatment are essential to help protect product quality, support equipment longevity, and assist in compliance with global food quality requirements. Donaldson, with decades of experience in food and beverage filtration, provides solutions that help address these critical needs across every stage of dairy processing—from milk reception to final packaging.

Designed to deliver measurable value, Donaldson's technologies help dairies support product quality, support long filter life, help manage downtime, and assist in compliance - making Donaldson a trusted partner for dairy operations worldwide.

THE THREE PILLARS: LIQUID, AIR, STEAM

- **Liquid (water and process liquids):** Utility and process water for reception, cleaning-in-place (CIP), dilution, and ingredient preparation.
- **Air (compressed and sterile gas):** Instrument air, blow-off air, aeration, inert overlays, and sterile tank vents.
- **Steam:** Thermal treatment, SIP, and heating duties where condensate quality is critical.

The following chapter explains the core types of filters used in those applications and the reason why filter choice and maintenance matters.





LIQUID FILTRATION

PROCESS WATER AND INGREDIENT WATER

Clean water is fundamental to every dairy process, whether used as an ingredient, for cleaning-in-place (CIP), or for cooling. Donaldson liquid filter housings and elements provide reliable particle and microbial control down to 0.2 μm , helping reduce contamination risks in both product and utility applications.

NOMINAL FILTERS

Nominal filters are usually polypropylene-based depth filters, used for rough prefiltration or to help protect downstream process steps from a high number of particles. They typically have retention efficiencies up to 98% and may vary in efficiency due to the lack of stability in their filter matrix. They should not be used to protect highly sensitive process steps like sterilizing membranes.

Typical use cases:

- Reverse osmosis prefiltration.
- First particle reduction step in a multistage filtration.

ABSOLUTE FILTERS

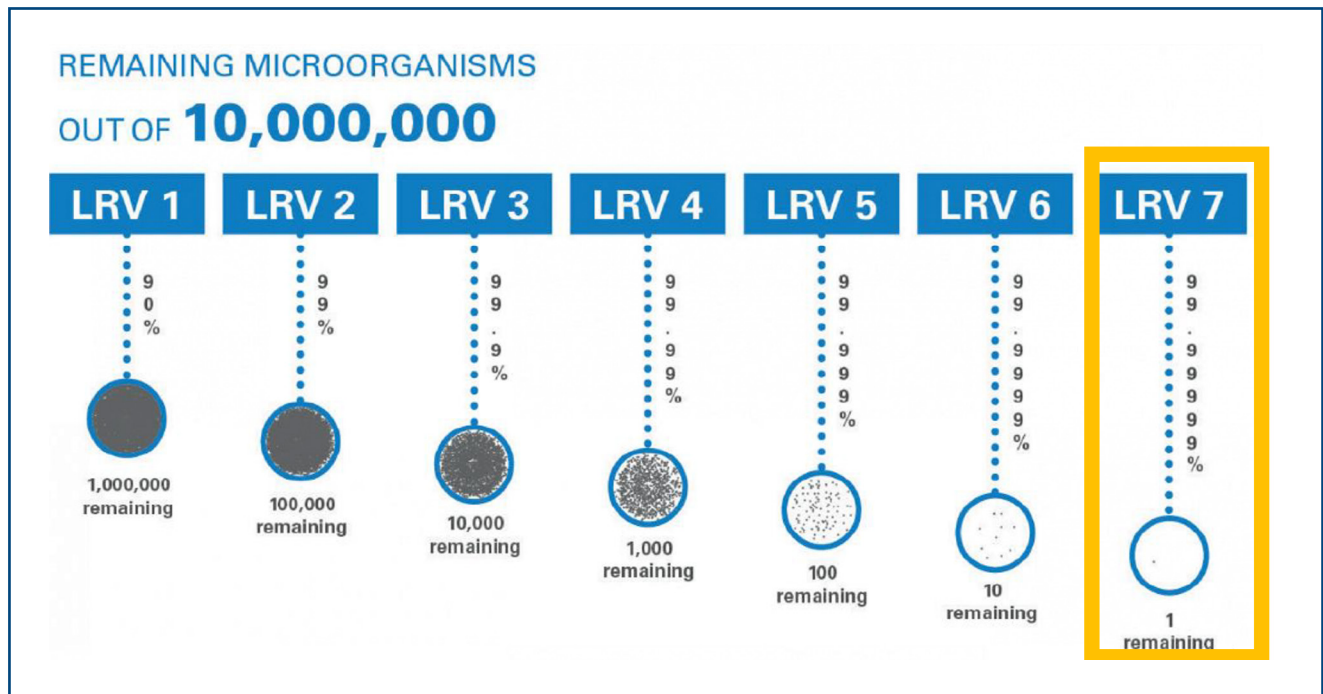
Absolute filters are usually polypropylene-based depth filters, used for fine prefiltration and to help protect sensitive downstream process steps from small particles. They typically have high retention efficiencies of up to 99.98% and consistently achieve those efficiencies due to a stable filter matrix.

Typical use cases:

- Fine particle protection for sterilizing membranes.
- Trap filtration after active carbon or filter aid tanks.

STERILE MEMBRANES

Sterile membrane filters are validated for the retention of specific micro-organisms and achieve defined Logarithmic Reduction Values (LRV) for those microorganisms.



One of the most used microorganisms to validate liquid filters is *Brevundimonas Diminuta*, which is also the validation bacteria required by the FDA (Food & Drug Administration, US). Sterile-rated membranes can be classified as sterile if they achieve a LRV of ≥ 7 for those microorganisms. All membranes come with the benefits of being sterilizable with steam¹ and can be tested for integrity.

Typical use cases:

- Final filter for water when sterility is required.

MULTISTAGE FILTRATION

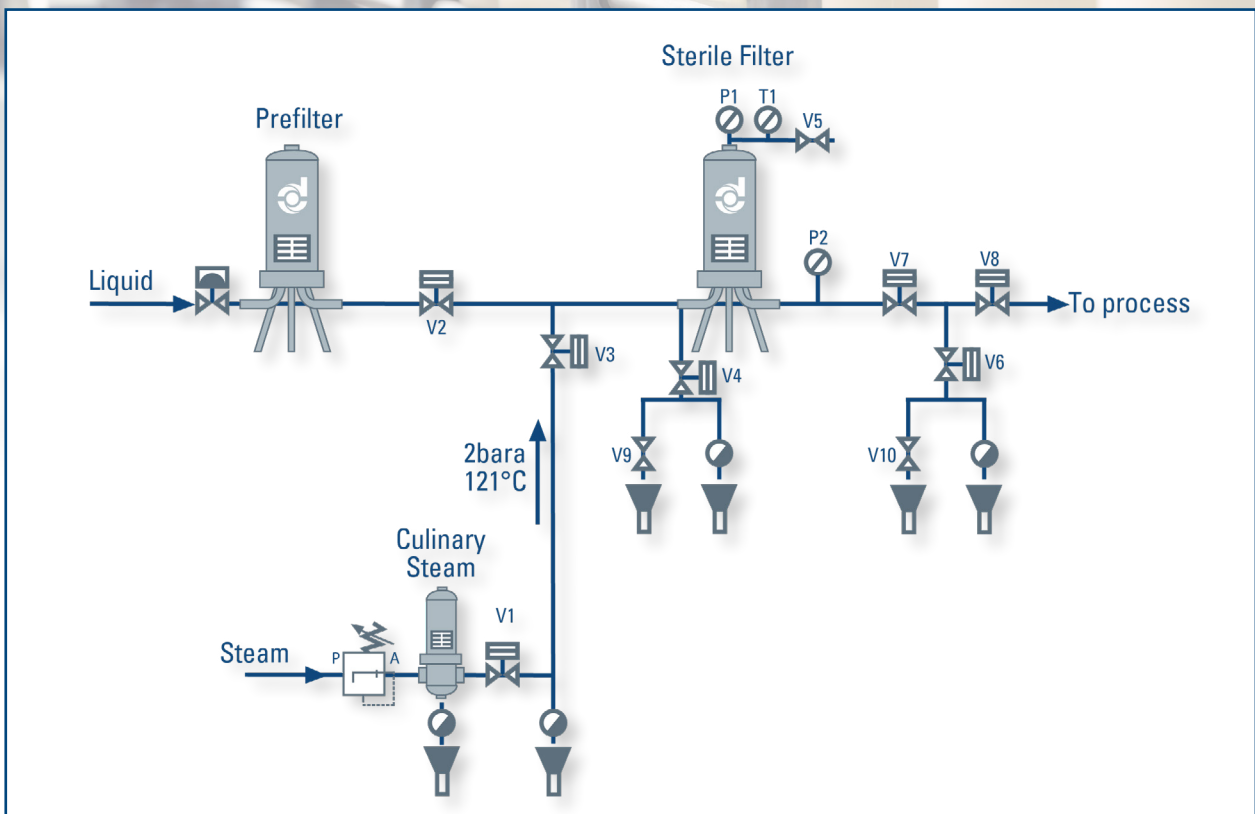
In most applications, a single filtration step is not sufficient; multiple filtration steps need to be combined to achieve the required element lifetime and performance. Additionally, depending on the application, utilities in contact with the liquid filtration line, for example steam, also need to be filtered at the point of use. Different types of filters also concentrate on different kinds of contamination:

Prefilters: Removal of particles

Membranes: Removal of bacteria

¹ In accordance with the manufacturer's instructions.

BEST PRACTICE EXAMPLE:



Selecting the appropriate prefilter for a final membrane filtration step is key to help protect the membrane from particles.

There are empirical test methods like a water analysis, particle counting or small-scale filterability test that can be used to support correct filter choice. Donaldson can support this step with the correct filter choice by performing this analysis. Please reach out to

your Donaldson Filtration contact person for more information.

FILTER EXCHANGE INTERVALS

A common question is when to replace liquid filters. This depends on the type of filter used (depth filter or membrane) and other factors such as pump capacity and a process integrity risk assessment.

For depth filters and prefilters, the replacement interval is determined by the following criteria:

- Each polypropylene-based filter should generally be replaced at least once a year.
- Each stainless steel filter should typically be replaced after 2–3 years, depending on condition.
- Differential pressure is often the limiting factor since, over time, with the removal of contaminants, the differential pressure will rise.
- For efficient filtration, the differential pressure should generally not exceed 1.5 bar; however, this depends on pump capacity.
- The higher the differential pressure of a depth filter, the more challenging a potential cleaning step will be.
- Always refer to the product data sheet and/or manufacturer replacement guidelines for more detailed instructions.

For membrane filters, the replacement interval is determined by the following criteria:

- Since most membrane cages are polypropylene-based, each filter should be replaced at least once a year.
- If not sufficiently protected by prefilters, differential pressure can become a limiting factor since, over time, with the removal of contaminants, the differential pressure will rise.
- Additionally, membranes can lose integrity and should therefore be tested with appropriate integrity tests to help maintain process integrity.
- Sterilization with steam followed by shock cooling can pose a risk for membrane integrity loss.
- A membrane can theoretically withstand the number of sterilization cycles indicated on the product data sheet, however, this can vary significantly depending on individual process conditions.



SIP (STERILIZATION IN PLACE)

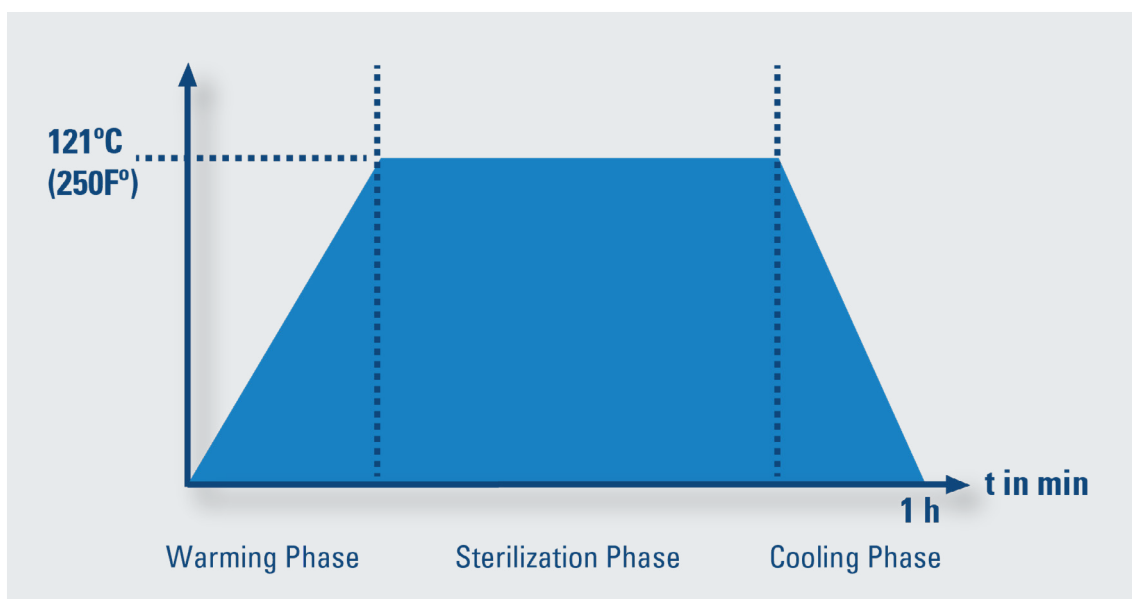
In general, when using a membrane, regular steam sterilization is recommended to help prevent bacterial growth through the membrane to the clean side.

The two most important aspects of steam sterilization are:

- **Process Validation** (e.g. ensuring the sterilization process is optimized to help avoid membrane damage).
- **Sterilization Interval** (e.g. balancing continuous production with process integrity risk).

Key parameters to help optimize steam sterilization for liquid filters include:

- Steam temperature and continuous temperature control.
- Heating and cooling phases: filters experience the greatest stress during heating and cooling phases, where thermal stress within the material is highest. Extending or 'softening' these phases can help support filter longevity.
- Steam mass flow through the element during the sterilization procedure.
- Differential pressure during the sterilization procedure.
- Steam quality.
- Condensate management (less critical for liquid filters than air filters).
- Regular integrity tests on the membrane filter are important to help confirm whether the current steam sterilization method is optimized and does not damage the filter.



BEST PRACTICE EXAMPLE:

The following guide provides a best practice example for sterilizing a typical two-stage filtration installation:

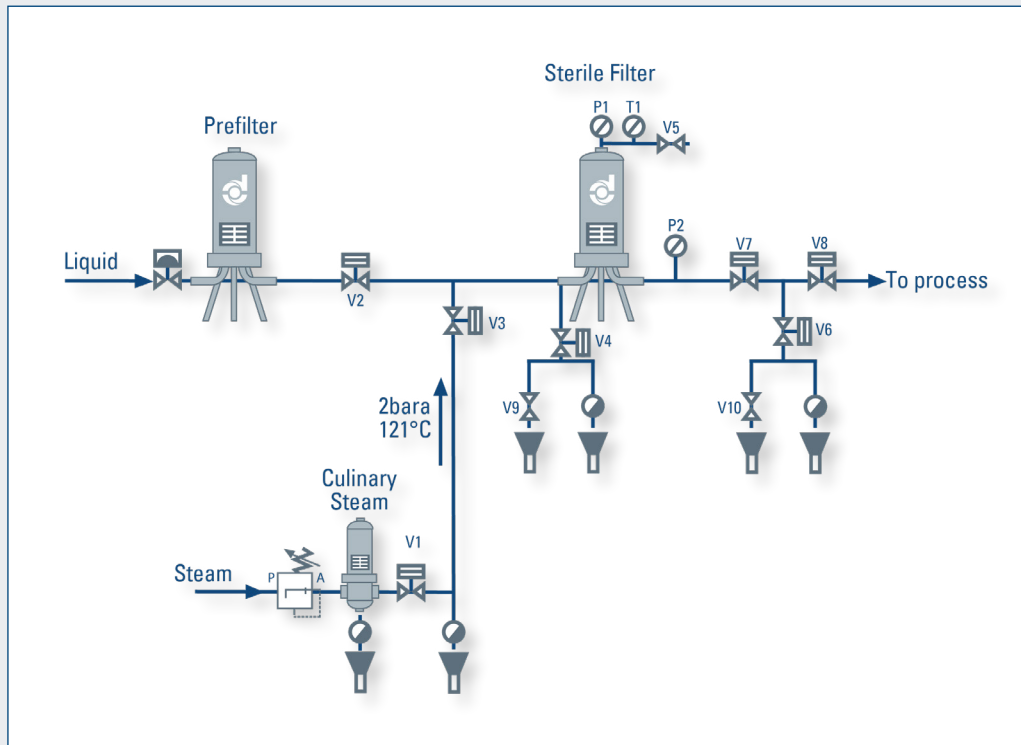


Figure 5: Forward steam in place procedure for liquid filters.

1. Open valves V4, V6, V9 and V10.
2. Drain the product from the filter system and associated piping. Opening valve V5 will aid this process.
3. Open valve V1 and allow the steam condensate to drain until the steam trap below valve V3 closes. Close valve V9.
4. Slowly open V3 allowing steam into the system: this will flow across the filters and through valve V4 and V5. This will allow the heating of the housing, the filters and associated piping without generating a significant differential pressure across the filters.
5. When 'live' steam flows from valve V5 close valve V5. This will direct the steam through the heated filter. Close valve V10.
6. Observe the pressure gauges P1 and P2, control the steam flow rate at valve V3 and set the sterilization steam pressure to ca. 300 mbar above the required saturated steam pressure (P1).
7. Ensure that the differential pressure between P1 and P2 does not exceed 0.2 - 0.3 barg.
8. When the steam trap below valve V6 closes, the steam pressure will begin to rise.
9. Steam sterilize the cartridges for the time specified ensuring the conditions of temperature and pressure stay at a constant level.
10. On completion of the Steam-In-Place cycle, close V3 and V1 in that order.
11. Slowly open V10 to release the steam pressure from the filter system and associated piping. When the pressure on P2 reads 0.1 barg pressure close valve V10. Fully open valve V9 to release the remaining steam pressure from the filter system. When the pressure on P1 reads 0.1 barg pressure, close valve V9.

CIP (CHEMICAL CLEANING IN PLACE)

In general, most liquid filters can typically withstand chemical cleaning in place². However, there are several important factors that should be checked and controlled. One common source of failure during CIP of filtration systems is the use of old or stacked chemicals. For filtration systems, it is recommended to use a dedicated CIP system with fresh chemicals. This helps fine-tune the CIP process to the filter line and support effectiveness and filter longevity. Higher concentrations of chemicals can reduce filter cartridge longevity and increase the risk of integrity loss.

Typically, the concentrations shown in the best practice example are sufficient for chemical cleaning of filter cartridges, and higher concentrations generally do not significantly improve cleaning results.

The key to an efficient CIP procedure is using the right chemicals suited for removing contamination within the individual process, as validated by the user.

Stainless steel cartridges are less sensitive to temperature and concentration, so CIP procedures can be more aggressive for these types of filters. They can also be regenerated using ultrasonic baths.

It is important to use the following CIP flow directions to help avoid filter damage:

Donaldson Depth filters and stainless steel filters:	Forward and/or backwards
Donaldson Membranes:	Forward

Regeneration should be planned when timing aligns with the production schedule or when filter steps show inefficient differential pressure or reduced flow. Regeneration of filter cartridges is generally easier and more efficient when differential pressure is still low.

In addition, the following advice for CIP procedures for liquid filters can be given:

- Water used for sanitation should be particle-free (5 µm) and soft (low Mg and Ca content < 7.5° German Hardness).
- Chemicals should not come from centralized CIP tanks used for conventional cleaning of components, as particles carried in used chemicals can significantly reduce filter longevity.
- For cleaning or regeneration of filters, only freshly prepared caustic chemicals and acid should be used.
- Verify that O-rings are compatible with the chemicals to help ensure they withstand exposure without degradation.

² Always consult the manufacturer's instructions on appropriate process for chemical CIP

INTEGRITY TESTING

Every membrane filter used for liquid filtration can lose integrity over time, after a certain filtered volume, or following multiple sterilization or CIP cycles. Additionally, a membrane filter can lose integrity due to unexpected occurrences such as pressure shocks or human errors.

Regular integrity tests are important to help maintain process integrity and appropriately manage contamination risks. When performed correctly, an integrity test can provide a fast, reliable, non-destructive method to help confirm product and process

integrity at critical control points such as the final filtration step.

The following tests can be included as part of an integrity testing protocol.

Bubble Point Test:

This test is based on the principle that liquid is held in the pores of the filter by surface tension and capillary forces. Bubble point is defined as the pressure at which gas displaces liquid from the largest pores and flows rapidly (bulk flow) through the filter.

The theoretical equation describing bubble point is:

$$P = \frac{4k\gamma \cos(\theta)}{D}$$

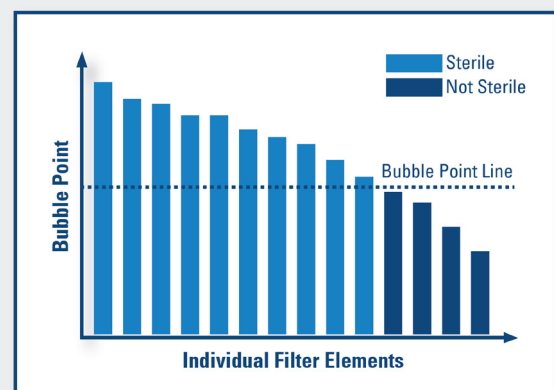
P = Bubble point pressure

D = Pore diameter

k = Shape correction factor

Y = Liquid-solid contact angle

Ø = Surface tension



Other factors that can affect bubble point measurements include membrane structure, temperature, wetting fluid, and degree of wetting.

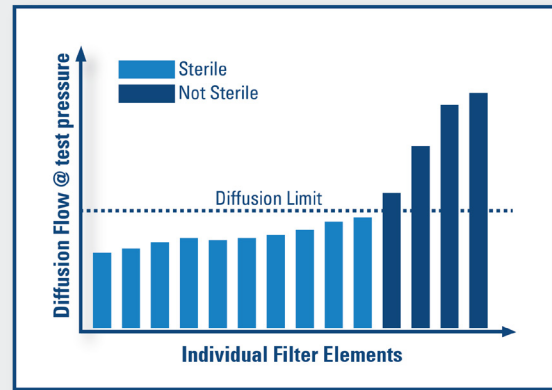
Diffusion/Pressure Hold Test:

A diffusion test involves applying differential gas pressure below the bubble point. Gas molecules migrate through the water-filled pores of the membrane following Fick's Law of Diffusion. The gas diffusion flow rate for a filter is proportional to the differential

pressure and the total surface area of the filter. At approximately 80% of the minimum bubble point pressure, the gas that diffuses through the membrane is measured to help determine the filter's integrity. This flow is significantly smaller than the bulk airflow associated with the bubble point.

$$Q = \frac{K \Delta p A p}{L}$$

- Q** = Diffusional flow
K = Diffusivity/solubility coefficient
Δp = Pressure difference across the system
A = Membrane area
p = Membrane porosity
L = Effective path length



Factors that can affect diffusion measurement include the degree of membrane wetting, wetting fluid, gas type, and temperature. If a filter fails an integrity test, additional parameters should typically be checked first.

There are three common options for integrity testing: pre-use/post-sterilization, pre-use/pre-sterilization, or post-use. The frequency of integrity testing depends on the process integrity risk assessment and specific applications. Each method has advantages and disadvantages, summarized below:

PRE-USE/PRE-STERILIZATION INTEGRITY TEST

Advantages:

- Potential contamination by manipulating the downstream side of the filters is negated by the sterilization step afterwards.
- Control of filter before any process step is performed.
- Ensures proper installation.

Disadvantages:

- Filter may be damaged after the integrity test by sterilization or filtration process which would not be detected.
- Uncertainty during filtration whether filter is still maintaining integrity.

PRE-USE/POST-STERILIZATION INTEGRITY TEST

Advantages:

- Possible damage by sterilization is detected.
- Control of filter before actual filtration is performed.
- May help to identify problems with sterilization.
- Ensures proper installation.

Disadvantages:

- Manipulation of clean downstream side introduces risk of contamination (reason for low to no usage of this method in aseptic installations).
- Uncertainty during filtration whether contamination is present.

POST-USE INTEGRITY TESTING

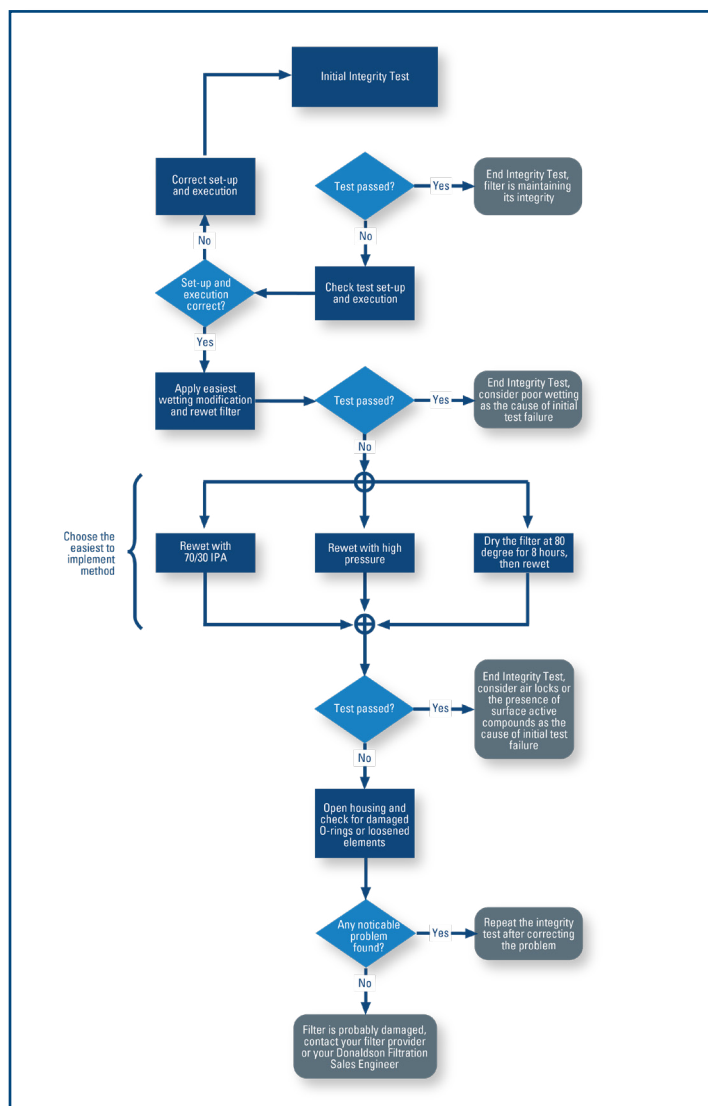
Advantages:

- No manipulation of the filter and downstream side before filtration.
- Best chances of batch integrity.
- May help identify problems during filtration.

Disadvantages:

- If filter integrity has not been maintained, batch may be contaminated and must be re-evaluated.

TROUBLESHOOTING INTEGRITY TEST FLOWCHART



Since every installation and process is unique, please discuss with your Donaldson Filtration Sales Engineer the possible risks and advantages at your installation.

This flowchart provides a guideline for additional steps when troubleshooting integrity tests.

For further information about integrity test risk assessment, schedules and devices, please contact Donaldson Filtration.

COMPRESSED AIR TREATMENT

Compressed air is one of the most critical utilities in dairy plants. Donaldson offers a complete portfolio to support ISO 8573-1:2010 compliance, including:

- High-efficiency coalescing filters for oil and aerosol removal.
- Particulate filters to help protect downstream equipment and filtration steps.
- Adsorption dryers for precise dew point control, helping prevent moisture-related microbial risks.

Note that the removal of micro-organisms is not covered by the ISO 8573-1:2010 and will be followed in a next step with the selection of the right sterile filter at point-of-use.

Together, these solutions help support compressed air quality for valve actuation, bottle blowing, or direct product contact—keeping air clean, dry, and oil-free.

STERILE AIR AND VENT APPLICATIONS

Fermentation tanks, spray dryers, and packaging lines rely on sterile air to help prevent airborne contamination. Donaldson sterile air filters are validated for bacteria and phage retention, making them a dependable choice for critical control points. Vent filters support the sterility of tanks and vessels, helping protect ingredients, cultures and finished products alike.

ISO 8573-1:2010 CLASSIFICATION

When understanding filter types for compressed air, the most critical standard to reference is ISO 8573-1:2010. It classifies compressed air quality in three categories: particles, oil, and humidity.



ISO 8573-1:2010 CLASS	Solid Particles			Water		Oil
	Maximum number of particles per m ³			Pressure Dewpoint		Total Oil (aerosol liquid and vapor)
	0.1 - 0.5 micron	0.5 - 1 micron	1 - 5 micron	°C	°F	mg/m ³
0	As specified by the equipment, user or supplier and more stringent than Class 1					
1	≤ 20,000	≤ 400	≤ 10	≤ -70°C	≤ -94°F	≤ 0.01
2	≤ 400,000	≤ 6,000	≤ 100	≤ -40°C	≤ -40°F	≤ 0.1
3	—	≤ 90,000	≤ 1,000	≤ -20°C	≤ -4°F	≤ 1
4	—	—	≤ 10,000	≤ +3°C	≤ +38°F	≤ 5
5	—	—	≤ 100,000	≤ +7°C	≤ +45°F	—
6	—	—	—	≤ +10°C	≤ +50°F	—

Meeting the ISO 8573-1:2010 air quality class required for each specific application in terms of dew point, oil, and particulate limits helps support audit readiness and food quality plans, reducing corrective actions and product holds. Most importantly, helping to prevent contamination incidents helps protect product quality and brand equity, turning risk points into reliable control points across the plant. ISO 8573-1:2010 air quality classes needs to be regularly measured and

controlled within the whole plant, including point of compressed air creation as well as point of use.

Different types of filters can help achieve different levels of compressed air classes. Please refer to the Donaldson Compressed Air & Gas Portfolio and connect with your Donaldson contact person for the exact combination of filters you will need to achieve the desired air quality classes.

Below you can find a table with the most commonly required ISO 8573-1:2010 compressed air quality grades by application:

APPLICATION	Recommendation for Air Quality Classes (corresponding to ISO 8573-1:2010)*		
	PARTICULATES	HUMIDITY	OIL
Systems without incidental contact with the product or packaging	3	4	2
Systems with indirect contact with the product or packaging	1	2 - 4	1 - 2
Systems with direct contact with the product or packaging	1	2	1

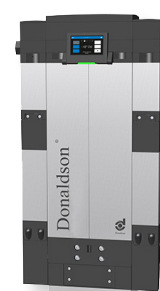
** Dependent on the risk assessment and unique processes and installations.*



**Particle
Removal**



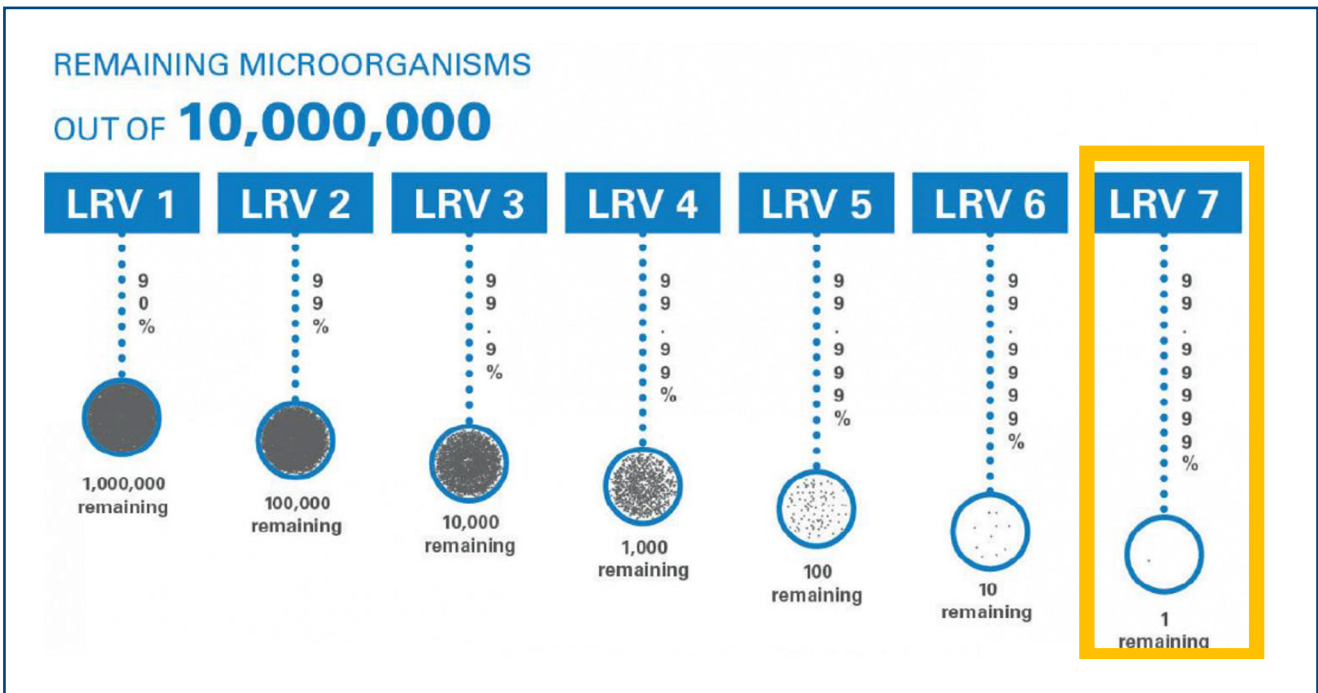
**Oil
Removal**



**Drying
Technology**

STERILE AIR FILTRATION

In addition to implementing the right filtration solutions to meet the ISO 8573-1:2010 quality requirements that are set for your dairy process, sterile filtration is critical at point of use and serves as a critical control point. Sterile filters are validated for the retention of specific microorganisms and achieve defined Logarithmic Reduction Values (LRV) for those microorganisms.



One of the most commonly used microorganisms to validate liquid filters is *Brevundimonas diminuta*, which is also the validation organism used in several regulations.

Sterile-rated membranes can be classified as sterile if they achieve an LRV of ≥ 7 for those microorganisms. All sterile filters offer the

benefit of being steam-sterilizable and can be tested for integrity.

Typical use cases:

- Compressed air for packaging.
- Compressed air for aseptic tank ventilation.
- Compressed air for ice cream processing (texturing).

Sterile air filters can be produced as PTFE-membrane filters or as depth filters using borosilicate fibers coated with PTFE.

Both types have advantages and limitations. Please contact your Donaldson representative for more information.

INTEGRITY TESTING

Please refer to the **Integrity Test** section under Liquid Filtration.

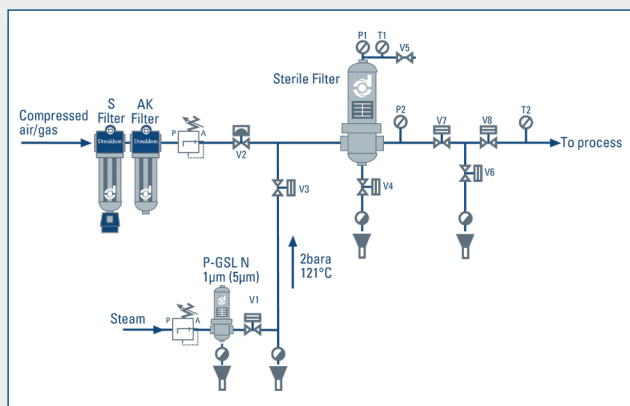
In addition to Bubble Point Testing, sterile depth filters produced with coated borosilicate fibers can be integrity tested using the DOP test with aerosol retention efficiency correlation. The DOP test (formerly Dioctyl-Phthalate, now Dispersed Oil Particles) disperses paraffin oil droplets through a nozzle to approximately $0.2\ \mu\text{m}$ and transports them to the filter in a clean airflow.

The concentration of oil particles is measured before and after the filter, providing retention efficiency for the filter element as a percentage. If retention efficiency reaches 99.99998%, the filter is considered intact and suitable for sterile use. This test is used exclusively for depth filters.

For accurate measurement, the filter should be dry during testing. The test device cannot differentiate between water droplets from the filter cartridge and oil droplets, which can result in inaccurate measurements for wet filters. This is especially important when steam-sterilized filter cartridges are DOP tested immediately after the sterilization process.

SIP (STERILIZATION IN PLACE)

Please refer to the **SIP (Sterilization In Place)** chapter under Liquid Filtration for the basic principles of SIP. The following guide provides a best practice example for sterilizing a typical two-stage air filtration installation:



1. Open valves V4, V5, V6 and V7.
2. Open valve V1 and allow the steam condensate to drain until the steam trap below valve V3 closes.
3. Slowly open V3 allowing steam into the system: this will flow across the filters and through valve V4 and V5. This will allow the heating of the housing, the filters and associated piping without generating a significant differential pressure across the filters.
4. When 'live' steam flows from valve V5, close valve V5. This will direct the steam through the heated filter.
5. Observe the pressure gauges P1 and P2, control the steam flow rate at valve V3 and set the sterilization steam pressure to ca. 300 mbar above the required saturated steam pressure (P1).
6. Ensure the differential pressure across the filter does not exceed 0.2 - 0.3 barg.
7. When the steam trap below valve V6 closes, the steam pressure will begin to rise.
8. Ensure the steam pressure/temperature does not exceed the maximum allowable pressure/temperature for the cartridge type being steamed. If reading from pressure gauges it is recommended the maximum steam pressure is 3.0 barg in the forward direction.
9. Steam sterilize the cartridges for the time specified ensuring the conditions stated in steps 5 to 7 are followed.
10. On completion of the Steam-In-Place cycle, close V4, V8, V3 and V1 in that order.
11. Fully open V5 to flash-dry the filter (or step 12).
12. Open V2 to allow compressed air into the system. The pressure of the air should be no more than 0.5 barg above the steam pressure.
13. Allow the system to cool for 15 minutes, then close V5 (flash-dry only).



RISKS AND IMPACTS OF POOR FILTER MAINTENANCE

Risk	Impact on Dairy Plant	Donaldson Solution
Particle contamination in compressed air or water	Clogged valves, product defects, potential non-compliance	High-efficiency particulate filters such as the Donaldson DF series for compressed air
Oil aerosols in compressed air	Packaging contamination, potential audit failure	Donaldson activated carbon and coalescing filters for oil removal
High humidity or poor dew point	Condensation, microbial growth, and reduced shelf life	Point-of-use Adsorption dryers like Ultrapac™ Smart dryers or centralized dryers like Ultrapac™ HL-ALD/HL-MSD Heatless Desiccant Compressed Air Dryer, followed by dew point monitoring solutions
Inadequate sterile air or vent filtration	Microbial contamination in tanks or packaging	Donaldson SRF series elements as validated sterile air and vent filters

STEAM FILTRATION

CULINARY AND PROCESS STEAM

Steam used for heating or direct injection should be free from rust, scale, and other contaminants to help protect product quality.

Donaldson steam filters are engineered to help meet dairy industry requirements, including 3-A Sanitary Standard performance, which specifies at least 95% removal of particles greater than 2 microns. This helps support culinary-grade steam quality, assisting in protection of heat exchangers and product integrity.

With durable designs for high-temperature, high-moisture environments, Donaldson steam filters are designed to help support reliable performance during pasteurization, sterilization, and direct injection processes.

PROCESS STEAM

Process steam is the general term for steam used in process applications as a source of energy for process heating, pressure control and mechanical drives among others. Process steam may come into contact with the final product or process, but usually culinary steam is recommended for those applications.

THE 3-A STANDARD FOR CULINARY STEAM

Culinary steam is steam that is free of entrained contaminants, is relatively free of water in liquid form, and is suitable for use in direct contact with food products, other comestibles, or food-contact surfaces.

This standard addresses the sanitary and hygienic aspects of equipment - such as filters, traps, and separators—in the production and delivery of culinary steam, from the boiler or steam source through distribution to the point of use.

The 3-A Standard is an accepted practice rather than a mandatory regulation and provides minimum sanitary criteria to help ensure hygienic steam handling.

TWO-STAGE FILTRATION SCHEME:

A common hygienic approach to Culinary and Process Steam is to use a pre-separator/re-filter/entrainment separator (removes larger particulates, water droplets) followed by a final culinary steam filter at or near the point of use. The pre-filter or entrainment separator should remove particles (and droplets) of ~ 10 microns and larger.

The final culinary steam filter (at the point of use) is designed to help remove at least 95% of particles 2 microns and larger.

INSTALLATION BEST PRACTICES

The final filter should be mounted at or near the point of use (e.g. as close as practical to where steam contacts food or food-contact surfaces) so that downstream piping is minimal, helping reduce the risk of re-contamination.

Differential pressure measurement across the filter is recommended so that element change/servicing can be performed when filter loading is indicated. The materials must withstand the expected steam temperature, pressure, cycling, and any sanitation or sterilization regimes used in the process³.

STEAM ELEMENT REGENERATION

Steam elements can be regenerated using several different techniques. In general,

cleaning an element more frequently can help support effective regeneration. The following is some general background on methods of filter regeneration. Remember to always check the manufacturer's instructions for recommended regeneration techniques that are appropriate for the filter.

BACKFLUSH

The filter media can be washed with either clean liquid or clean gas in a reverse, or counter-flow, cycle. Pulsing the flow to loosen attached particles can enhance cleaning. This method is excellent when retained particles are on the surface of the media rather than penetrated deeper into the media pores.

³ Always consult your filter manufacturer's instruction manual or validation guide for more information

SOLVENT CLEANING

In some cases, oil and other contaminants in the steam cause particles to be retained on or within the filter media. Detergents and/or solvent cleaning might be required in these instances, not only to remove the oil or oil-like contaminants, but to release particles as well.

ULTRASONIC CLEANING

The most thorough regeneration is typically achieved using ultrasonic cleaning. In this method, filter elements are immersed in a solvent or water bath in which ultrasonic vibrations loosen and remove particles embedded in the media. Regeneration leaves elements close to their original state.

HANDLING & MAINTENANCE BEST PRACTICES

Filtration systems in dairy plants are only as reliable as the way they are handled and maintained. Even the best-designed filter or dryer may lose effectiveness if installed incorrectly, stored poorly, or left unchecked. What may seem like a small oversight, such as touching a filter element with bare hands or skipping a daily drain check, may contribute to product risks and compliance issues.

HANDLING FILTERS WITH CARE

Filters are sensitive pieces of equipment. Proper handling during delivery, storage, and installation helps support performance as intended from the first day of use.

- Store filters in clean, dry areas away from dust and chemicals.
- Use protective gloves when installing to prevent direct contact with the filter media.
- Check packaging seals before use to avoid introducing contamination.

Why it's important:

Poor handling can damage the filter media or compromise sterility before the unit is even in service, leaving a gap in protection at the very start of production.



RECOGNIZING CRITICAL CONTROL POINTS (CCPS)

Not all filtration steps are equal. Certain applications represent true CCPs, where failure may lead to product or compliance risk.

- **Pasteurization:** Inadequate steam quality can compromise heat treatment, or sabotage heat treatment equipment.
- **Cooling tanks:** Poor water filtration can seed microbial growth.
- **Fermentation:** Vent filters help protect cultures from airborne contaminants.
- **Packaging:** Compressed air and sterile air help to safeguard the product's final stage before it reaches the consumer.

Why it's important:

CCPs are where auditors focus, and where even a minor filtration failure can result in a batch loss, recall, or regulatory breach. Treating them as non-negotiable safeguards helps support protection of both consumers and the plant's reputation.

We suggest considering these daily, weekly and monthly checks as part of our best practice guidance. For more detailed information and instructions, please refer to your filter manuals.

DAILY CHECKS

- Drain the condensate traps and verify trap operation (air and steam); observe the sight glass/blowdown where fitted to confirm no live-steam loss.
- Monitor pressure drops across prefilters and final filters on air and liquid lines, and log differential pressure against the baseline.
- Check dew point on compressed air at critical points, and for liquid utilities, spot check final rinse water turbidity (NTU) and, where relevant, free chlorine residual.

WEEKLY CHECKS

- Inspect pre-filters and coalescers for signs of loading or oil carryover (air), and check drain function and bowl condition.
- Check steam strainers/separators and drip legs for scale or particulate; confirm trap cycling; review condensate appearance.
- Sample utility/process water and test for microbiological counts (e.g. ATP/CFU) and taste/odour; confirm softener brine level, and review RO skid differential pressure trends.

MONTHLY CHECKS

- Schedule integrity tests for sterile air filters and review maintenance logs for trends.
- Verify culinary steam quality: inspect traps and separators, check for carryover, and review simple condensate indicators (e.g. conductivity/TDS, visible oil).
- Audit CIP final-rinse performance (e.g. conductivity and/or pH to setpoints), review and confirm liquid filter change-out based on differential pressure (DP), and compare prefilter replacement intervals with filter loading history to determine if any change in interval is needed.

YEARLY CHECKS

- Donaldson provides customers with yearly (or more frequent if required by the facility) on-site ISO 8573-1:2010 air quality tests. These tests measure the actual compressed air quality at points of use, verifying if actual air quality aligns with the requirements of the application.
- Donaldson on-site technical services and in-house lab facilities support customer specific quality and maintenance needs.

Why it's important:

Neglecting maintenance checks may allow gradual problems to go unnoticed, from moisture creeping into compressed air to microbial buildup in filter housings. These issues, especially when unchecked, can lead to sudden disruptions in production when it matters most.



CASE STUDY & CRITICAL CONTROL POINT RISKS

Even well-designed filtration systems can fail if they are installed incorrectly, maintained poorly, or left unmonitored. In dairy production, these failures are often discovered at the most critical points, when the product is already exposed. Looking at typical dairy processes, every product line contains control points where filtration and compressed air treatment can influence whether product integrity is protected or compromised.

ICE CREAM – AIR INCORPORATION DURING FREEZING

In ice cream production, compressed air is introduced to create texture and volume. If this air is not sterile, microorganisms such as molds or yeasts can enter the mix. In one case, improper installation of a final sterile air filter led to airborne spores contaminating batches, causing early spoilage in frozen storage.

Lesson: Every air contact in freezing should be treated as product contact. Sterile air filters should be integrity-tested, and pressure drop should be monitored periodically.

Further Reading:

- [Explore Donaldson complete solutions for reliable air quality](#)
- [See how Donaldson services help to maintain Compressed Air Quality & Integrity](#)



FLUID MILK – BOTTLE BLOWING AND FILLING

Fresh milk has a short shelf life, which means any added contamination quickly shows. A plant experienced recurring shelf-life complaints that were traced to condensation in the bottle-blowing step. The root cause was a dryer set outside its dew point specification, allowing moisture to condense in compressed air lines feeding sterile air into bottles.

Lesson: Dew point monitoring is critical alongside particle and oil control. Even slight changes in humidity can accelerate microbial growth and reduce shelf life. Compressed air-drying equipment should be correctly sized for the maximum air flow, pressure, and seasonal temperature fluctuations.

Further Reading:

- [Find the right dryer for your application](#)



MILK POWDER – SPRAY DRYING AND PACKAGING

Spray dryers rely on large volumes of sterile air to carry powder through the drying chamber. In one incident, a bypassed vent filter led to powder being exposed to unfiltered plant air, resulting in contamination in the packaging and a recall of multiple lots.

Lesson: Vent filters and sterile air at spray dryers are critical control points (CCPs). Any installation shortcut or missing element can expose the finished product.



Further Reading:

- [Learn how LifeTec™ P-SRF V Sterile Vent Filter prevents contamination](#)

YOGURT – FERMENTATION VESSELS

Fermentation relies on a controlled culture. Inadequate vent filtration on a yogurt fermentation tank once allowed airborne yeast into the vessel, which outcompeted the starter culture and spoiled the batch. The contamination was only discovered after production, causing a complete batch loss.

Lesson: Vent filters should be treated as critical equipment, not optional add-ons. Integrity testing and regular replacement are recommended.

Further Reading:

- [Learn how LifeTec™ P-SRF V Sterile Vent Filter prevents contamination](#)



BUTTER – BRINE AND INGREDIENT WATER

Butter quality is often influenced by the brine solution used for salting. In one case, particulates passed through an undersized water filter, settling in the brine and causing oxidation issues that contributed to off-flavors.

Lesson: Even non-microbial risks, such as particulates and oxidation, can compromise product quality. Proper water filtration helps protect both taste and shelf life.

Further Reading:

- [Learn about Donaldson's full liquid filter line](#)



CHEESE – MOULDING AND PACKAGING

Cheese processing involves multiple compressed air points, particularly in moulding and packaging. A plant once discovered oil residue in packaging film caused by compressor carryover and insufficient coalescing filtration. This triggered an audit non-conformance and immediate corrective action.

Lesson: Oil aerosols in compressed air can be a hidden but serious hazard. High-efficiency coalescers and regular monitoring are recommended to help protect both product integrity and compliance.

Further Reading:

- [Learn how Donaldson Solutions prevents oil contamination](#)



WHAT THESE EXAMPLES SHOW

Across every dairy product type, filtration and compressed air treatment intersect directly with product quality, shelf life, and compliance. The risks may vary from mould in ice cream, condensation in fluid milk, to oxidation in butter, but the pattern is the same. Where utilities touch the process, failure to control them can result in a critical control breach. By analysing CCPs through this lens, handling, maintenance, and monitoring should be considered essential practices to support consistent, compliant dairy production.

[Learn how Donaldson supports your process and product integrity from source to application](#)

WHY DONALDSON FOR DAIRY FILTRATION?

Dairy production demands consistency, quality, and efficiency at every stage, from raw milk reception to final packaging. Donaldson is a trusted partner offering solutions designed to support process and product integrity and address the unique challenges of dairy processes.

We offer:

- **Specialist filtration support across liquids, steam, and air:** Our specialists can help you to evaluate the filtration needs for different dairy applications.
- **Technology leadership with dairy in focus:** Continuous R&D investment and innovation centers dedicated to advancing filtration for Food & Beverage applications.
- **High-quality standards for food safety:** Products manufactured under strict quality standards, assembled in cleanrooms, ISO-certified, and traceable, supporting compliance with food contact regulations such as CFR Title 21 and EC/1935/2004 as required.
- **Global reach with local expertise:** With operations in more than 140 locations, we provide fast delivery and hands-on support, helping dairy plants reduce downtime and maintain audit readiness.
- **Reliable supply chain:** Key filters and housings are stocked and distributed through our robust network, helping you to have the right part when you need it.
- **Comprehensive service and support:** From on-site technical specialists and laboratory testing to integrity testing and maintenance guidance, we aim to help dairies optimize performance and extend filter life.





ADDITIONAL RESOURCES

For a complete overview of filtration solutions for dairy applications, including product portfolio, connection types, typical installations (e.g. culinary steam, compressed air, process water), and recommended replacement intervals to support product quality and reliable operations, please access:

- **[Our Process Filtration Catalogue: Product Catalog](#)**
- **[Compressed Air & Process Filtration | Donaldson Compressed Air & Process](#)**



Q&A

WHAT ARE THE LIMITATIONS OF POLYPROPYLENE-BASED FILTERS VS. STAINLESS STEEL CARTRIDGES?

Typical limitations for polypropylene-based cartridges are:

- Operation temperature limit: Max 82°C.
- Chemical concentrations.
- Potential contact with ozone (Oxidation Risk).
- High viscosities (e.g. syrup filtration).

Usually when one of those limitations is reached, a stainless-steel cartridge will be the better option for this application.

HOW OFTEN SHOULD I CHANGE MY FILTERS?

There are multiple reasons a liquid filter may need to be changed. This can vary from high differential pressures to loss of integrity. In general, a filter should be changed when:

- It reaches high differential pressures and cannot be regenerated.
- The regeneration is not effective anymore.
- It has lost integrity and therefore process integrity is compromised.
- It is being used beyond the recommended lifetime and the risk of material fatigue is too high.
- Process failures (e.g. wrong valve opened).

Please refer to the chapter **Filter Exchange Intervals.**

HOW OFTEN SHOULD I STERILIZE MY FILTERS?

The sterilization of filters should be integrated with a reasonable balance between process integrity and continuous production best practices. Typical schedules for sterilization may include the end of a production week, the start of a production week, or before batch production.

It is recommended to perform a process integrity risk analysis to determine the correct sterilization interval for an individual process. In general, membrane filters should at least be sterilized once per week.

IS BACKFLUSHING OF FILTERS POSSIBLE?

The following Donaldson filter types can be backflushed to regenerate them from particle contaminations:

- Polypropylene-based depth filters.
- Stainless steel filters.

The following filters cannot be backflushed:

- Membrane filters.

Backflushing may help lower differential pressure and remove insoluble contamination like sand from prefilter steps. For an efficient backflush, approximately 1.5 times the product flow is recommended. Pulsating pressures can also support particle removal from deeper layers of depth filters.

HOW DO I COOL FILTER ELEMENTS AFTER A STERILIZATION WITH STEAM?

The heating and cooling phases during an SIP-cycle can be critical and carry a higher risk of damaging a filter. A softer cooling phase helps reduce the risk of damaging a membrane through thermal stress.

The cooling phase can be softened by:

- Passive cooling period (risk of vacuum, can be balanced with opening upstream side to atmosphere, therefore not preferred process for aseptic installations).
- Active cooling with sterile compressed air or cold water (to avoid temperature shock, low flow with the use of a regulating valve is recommended).

HOW OFTEN SHOULD I INTEGRITY TEST MY FILTERS?

The integrity test of filters should be integrated with a reasonable balance between process integrity and continuous production best practices. Typical schedules for integrity tests may include pre or post-sterilization or timed intervals (e.g. once per week).

It is recommended to perform a process integrity risk analysis to determine the correct integrity test interval for an individual process. In general, membrane filters should at least be integrity tested once per week or with each sterilization.

WHY DOES MY INTEGRITY TEST KEEP FAILING?

There are several reasons an integrity test can fail. Potential causes include:

- Leakages in test housings, O-Rings, etc.
- Wrong test parameters.
- Insufficient wetting.
- Broken membranes.

Donaldson can provide support with integrity test troubleshooting on-site and offers lab integrity tests to help confirm certain failures, including failure analysis. Donaldson can provide support with integrity test troubleshooting on-site. Ask us about our filtration services in your area.

WHY ARE MY FILTERS BLOCKING SO FAST?

When filters are blocking 'too fast', initially the filter life expectation needs to be checked. A filter blocking indicates it is performing its intended purpose—removing contamination from the process.

Donaldson can provide guidance on best practice filter lifetime expectations. When expected lifetimes are not met (e.g. an existing lifetime benchmark is not reached) possible reasons include:

- Fluctuations in particle count were not taken into consideration for installation design.
- Sizing of the installation is too small (contaminations per area are too high).
- Amount of filtration steps is too low (contaminations per area are too high).
- Wrong prefilter choice in single prefilter step (contaminations will be handled by one step only).
- Wrong prefilter-choice in multiple prefilter steps (contaminations are not correctly distributed amongst filter steps).
- Insufficient protection of membranes from particles (e.g. no use of an absolute prefilter).



WHAT ARE THE REQUIREMENTS FOR AIR AND STEAM QUALITY FOR INTEGRITY TESTS AND STERILIZATION?

When air is used for integrity testing or for post-sterilization cooling, it is recommended to use pretreated, sterile air.

Therefore, the following requirements should be met (per ISO 8573-1:2010):

- **Dew Point:** $\leq -40^{\circ}\text{C}$ (Class 2 or better, ISO 8573-1:2010).
- **Particles $0.1\text{ }\mu\text{m} < d < 0.5\text{ }\mu\text{m}$:** ≤ 20.000 particles per m^3 (Class 1 or better, ISO 8573-1:2010).
- **Particles $0.5\text{ }\mu\text{m} < d < 1.0\text{ }\mu\text{m}$:** ≤ 400 particles per m^3 (Class 1 or better, ISO 8573-1:2010).
- **Particles $1.0\text{ }\mu\text{m} < d < 5.0\text{ }\mu\text{m}$:** ≤ 10 particles per m^3 (Class 1 or better, ISO 8573-1:2010).
- **Oil concentration:** $\leq 0.01\text{ mg/m}^3$ (Class 1 or better, ISO 8573-1:2010).
- This pretreatment leads to the compressed air quality after ISO 8573-1:2010 [1:2:1].

In addition to this air quality, a sterile air filter needs to be installed at point of use. Typical filters here are the Donaldson LifeTec™ P-SRF-C 0.2MIC.

For steam, it is recommended to use culinary steam after 3-A Standard 609-03, but at least particle filtered steam. Culinary steam after 3-A Standard 609-03 needs to be filtered by a filter with 95% retention of particles $>2\text{ }\mu\text{m}$. Typical filters here are the Donaldson LifeTec™ GSL N 5MIC or Donaldson GS VE 1MIC.

CAN I COMBINE POLYPROPYLENE-BASED FILTER CARTRIDGES WITH OZONE?

Contacting polypropylene-based filters with ozone is not recommended, as it can lead to rapid oxidation of the material. When possible, ozone treatment should occur downstream of polypropylene-based filters. If unavoidable, stainless-steel filters can be used as an alternative.

WHAT IS THE DONALDSON REPLACEMENT PART NUMBER FOR MY EXISTING FILTERS?

Please contact Donaldson Filtration for a quick cross-reference of existing filters or use the Donaldson online shop at shop.donaldson.com.



LET'S TALK DAIRY FILTRATION

Donaldson supports dairy producers with filtration solutions tailored to the unique demands of the industry. Whether you're exploring ways to strengthen your process, meet regulatory expectations, or reduce downtime, our team is ready to collaborate.

Get in touch to request a dairy filtration assessment or to learn more about how our technologies and services can support your operations.

CONTACT US



Stay informed about filtration innovations, application insights and food and beverage industry expertise by following the Donaldson Food & Beverage LinkedIn Showcase Page.



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