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# Sugar Syrup Filtration With the Jumbo Star System: Technological Innovation and Improved Sustainability for an Evolving Application

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## Abstract

Fruitful relationships between Sartorius and Sibeg – manufacturer of beverages for the Coca-Cola brand – have been ongoing for more than twenty years, with the goal of optimizing technological solutions for Sibeg filtration processes, from service fluids (water, air, gas, steam) to some components of Coca-Cola soft drinks, all the way to microbiological testing for QC | QA.

In particular, Sibeg production process involves the annual transformation of 10,000 tonnes of sugar – a very important ingredient whose quality is influenced by several factors, such as country of origin, manufacturing technology and transportation – into sugar syrup at 60 °Brix at 55 °C, to be filtered at 20 µm to ensure the particulate quality standards required.

Aim of this project was to improve and automate the sugar syrup filtration process – in relation to the use of traditional 20 µm polypropylene cartridges – in order to reduce water and energy consumption for washing cycles, optimize manpower for the production process, and minimize the use of consumables, thus reducing operating costs as well as the environmental footprint.

Therefore, Sartorius introduced the MF Semi-automated 2PD Jumbo Duo system, that has allowed to achieve the set objectives.

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# Introduction

To better meet the production process demands, polypropylene (PP) was the filter material of choice, on account of its ideal properties:

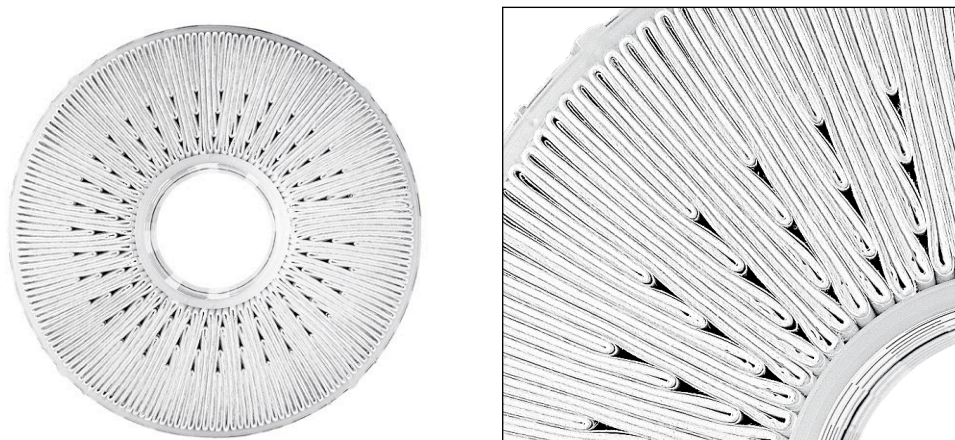
- Outstanding resistance and robustness – It tolerates high filtration temperatures (60 °C) and can withstand pulsating turbulence while maintaining a consistent quality of the filtrate, even in case of high pressure drop (1 bar)
- Wide chemical compatibility (pH 1 - 14) – It allows optimal regeneration of the filter medium with both alkaline and acid cleaning agents
- Highly eco-compatible – It is completely non-toxic, it requires low amounts of energy to manufacture, and its high energy content makes for efficient thermal recycling (upcycling)

It is therefore a material that ensures long filtration autonomy with consistent performances, and the innovative configuration of the Jumbo Star system further improves autonomous filtration and quality of the filtered product, while optimizing production costs and environmental sustainability.

Specifically, the Jumbo Star system is based on the innovative pleating technology of the filter material (Figure 1) that results in 28 m<sup>2</sup> filtration area for each 40" module. Moreover, the filter geometry and the filter adapter large diameter (DN100) make it possible to backflush the system with accurate flow rate, and consequently to optimize the regeneration efficiency.

Drawing on the experience acquired in designing and manufacturing micro-filtration systems for the past 50 years, the Jumbo Star systems have been developed with optimally automated filtration and regeneration stages.

**Figure 1:** *Pleating Technology of the Filter Cartridge Jumbo Star*



# Sibeg

Sibeg is the Sicilian authorized manufacturing, bottling, distributing and product development company for beverages under The Coca-Cola Company brand name.

Founded in 1960 by a group of Sicilian entrepreneurs from the pharmaceutical sector, the company expanded in a short time and before long its steady growth drew the attention of the major players in the beverage industry. In the mid-70s Gruppo Busi (already a bottler for Coca-Cola in the regions of Marches and Romagna) took control.

The manufacturing plant, based in Catania, features innovative technological solutions that ensure the high-quality standards required by Coca-Cola worldwide. Thanks to two blow moulding lines and seven filling lines, Sibeg produces 500,000 liters/day of beverages under The Coca-Cola Company brand. With an annual turnover in excess of 162 million Euro, Sibeg currently has 372 employees and holds 62% of the Sicilian soft drinks market. Highly sustainability-oriented – all bottles and cans are 100%-recyclable, 100%-recycled plastic is used for multi-packs, and 100%-recycled PET for different formats – thanks to the installation of a trigeneration plant in 2019, Sibeg is now in a position to self-produce 50% of the electrical energy required, as well as steam and cooling water.

Moreover, one of the first Sicilian companies to install a 189 kWp photovoltaic system – modernized and upgraded in the course of 2022 – today Sibeg can self-produce around 74% of the electric energy consumed in the production plant.

## The Production Process

Granulated sugar, from either sugar beet or sugar cane, arrives in tankers or Ultra BIG BAG in containers, to be stored in suited silos. Before unloading, it is necessary to make sure the sugar meets the requirements set out by The Coca-Cola Company. Therefore, a sample taken from the cistern is tested for:

- Humidity percentage measured with a Sartorius Moisture Analyzer MA100C
- Color index through spectrophotometric analysis on a 50 °Brix solution
- Taste and odor after acidification
- Visual check for carbon particles
- Microbiological testing for detection of yeasts, molds and CFUs (every 5 loads)

## Preparation of the Simple Syrup Through Sugar Dissolution

Sugar is one of the ingredients in the production of carbonated soft drinks and, in order for it to be used, it must be transformed into simple syrup through a dissolving process in water. The sugar is conveyed by pneumatic pipelines through a bag filter system to retain any powders that might cluster and clog the conveying line. When sugar reaches the dissolving system, it is loaded into a weigh hopper that releases it into a dissolving tank in 300 kg batches. The tank is fed with water treated at a temperature of approx. 55 °C to facilitate the sugar dissolution. A stirring recirculation system, together with an online °Bx monitoring instrument, make sure the solution is ready when the set point of 60 °Bx is reached. A pumping system pushes the solution through a stainless-steel sieve for the retention of any suspended particulate matter, then transfers it to the 20 µm filtration system before being stored in the storage tank. Dissolution is brought about in batches until the storage tank is full. A possible pasteurization process, necessary only for some product formulations, is carried out after the other components of the formula (Recipe) are added to the sugar syrup.

## Sartorius Solution With the Jumbo Star System

Before now, traditional 20 µm Sartopure® IND cartridges had efficiently been used for this application, ensuring a consistent filtrate quality (99.9% particle retention at 20 µm). However, with new needs arising for Sibeg, this solution had a lesser autonomy, due to the difficulty of backwashing and the manual labor needed for cleaning | regeneration, entailing long operating times and high operating costs.

The need for Sibeg to optimize sugar syrup filtration after the dissolver was the reason behind the proposal for a semi-automated Jumbo Star system, which can minimize human intervention and increase efficiency with an automatic intermediate washing procedure. Moreover, considering the variable filterability characteristics of the product, the available filtration area of the Jumbo Star system (28 m<sup>2</sup>)—nearly twice as large as that of a traditional cartridge system (16 m<sup>2</sup>)—is very important. Also, the configuration of the filtration area and membrane pleating is designed for maximum efficiency of backwashing with water. The filtration system consists of two parallel stages that allow continuous filtration even in the case of clogging, which was not possible with the previous system.

The MF Semi-automated 2PD Jumbo Duo sanitary system comprises two parallel Jumbo Star filtration lines with 20 µm cartridges, one in operation and the other in stand-by (Figures 2 and 3). When pressure on the working filter drops to the defined point, the system automatically switches filtration to the second line on stand-by, thus ensuring uninterrupted process. In the meantime, the system autonomously performs a pulsed backflushing with cold and hot water of the clogged line, making it available again (Figure 4). The system ensures a flow rate of 70 hL/h sugar syrup 60 °Brix at 55°C.

The quantity required by the production processes is around 300 hL/day per batch, which is the technical limit set on the program to optimize both process performance and operational uniformity of the two filtration lines with Jumbo Star cartridges.

**Figure 2:** *Duo Jumbo Star System*

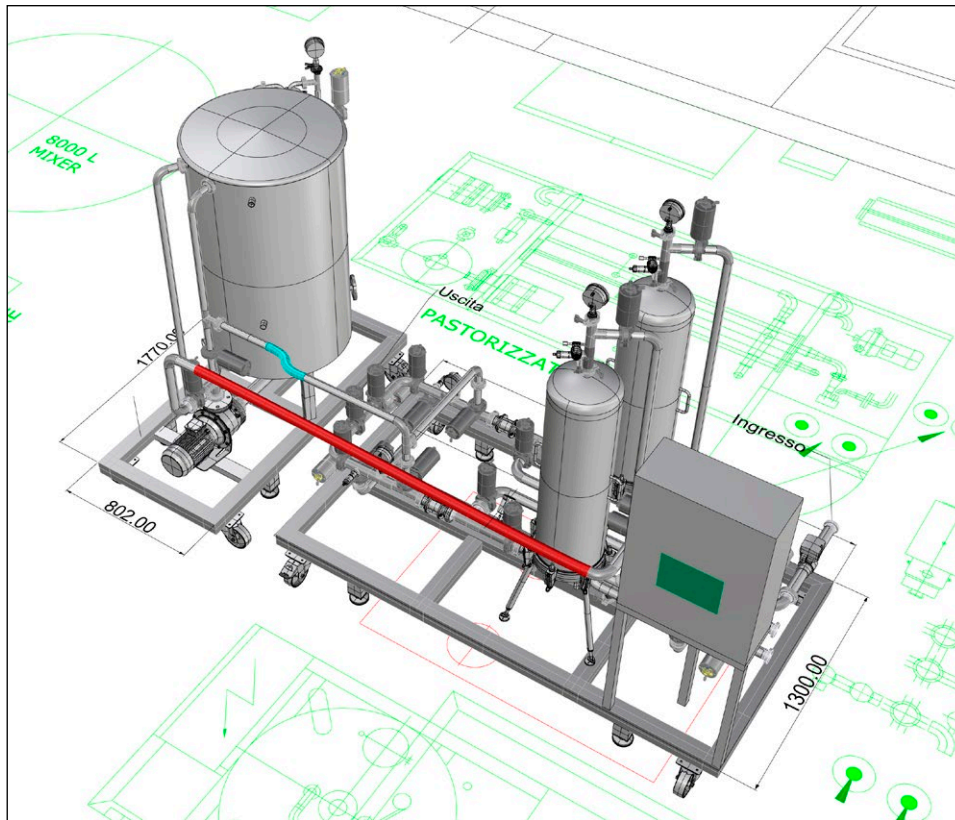


**Figure 3:** *Detail of the Duo Jumbo Star System*



The system is equipped with a SCADA (Supervisory Control and Data Acquisition) software to continuously collect and store all generated data in a data base, so that fundamental information is available for process optimization. Unlike the side-mounted operator control panels, the opposed SCADA terminal makes it possible to manage the collected information for analysis or reporting without affecting the regular operational performance of the system during production, with the user-friendliness of a PC workstation.

**Figure 4:** Duo Jumbo Star With CIP System



The operating conditions are displayed by means of synoptic graphics (HMI) that show, besides the system status and its active stages, the main performance and consumption indices (alarms for targeted searches and measurement trends), compared with the historical records of previous processes for production optimization (Figures 5 and 6). The system enables the operator to transfer information relative to the batch being processed (batch name and origin, quantity to be treated and other information essential for traceability).

The system provides for the creation of general or ad hoc reports (on production or washing consumption and duration) both automatically, based on given occurrences, or manually on the operator's request.

# Data Test

The Jumbo Star system was installed in Sibeg in November 2022 and in 11 months has filtered with the same cartridges 180,000 hL of sugar syrup (90,000 hL per cartridge), that is as many as 180,000,000 liters.

The continuous monitoring of the filtration parameters has made it possible to optimize the process with respect to chemical regeneration and backflushing procedures in production.

Figure 5: Filtration Synoptic Graphic

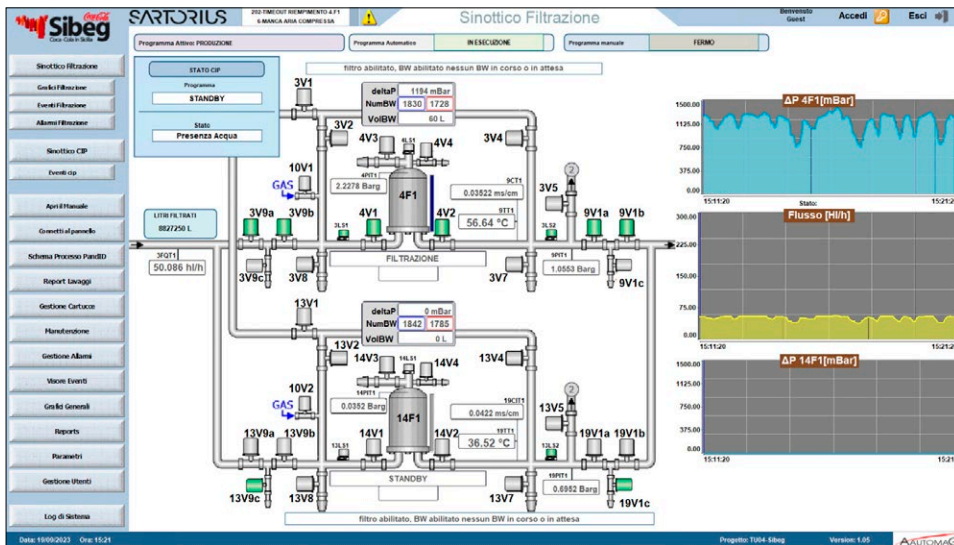
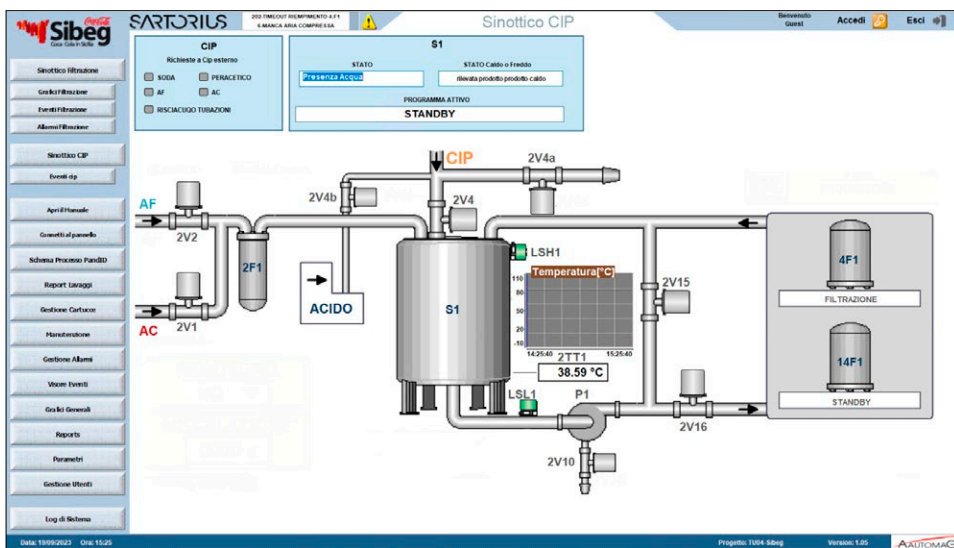


Figure 6: CIP Synoptic Graphic



# Conclusion

After being in use for nearly one year, the MF Semi-automated 2PD Jumbo Duo sanitary system with Jumbo Star technology has brought Sibeg the following advantages:

- Manpower reduction in the production process and decrease of sugar syrup filtration times, changing from a discontinuous to a continuous system that has always guaranteed average flow rates above 60 hL/h
- Workflow and CIP procedures optimization through continuous monitoring of the system, with fundamental reporting for certifiable traceability of the filtered product
- Over 60% reduction of filtration costs compared to traditional cartridge filtration, with halved footprint reducing costs and waste
- Saving of energy costs related to pulsed flushing (high backwash water flow for a short time) with an eye toward sustainability – reduction of water and energy consumption – a key objective for Sibeg
- 4.0 innovation representing the fourth industrial revolution, that is leading to an entirely automated and interconnected production process. The system, with its SCADA interface, follows a development path such as data acquisition and transformation (analytics) and human-machine interaction (HMI) via touch interfaces and augmented reality.

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