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*Ben Gido holds a M.Sc. in Environmental Engineering from the Technion, Israel. As the manager of the R&D Department at Filtersafe, he has vast experience in the research and piloting of new products, technologies, and applications, with special attention to the environmental advantages of automatic screen filtration.*

*Alexandra Agranovsky holds a B.Sc. in Biotechnology and Environment Engineering. As an application engineer at Filtersafe she uses her previous experience in desalination system design and operation to optimally apply Filtersafe's products in desalination applications. Alexandra also assists in planning pilots and establishing the company's products in the desalination market.*

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# AUTOMATIC SCREEN FILTRATION for

## protecting RO membranes with minimized environmental footprint

*Ben Gido, Filtersafe, Ha Ella St., Tefen Industrial Park, P.O.Box 23, 2495900, Israel, ben@filtersafe.net, Tel: +972 4 9873620 | Alexandra Agranovsky, Alexandra@filtersafe.net*

## INTRODUCTION

A unique screen flushing mechanism enables reliable continuous operation of a very fine screen (<10µm) filter, introducing an interesting alternative to the conventional use of disposable cartridge filters for RO pre-treatment. Cartridge filters, while common in use, are made of nondegradable materials and must be disposed of at least every three months, increasing operating costs. During this period, significant energy is invested in overcoming the internal head loss in these cartridges, and the manual replacing process involves unit downtime and additional human resource costs. Another significant OPEX component is the price of the disposable cartridges themselves. The environmental footprint of this practice includes the disposal of the used nondegradable cartridges and environmental impact.

Pilot results from a seawater desalination plant in Israel show that an automatic self-cleaning screen alternative can achieve significant savings of operating costs of energy, manpower and consumables, without compromising on filtrate quality. Analysis and breakdown of O&M costs of cartridge filters indicate a potential OPEX saving of 80-92% by the automatic alternative. In particular, 88% of the energy invested in pumping water through cartridges can be saved, minimizing the environmental footprint of the desalination plant by hundreds of metric tons of CO2 per year. Protecting RO membranes by a fine automatic screen is an economical and environmentally friendly alternative to the current standard.

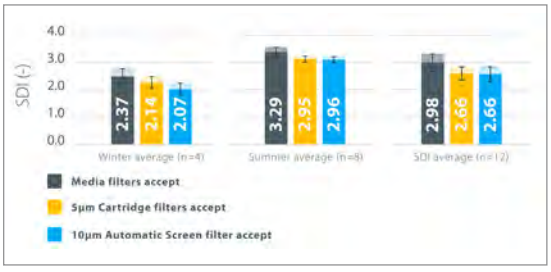


**FIGURE 1.** SDI values from VMD, winter 2018 – summer 2019. Error bars = SE.

## COMPARABLE FILTRATION ABILITIES

The automatic screens Filtersafe is offering have a filtration grade of 10-20µm. The data collected by the automatic screen pilot project at the Via Marris Desalination Plant (VMD) indicates comparable silt density index (SDI) reduction abilities to the currently used 5-10µm cartridges, despite the fact that the cartridges are rated for finer filtration grade. **Figure 1** demonstrates the seasonal variations and comparable SDI reduction in 2018-19.

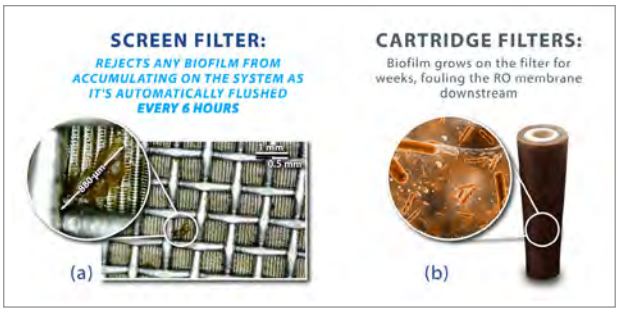


**FIGURE 2.** RO protection by the two alternatives. (a) Close-up on un-flushed screen, covered by solids removed from the RO feed. A large biofilm particle is magnified. (b) Illustration, a used cartridge.

## THE AUTOMATIC ALTERNATIVE FOR RO PROTECTION

As demonstrated in Figure 1, it is not the cartridges that are responsible for the actual pre-treatment of RO feed at VMD; it is multi-media filters (MMF) which are responsible for most of the SDI reduction, lowering the unmeasurable SDI of raw seawater to 2-3.5 SDI. In other desalination plants, pretreatment is done via UF membranes. Cartridges, however, are being placed not for SDI reduction, but primarily to serve as a sentinel—that is, a final barrier before the membranes, protecting them from large particles which can clog the front membranes and cause mechanical damages in energy recovery devices (ERDs). The automatic screen alternative, with a fine 10µm screen, can equally serve this purpose when placed between UF/MMF and the RO membranes, preventing solids from getting downstream. Examination of large particles captured by the pilot screen revealed escaped media, paint fractions, what seemed to be chunks of mineral scaling formed upstream and detached, and biofilm chunks created upstream **(Figure 2)**.

Unlike the cartridges which accumulate solids for weeks, Filtersafe's automatic screen flushes itself clean every few hours. A differential pressure sensor senses the accumulation of solids on the screen surface, triggering the flush mechanism. An internal suction scanner with patented proximity nozzles (NozzleXTM) scans the screen surface, and within minutes the screen is cleaned, and its hydraulic properties are restored, keeping head loss at minimum. During the flushing process there is no down-time. The filter is maintaining filtrate production and uses a fraction (~5%) of the filtered water to clean itself, with no need for an external clean water tank or flush pumps.

**Figure 2** illustrates how the screen protects the membranes downstream from small and large organic particles. On the left-hand-side, a biofilm particle, almost 900µm in size, was found to be removed by the 10µm screen. The exact source of this biofilm is unknown, but it is likely it was detached from a grown biofilm on piping/equipment upstream. The non-automatic alternative (cartridges) is certainly capable of capturing similar biofilm particles. However, while the automatic screen flushes and rejects captured particles within 3-6 hours, this biofilm can stay for weeks on cartridges, continuing to grow, and eventually releasing bacteria and EPCs to the membranes downstream, contributing to their biofouling.

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## MINIMIZED ENVIRONMENTAL FOOTPRINT

The environmental footprint related to the production, transport and disposal of the cartridges is site-specific and hard to quantify. However, the energy usage profile of cartridges is quite ubiquitous. **Figure 3** illustrates the differential pressure profile of cartridges versus a screen filter. With the lack of self-flushing ability, cartridges typically develop a significant head loss before being replaced, we assume the average head loss is 7.5 PSI (0.5 bar). In contrast, the screen filter is flushing itself when reaching 2.9 PSI (0.2 bar) of differential pressure, yielding average head loss of less than 1 PSI (0.06 bar). In total, 88% of energy related costs and carbon emissions can be saved.

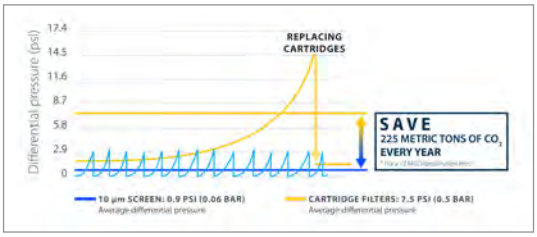


**FIGURE 3.** Head loss profiles of cartridges and automatic screen.

**TABLE 1.** Demonstrating minimized carbon footprint in real desal plants in the USA. Data include open source data for desalination production rate. Calculated values were made with typical parameters for pump efficiency, and feed-product ratios. Conversion factor by EPA website.

| PLANT | PLACE | BW/ SW | Produce MGD | MWh/y saving | Metric Ton CO2 saving annually |
|---|---|---|---|---|---|
| C. Marvin Brewer Desalter Treatment Facility | San Francisco Bay, CA | BW | 5 | 166 | **118** |
| Richard A. Reynolds Brackish Groundwater Desalination Facility | Chula Vista, CA | BW | 10 | 337 | **238** |
| Orange County GWR | Fountain Valley, CA | BW | 72 | 2558 | **1809** |
| Charles Meyer Desalination Plant refit | Santa Barbara, CA | SW | 2.3 | 123 | **87** |
| Corpus Christi SWRO | Corpus Christi, TX | SW | 9.4 | 501 | **354** |
| Claude "Bud" Lewis Carlsbad Desalination Plant | San Diego, CA | SW | 50 | 2481 | **1884** |

## SUMMARY

The conventional use of cartridges as final sentinel to protect RO membranes now has a feasible automatic alternative. The pilot results from VMD suggests that similar filtration performance can be maintained, with the additional benefits of reduced biofilm potential downstream and significant reduction in OPEX. Filtersafe is developing a marine-grade automatic 10-20µm screen filters to keep up with the environmental needs of the industry. ■