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Integration of Systems and Services at Centro Universitário Senac - Santo Amaro Campus Aimed at Rationalizing Water Use and Minimizing Effluent Generation

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Abstract. At Centro Universitário Senac - Santo Amaro Campus, several systems and services have been developed, whose integration, respecting sustainability and industrial ecology premises, promote the rationalization of water use, minimization of effluent generation, and reduction of the institution's socio-environmental impacts. With a total area of 154,000 m^2, the campus's occupancy rate can reach 9,594 people/day. By installing faucets and showers with a timer and flow reducer, aiming to reduce water consumption and waste, a 30% reduction in monthly consumption was achieved. An Sewage Treatment Plant (STP) with an anaerobic UASB type stage, associated with an aerobic microbiological treatment system, processes more than 300 m^3/day of effluent, treating practically 100% of the wastewater generated by the campus activities, which is converted

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into reuse water, subsequently used for garden irrigation, facade and floor cleaning, toilet flushing, water recharge for the air conditioning system's heat exchangers, and increasing the volume of treated water returned to the groundwater through a contaminated water treatment plant. A solar water heating system with recirculation provides hot water for kitchens and locker rooms without increasing energy and water consumption on the campus. The pool water is treated with ozone gas, more effective than chlorine and less aggressive to the environment. Education for Sustainability regularly carried out with campus users complements the integration of the systems and services offered.

Keyword:
Water Use Rationalization, Integrated Systems and Services, Energy and Water Sustainability, UASB-Type Sewage Treatment Plant

1. Introduction

Water resources are fundamental to the survival and development of society, but their availability is limited and increasingly threatened by climate change and increasing water demand (Brasil, 2023). Rationalizing water use is an important strategy to ensure the sustainability of water resources and the preservation of the environment (UN, 2015).

In this context, the use of reused water has proven to be a viable and promising alternative to meet non-potable demands, such as plant irrigation, floor washing, toilet flushing, among others (EPA, 2023). This type of water is obtained from the treatment of wastewater, which undergoes filtration, disinfection, and decontamination processes to remove impurities and contaminants. The use of reused water contributes to the preservation of water resources, as it reduces the demand for potable water, as well as generating financial savings and operational cost reduction, as the treatment and distribution of potable water for non-potable uses can be avoided (UN, 2023).

The adoption of reused water in various activities and operational processes is one of the strategies adopted by Centro Universitário Senac - Campus Santo Amaro. The efficiency in rationalizing water resources is optimized by combining this practice with other forms of water consumption reduction or better utilization. The following is a report on the results of integrating technologies, coupled with education for sustainability, aimed at preserving water resources and ensuring environmental sustainability.

2. Points of Results and Discussions

The integration of systems at the Centro Universitário Senac - Campus Santo Amaro allows for proper rationalization of water usage while minimizing effluent generation, without affecting or reducing the quality of provided services. For a better understanding, it is necessary to know a little more about the institution and the technologies used, as well as their results and gains.

2.1. The Centro Universitário Senac – Campus Santo Amaro

The Centro Universitário Senac - Campus Santo Amaro is located in the district of Santo Amaro (Jurubatuba), in the southern zone of the city of São Paulo, state of São Paulo, Brazil

(Figure 1), comprising several buildings, interspersed with green areas and extensive landscaping, occupying a total area of 154,000 m^2 (Centro Universitário Senac Santo Amaro, 2017). Among higher education and high school students, employees, and visitors, approximately 9,594 people circulate per day.

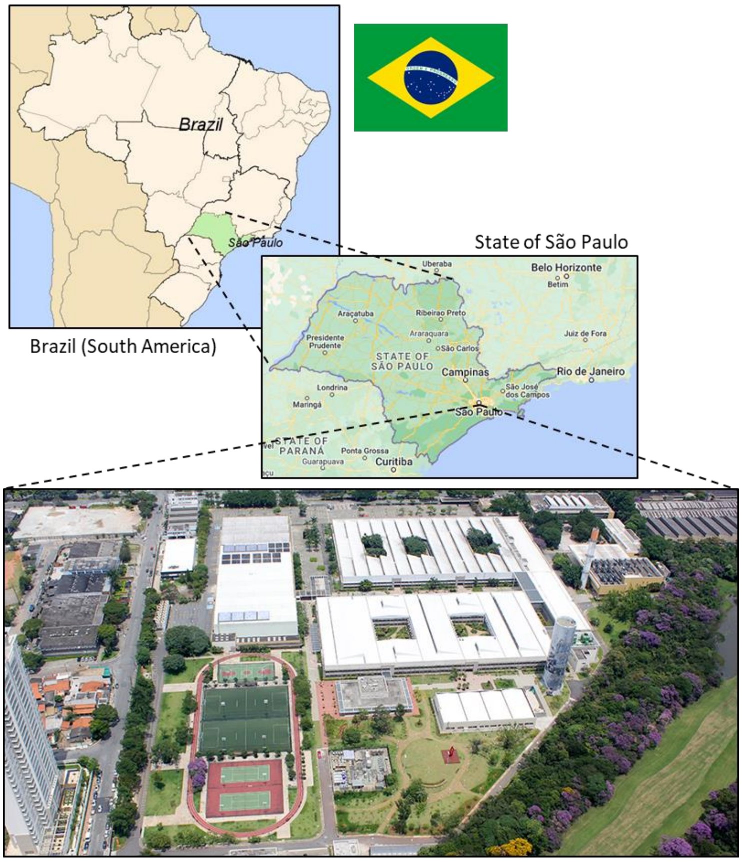

Figure 1. Aerial View of Centro Universitário Senac - Campus Santo Amaro. Source: Own Authorship.

The infrastructure of Centro Universitário Senac - Campus Santo Amaro includes offices and administrative areas, multimedia classrooms, amphitheaters, a central library, various laboratories (computer science, aesthetics and cosmetics, sports, nutrition, chemistry, physics, robotics and automation, telecommunications, engineering, design, architecture, and comfort, among others), studios (radio and TV, multimedia, others), academic workshops (carpentry, metalworking, electrical, painting, modeling, laser cutting, 3D printing, plastic injection, ceramics, among others), a gastronomic center (with professional kitchens and specialized environments), a convention center, sports center and courts, a gymnasium with a semi-Olympic swimming pool, a greenhouse, an outpatient clinic, a sewage treatment plant and conversion into reused water, a groundwater treatment and decontamination plant, maintenance and engineering sectors, among other facilities dependências (Centro Universitário Senac Santo Amaro, 2023). All indoor areas are air-conditioned.

Students have access to support services such as vocational guidance, psychopedagogical support, and technological support, ensuring a complete and high-quality education. The campus also has parking for cars and bicycles, providing convenience and safety to students and staff. In addition, access to the institution is facilitated by public transportation, including train, bus, and metro.

2.2. Sewage Treatment Plant and Other Systems Associated with The Conversion to Reused Water

The Centro Universitário Senac - Campus Santo Amaro uses a sewage treatment system that combines anaerobic and aerobic treatment to remove pollutants from water (Figure 2). This system consists of two main stages: the anaerobic treatment station (UASB reactor - Upflow Anaerobic Sludge Blanket) (Figure 3A) and the aerobic treatment station (Figure 3B).

Figure 2. Sewage Treatment Plant (STP) of Centro Universitário Senac – Campus Santo Amaro. Source: own authorship.

In the anaerobic treatment station, sewage undergoes a process of decomposing organic pollutants in the absence of oxygen. This process is carried out by anaerobic bacteria, which feed on the organic pollutants present in the sewage and produce biogas as a byproduct (Afonso, et al., 2016; Versiani, 2005). The biogas produced (in low quantity) is then captured, deodorized, and released into the environment.

After the anaerobic treatment station, the sewage is directed to the aerobic treatment station, where it undergoes a biological oxidation process (Mondal, Jana, Kundu, 2017). In this stage, the sewage is aerated to provide oxygen to aerobic bacteria, which feed on the remaining organic pollutants and produce water and carbon dioxide as byproducts. This aerobic treatment process is important to remove pollutants that were not eliminated in the anaerobic treatment station, and to ensure that the treated water quality meets the standards required by regulatory agencies (Tera, 2021). Finally, the treated sewage passes through a multimedia filter for polishing treatment (Rubim, 2012), is disinfected to eliminate any pathogenic microorganisms that may be present, and then released into the environment or reused for non-potable purposes, such as garden irrigation and toilet flushing. It is important to highlight that the entire sewage treatment process is monitored by a specialized technical team, which performs water quality analysis and tests at various points in the system to ensure treatment efficiency and compliance with environmental regulations.

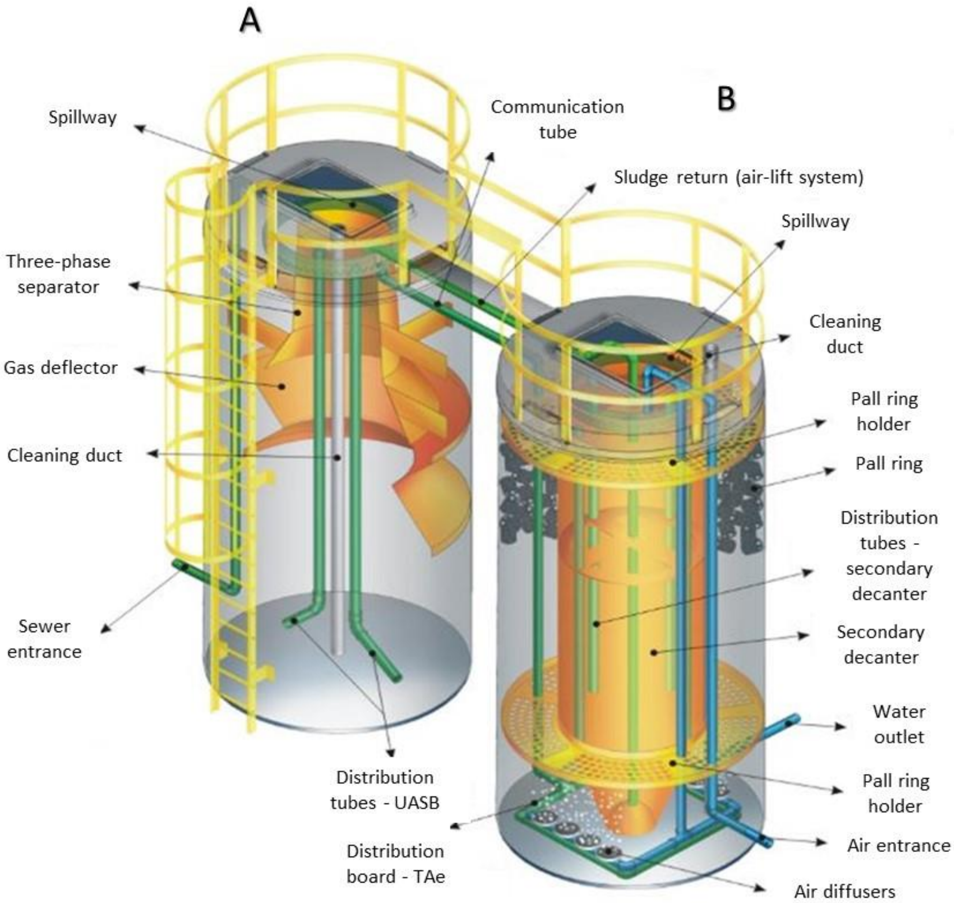

Figure 3. Sewage Treatment Plant (STP) with UASB reactor anaerobic treatment stage (A) and aerobic treatment stage (B). Source: EcoCasa, 2023, modified and adapted.

In the anaerobic stage (UASB reactor), up to 60% of the organic load in the effluent is removed, with a hydraulic detention time (HDT) of 8 to 10 hours horas (Trattare Soluções Ambientais, 2022). Additionally, in the aerobic stage, the efficiency of this treatment stage is superior to 75% for the removal of Biochemical Oxygen Demand (BOD), followed by removal of color and odor from the water. Disinfection is carried out by hypochlorite solution, with residual chlorine content of less than 5.0 mg/L.

Before passing through the multimedia filter, the final characteristics of the treated effluent include removal of over 90% of BOD and Chemical Oxygen Demand (COD), elimination of pathogens, removal of up to 50% of nitrogen and phosphorus, low turbidity, and absence of odor.

Considering an average occupancy rate of 9,594 people per day on Campus, the sewage treatment plant treats approximately 300 m3 of effluent per day. This represents the treatment of practically 100% of the wastewater generated by campus activities, which is converted into 10,000.80 m3 per month of reuse water, subsequently used for garden irrigation, facade and floor cleaning, toilet flushing, water recharge for air conditioning system heat exchangers, and increasing the volume of treated water that is returned to the groundwater through a contaminated water treatment station.

2.3. Other integrated systems that contribute to rationalizing water use

At Centro Universitário Senac – Campus Santo Amaro, various other technologies and processes are integrated to promote the best management of the water resource, in an eco-efficient and environmentally and energetically sustainable way (Figure 4).

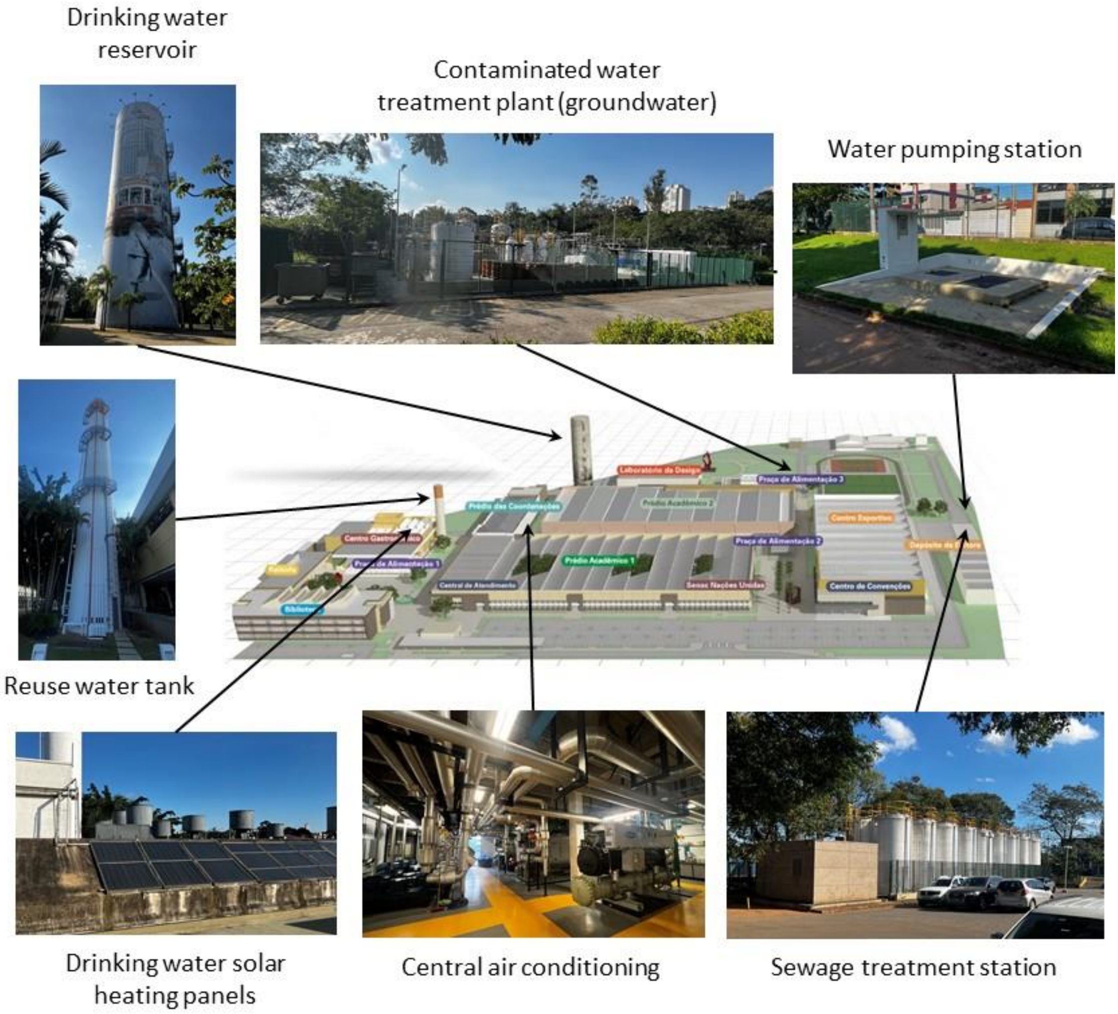

Figure 4. Integration of Systems and Processes at Centro Universitário Senac – Campus Santo Amaro, to Rationalize Water Use and Reduce The Generation of Effluents. Source: Own Authorship.

With 180 bathrooms and 8 locker rooms on Campus, water-saving measures have been implemented, including the installation of timed faucets and flow reducers. Similarly, flow reducers have been added to faucets in industrial kitchens, restaurants, and snack bars. In addition to these infrastructure measures, awareness campaigns promoting sustainable water use are regularly conducted. These practices have resulted in a 30% reduction in monthly consumption of potable water from the public water treatment plant (ETA - SABESP). Furthermore, all toilets on Campus use reclaimed water, significantly contributing to the rationalization of water resource use.

A solar water heating system with recirculation and a boiler, installed on the roof of the Gastronomic Center building, provides potable hot water for kitchens and locker rooms throughout the institution, without increasing energy consumption and minimizing water use on Campus.

The firefighting system at the University uses reclaimed water in its reservoir. This ensures that there is water available for immediate use without the need to use potable water.

The semi-Olympic pool at the gym is treated with ozone gas, which is more effective than chlorine and less harmful to the environment. The ozone treatment process also helps to reduce the amount of chlorine needed in the pool water, which is beneficial for people with allergies or respiratory problems.

The Campus Santo Amaro has a central air conditioning and cooling system that uses reclaimed water produced in the Sewage Treatment Station (STE) in its recirculation process. This system consists of a chilled water central unit that produces water at a lower temperature, which is distributed to the spaces through ducts and coils. The use of reclaimed water in this system aims to reduce the consumption of potable water, as well as minimize environmental impact and operation and maintenance costs. The reclaimed water is treated to ensure its quality and safety for use in the air conditioning system. The air conditioning system is divided into zones, allowing for individual temperature control in each area, using thermostats and control valves to adjust the temperature according to the needs of each space, providing a comfortable and efficient environment.

Producing more reclaimed water than the Campus consumes daily, some of this water is returned to the groundwater mixed with water that returns to the soil after decontamination in the contaminated water treatment plant on the institution's premises.

Education for Sustainability, regularly conducted among Campus users, complements the integration of systems and services offered.

3. Conclusion or Concluding Remarks

At Centro Universitário Senac - Campus Santo Amaro, various technologies and processes are integrated to form a network of eco-efficient systems and services that embrace sustainability and industrial ecology principles, promoting the rational use of water, the minimization of effluent generation, and the reduction of the institution's socio-environmental impacts.

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