Application Note

Technical Application Publication

Microfiltration in the production of carbonated soft drinks

Summary

Microfiltration is the removal of suspended particles and bacteria in liquids in the approximate range of 0.1 – 100 microns and in gas down to 0.01 micron. The technique may be applied for the purposes of clarifying, pre-stabilizing or sterilizing products, ingredients and ancillary fluids for both quality and food safety purposes. This application note looks at some microfiltration techniques that can be adopted at various points of manufacture within the bottling plant and provides selection criteria for different filter formats and their interrelation with other purification techniques.

Parker can work with you to provide optimized cartridge filtration solutions to a range of stabilization requirements to benefit carbonated soft drink production.

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Key Filtration Requirements:

- **Retention** – to what efficiency will it remove different sized particles?
- **Capacity** – how many particles will it remove before it blocks?
- **Flow characteristics** – what size of filter is required to achieve the desired flow within acceptable pressure limits?
- **Stability** – will the filter resist mechanical and physical damage during its use?
- **Cost** – are the capital and running costs economically viable?

One final characteristic that is often omitted is the filter's ability to remove species other than those suspended in the fluid. In beverages, incorrect selection of filter media can affect product consistency through change of colour or flavour, or can result in shortened lifetime of the filter due to the internal surfaces of the porous medium becoming clogged.

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Introduction

Standards within the production, packaging and distribution of non-alcoholic beverages are continually rising. Emphasis on improving process uniformity leads to competitive advantage through enhanced product quality and a long-term reduction in production costs. This is especially true for those producers wishing to expand across international boundaries where increased shelf-life of exported product is a probable requirement, consistency of product produced under licence is a goal and where food safety standards may differ from those of the home market.

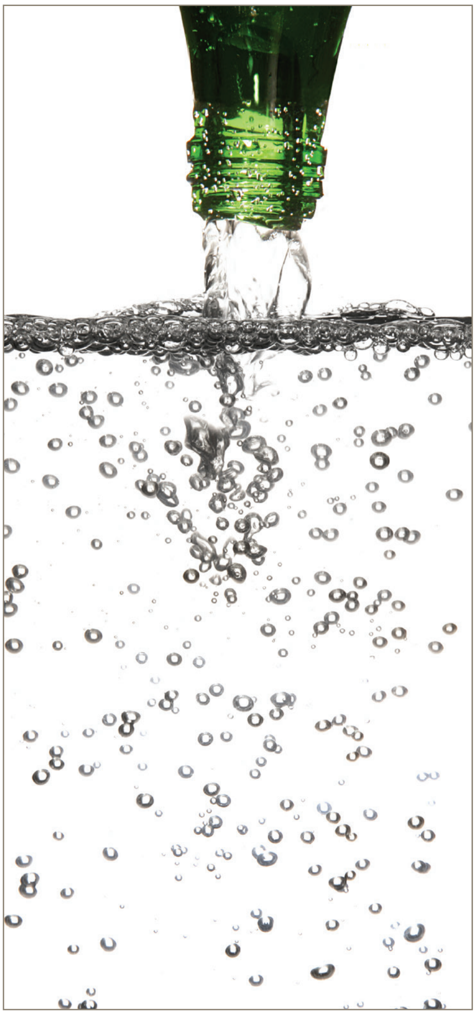
The degree of stability that the product requires is dependant upon its final destination and on the expectations of the consumer that it is aimed at. In achieving these aims, the challenges to producers include the management of the production processes, their associated costs and their impact upon the environment. Therefore, the selection of the technique to achieve its desired purpose must be the most cost effective and efficient method to hand.

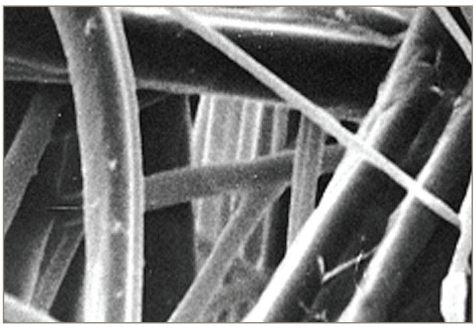
Stabilization

Preparation of beverages for packaging should ensure the absence of pathogenic species as well as preserving or enhancing the products' sensory qualities for subsequent storage and distribution.
The ability of beverages to withstand deleterious change can be categorized into physical, chemical and biological stability. Physical effects are those that result in formation of haze or sedimentation of precipitate. Chemical instability manifests itself in undesirable flavour change due to molecular interactions. Biological stability is impaired by the action of organisms that have the potential to produce flavour defects, odours or precipitates during the processing and storage of product.
However, presence of any microorganisms, whether or not they cause change in the products' characteristics or are harmful, is still undesirable, as their presence may be an indication of a degree of non-control of the process.

Stability can be influenced through every stage of the production process, but physical and chemical changes are more a result of ingredients compared to biological issues. There are a number of methods that may be used throughout the production process to arrive at a comfortable degree of security in terms of shelf-life of packaged product. Typically, physical and chemical stability are addressed by concentrating on the make-up of the product and the precursors that may influence its properties. This is achieved by either forcing the change to take place sooner than it would otherwise occur, or by removing one or more of the components responsible for the instability. Oxygen can play a large part, magnifying the likelihood of instability and leading to staling flavours. Oxygen presence also increases the possibility of microbiological contamination, which is managed through hygiene procedures (prevention of infection) and removal of microorganisms before they proliferate into numbers that can cause problems.

It is clear that stabilization is not a discrete operation within the overall production process. It is a gradual progression of procedures aimed at optimising the removal of undesirable content at each stage of production. The stabilization process begins with the selection of raw materials and water source. Ground water, highland spring water and domestic supplies will probably require very different treatment prior to blending or direct packaging. In functional and flavour ingredients, a small change in pH in either direction can lead to a significant change in solubility and consequent potential to produce haze. Thought must also be given to ancillary liquids and gases involved during the process. Rinse water, carbonation and nitrogen blanketing must not be the pathway for the ingress of spoilage organisms. For these reasons, more than one stabilization technique may need to be applied. This means that techniques that may be competitive in some applications may be complementary to one another in others and a multi-barrier approach makes complete sense.





General applications of microfiltration

Microfiltration applications, and in particular those associated with cartridge filters, can be categorized into three general areas – clarification, pre-stabilization and sterilization.

Clarification can be described almost exclusively as the removal of particulate, primarily to improve the visual quality if the product itself is being filtered, but also to provide a first stage of microfiltration to protect finer downstream filters in liquid and gas streams. The particulate encountered may be naturally present in incoming water and ingredients, however, it is often debris from upstream processes - scale and deposits from lines and fittings, precipitates 'thrown' during storage of the product or its ingredients, partially dissolved additives or specific powders and granules that have been used as pre-treatment filters or adsorbents.

Pre-stabilization is the process of microbiological control for short periods. Products or ingredients that are to be transported or left in finished storage for days rather than hours prior to packaging can be prone to physical and microbiological change. Pre-stabilization should be capable of complete removal of algae, moulds and yeasts and reduction of numbers of spores, cysts and bacteria. For short storage periods, this level of filtration should be sufficient to prevent microbiological deterioration.

Sterilization is defined as the removal or killing of all living organisms. A definition exists in the pharmaceutical industry that defines a 0.2 micron sterilizing filter. No such definitions exist within the beverage industry. Instead, the performance of the filter has to be defined by the required quality of the product. This may be recognized by food safety regulations such as drinking water standards, or by the producers' internal quality specifications.

Specific applications of microfiltration

Water

The most obvious applications are for the liquids which make up the product. Of these, in the bottling plant, water receives the most treatment. The specification of the water at each point of use (e.g. blending, bottle rinse, general plant) dictates the final grade of filtration that it must receive. Its source (e.g. ground, surface, municipal) dictates the pre-treatment required. Due to water's excellent solvent properties, its dissolved mineral content varies considerably around the world as does the risk of it containing other impurities. Municipal treatments such as the addition of chlorine add to the range of content so water almost invariably requires multi-barrier treatment. This may include sand, carbon, flocculation, ion exchange resin, reverse osmosis and a host of other treatments. Microfiltration is always expected to compliment and enhance these other techniques. Examples include:

- General clarification of incoming water to protect downstream storage and processes.
- Protection of reverse osmosis and nanofiltration membranes to prevent premature blockage.
- Clarification prior to ultraviolet irradiation to enhance its efficiency.
- Guard filtration to protect against glass and particulate entering the blender.
- Validated removal of microorganisms such as yeast, pathogens and spores as dictated by food safety or internal quality standards.

The filters may be required to operate in conjunction with chemical additions either dosed continuously into the water or used regularly for the purpose of sanitizing the process lines and equipment.

Liquid ingredients

By comparison, other liquids are usually microbiologically stabilized either naturally (e.g. 60 brix sugar solution does not support microbial growth) or by use of preservatives (e.g. in flavourings). Microfiltration therefore, is usually employed only for clarification in these cases. Care must be taken that dormant spores are not present and that the liquids are protected from contamination from the environment at later processing stages.

Gases

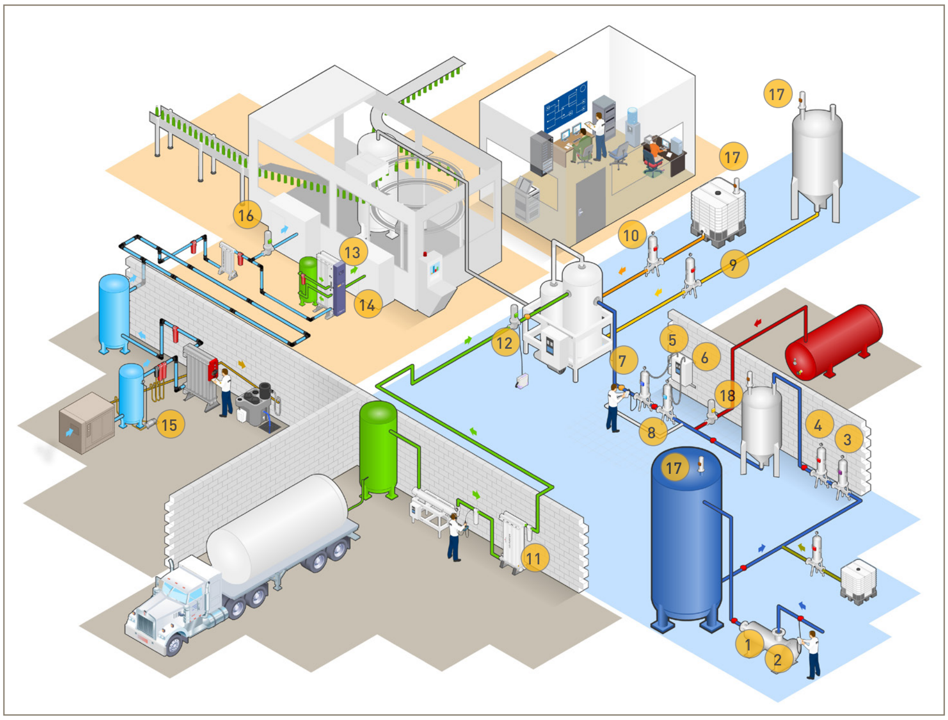
There is a need to ensure that re-contamination does not occur from contact with process and ingredient gases. This may include the polishing of carbon dioxide to ensure that gaseous impurities and contaminants fall within specifications for the beverage gas. Compressed air treatment may also be required to ensure compliance with ISO-regulated moisture, oil and particle levels. All gases that come into contact with product or ingredients should also be sterilized either in-line or through the use of vent filters on tanks.

Steam

There is a general need to ensure that steam used on product contact surfaces complies with culinary standards. From a filtration point of view this requires particulate removal, but from an overall approach also requires that the steam is produced in a safe manner using additives that are suitable for the steam's intended use.

Filter sizing and system design

The table below provides some examples of filter products from the Parker range. The final selection should be based on the balance of performance against cost, taking into account all those defining parameters that were discussed at the beginning of the article. With an emphasis on reducing water and carbon footprints, some accepted practices for filter design are now being questioned. It is becoming more essential that engineering, quality, production and environmental functions should work together with the filter supplier to review current processes and standard operating procedures and ensure that new systems are designed to find the right balance of cost and function.



Reference	Application	Typical filter type	Retention Typical	Retention Range for filter type
1	Incoming water clarification	PEPLYNMAX	10 - 40 μm	1 - 100 μm
2	Incoming water cyst removal	CRYPTOCLEAR	0.6 - 1 μm	0.6 - 1 μm
3	Pre-RO & NF membrane water clarification	PEPLYN	0.2 - 5 μm	0.6 - 100 μm
4	Treated water clarification	PEPLYN	1 - 20 μm	0.6 - 100 μm
5	Pre-UV water clarification	PEPLYN	5 μm	0.6 - 100 μm
6	Blending and rinse water guard	PEPLYN	1 μm	0.6 - 100 μm
7	Blending and rinse water pre-stabilization	PREPOR	0.5 - 1.5 μm	1 - 100 μm
8	Blending and rinse water sterilization	BEVPOR	0.2 μm	0.2 - 1.2 μm
9	Sugar clarification	PEPLYN	1 - 40 μm	1 - 100 μm
10	Syrup clarification	PEPLYN	1 - 40 μm	1 - 100 μm
11	Carbon dioxide polishing	PCO2	Adsorptive	Adsorptive
12	Carbon dioxide sterilization	TETPOR	0.01 μm	0.01 μm (gas) 0.2 μm (liquid)
13	Nitrogen generation	MAXIGAS	Adsorptive	Adsorptive
14	Nitrogen sterilization	TETPOR	1 - 100 μm	0.01 μm (gas) 0.2 μm (liquid)
15	Compressed air treatment	OIL-X Evolution	0.1 μm	0.1 μm
16	Compressed air sterilization	TETPOR	0.01 μm	0.01 μm (gas) 0.2 μm (liquid)
17	Tank vent sterilization	TETPOR	0.01 μm	0.01 μm (gas) 0.2 μm (liquid)
18	Steam clarification	Steam Filters	1 - 5 μm	1 - 20 μm

Conclusion

Production standards for carbonated soft drinks are increasing as the competitive advantages of consistent and extended stability of finished product are being realized. The processes involved in achieving stability at each stage of production are therefore required to deliver a consistently reliable level of performance. Correctly employed cartridge filtration techniques, sometimes used in conjuction with other techniques, will provide a cost-effective and controlled way of achieving the required level of stabilization at each stage of the process.

Parker utilize an application led philosophy to produce cartridge filtration systems which exceed the demands of the drinks industry. Our product portfolio is focussed on specific stabilization applications and coupled with our industry expertise, offers a wide degree of choice for optimization to suit any process.

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