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Application Note

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Colloidal Filtration of Natural Mineral Waters

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Abstract

Colloids issues in natural mineral waters can most significantly affect filtration costs. To reduce these costs it is very important to use filtration systems with filter media featuring high throughput and very high regeneration performance.

For this application, Sartorius developed the new polypropylene filter media Sartopure[®] PP3, that combine the highest total throughput with the most effective particle retention.

The Jumbo Star with polypropylene filter media, as a completely regenerable system, can guarantee a long service life of the filter with a compact footprint. Therefore, the Jumbo Star system could be a new alternative to sand filters and crossflow units.

Introduction

The purpose of this case study is to show how to increase the filtration life of our polypropylene filter media using chemical regeneration in backflush procedure.

"Natural mineral water" is the definition for waters that, originating in an underground water table or subsiding sedimentary basin, derive from one or more natural spring, are microbiologically pure at source, have a constant composition and possibly health benefits.

Rock-water interactions determine the chemical-physical characteristics of the waters, given by the balance of the different rock species in contact. For this reason, one of their peculiarities is the richness in minerals and they are generally classified according to the predominant characteristic constituent (Table 1).

Bicarbonate	Bicarbonate content >600 mg/l
Sulphate	Sulphates content >200 mg/l
Chloride	Chloride content >200 mg/l
Calcic	Calcium content >150 mg/l
Magnesiac	Magnesium content >50 mg/l
Fluorurate	Fluoride content >1 mg/l
Ferrous	Bivalent iron content >1 mg/l
Acidulous	Free CO ₂ content >250 mg/l
Sodium-rich	Sodium content >200 mg/l
Low-sodium	Sodium content <20 mg/l

Table 1: Mineral water classification

One of the major problems of this type of water is the presence of inorganic colloids that can cause particles precipitation in the bottle.

Filtration with polymeric filters is one of the separation technologies used to retain these substances. Sartorius has developed a new polypropylene filter material (Sartopure® PP3) that enables a higher particle retention and yield compared to traditional polypropylene filters (Fig. 1). Moreover, this new filter medium retains particles with the highest efficiency, even under fluctuating process conditions. This ensures safe and reliable operation and a significantly extended lifetime of all downstream equipment. Total Throughput Comparison



Fig. 1: Sartopure® PP3 performance - Total throughput per 10" cartridge (kg)

Sartopure[®] PP3 filter, with its combination of three overlapping layers, allows the particle burden to be uniformly distributed within the filter structure. Retention rates are available from 0.45 to 100 μ m. Furthermore, the high chemical resistance to acid, alkaline and oxidizing solutions makes it possible to subject the filters to chemical regeneration steps in order to increase their lifetime and reduce production costs.

The Jumbo Star Sartopure[®] PP is part of Sartorius polypropylene filter product family and one of its major characteristics is the high filtration area for each module (28 m² for 40″). This can guarantee high filtration autonomy and high flow rate (20 m³/h at 40″).

Furthermore, the Jumbo Star filter is easily regenerable thanks to its special size and shape. The specific back flush procedure is one of the unique techniques to increase the regeneration efficiency.

Materials and Methods

Materials

- 1.2 μm Sartopure[®] PP3 0.05 m² MidiCaps[®]
- Peristaltic pump Watson-Marlow
- Scanning electron microscope TM4000Plus Hitachi
- Detector EDX Oxford Instruments
- Acid solution 1% Ultrasil[®] 75 Ecolab[®]

Methods

The choice of the correct chemical regeneration protocol to increase the life of the filter depends on the type of colloids the water contains. Therefore, identification of their chemical properties is of fundamental importance to lay down standard operating procedures for a prefiltration system. In this study we started to filter a natural mineral water with a 1.2 µm Sartopure® PP3 0.05 m² MidiCaps®. The filter was blocked after 11 m³ of filtered water. Afterwards we used SEM (Scanning Electron Microscopy) together with EDX (Energy Dispersive X-ray Spectroscopy) to understand the size, shape and chemical nature of the substances that blocked the filter. Fig.2 illustrates the results.

The colloids were inorganic and the main chemical nature was Silicate-Aluminate. Moreover, the particles size was between 10 and 2 $\mu m.$

Therefore, we decided to implement the chemical regeneration with acid solution 1% Ultrasil[®] 75 and we performed it in backflush to increase the regeneration efficiency.

We started a new filtration trial with a new 1.2 µm Sartopure® PP3 0.05 m² MidiCaps® and we performed the following regeneration procedure: daily backflush with filtered water and twice a week with acid solution for 5 minutes at a flow rate of 1 l/min.

At the end of the trial, the filter was blocked after 30 m³ of filtered water.



Element Symbol	Element Name	Weight Conc.
0	Oxygen	41.46
Si	Silicon	24.48
Br	Bromine	11.07
Al	Aluminium	9.02
Fe	Iron	4.91
Са	Calcium	4.18
K	Potassium	1.75
F	Fluorine	1.18
Mg	Magnesium	1.07
Ti	Titanium	0.88

Fig. 2: SEM image of the blocked filter with EDX analysis

Results

Fig. 3 shows the results of a filtration study comparing the filtration capacity of a 1.2 μ m Sartopure[®] PP3 filter with the capacity of one subjected to regeneration steps.

The filtration capacity of the regenerated filter has increased three times compared to the filter that has not undergone treatments. Therefore, regenerations with acid detergents as a preventive measure could hinder the formation of inorganic film on the filters surface and increase their life, with a significant cost reduction.



Fig. 3: Filtration capacity of the filter with and without regeneration step

With a view to maximizing regeneration effectiveness, Jumbo Star Sartopure® PP proves to be the best filter with polypropylene filtration material on the market. Sartorius has patented a special pleating technology that results in 28 m² filtration area (40″ height) with a single adapter DN100 (Fig. 4). The particular configuration and robustness make it possible to backwash the filter with high regenerative efficiency.







Male	e ada	apter
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Diameter:	275 mm
Height 10″:	280 mm
Height 20″:	518 mm
Height 30″:	796 mm
Height 40″:	1055 mm



Fig. 4: Jumbo Star configuration

The Jumbo Star equipment can replace sand filters for such application, with many advantages such as:

- Lower Capex
- Smaller footprint for the same flow rate
- Flexibility in the choice of retention rate: from 0,45 to 20 μm
- No risk of particles release out of the filter media with reliable filtration over time
- Little human intervention necessary to change filters, regeneration by backwashing
- Back wash regularly according to the quantity of particles in water with low water consumption
- Hygienic design with sterilization with hot water, steam or chemicals in 30 min. The installation can be sterilized every week very rapidly

Conclusions

Colloids issues in natural mineral waters can most significantly affect filtration costs. To reduce these costs it is very important to use filtration systems offering a very high regeneration performance while developing an ad hoc cleaning protocol based on the type of colloids present in the water. The Jumbo Star Sartopure® PP can be a valid solution for processes where filter regeneration is fundamental to reduce costs.

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