

Best Practice Guide in

WATER EFFICIENCY

Food and Beverage
Manufacturing Sector



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PUB, Singapore's National Water Agency

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PREFACE

Singapore's water consumption stands at 430 million gallons a day, with the domestic sector accounting for 45% of total water use, while the remaining 55% comes from the non-domestic sector. By 2060, Singapore's water consumption is expected to double, with the non-domestic sector making up 70% of total water demand. Therefore, it is important that PUB's partners in the non-domestic sector join us in the move to conserve water and reduce water demand. This will help Singapore in its water sustainability journey.

The aim of this [Best Practice Guide in Water Efficiency – Food and Beverage Manufacturing Sector](#) is to provide professional engineers, developers, plant owners and facilities operators involved in water management, with the basic knowledge of designing, maintaining and operating a water-efficient plant. We have also compiled best water efficiency practices in this publication to help you in your journey towards sustainable water use.

ACKNOWLEDGEMENTS

This guide could not have been possible without the participation, assistance and invaluable insights from the following organisations. Their contributions are appreciated and gratefully acknowledged.

Asia Pacific Breweries Pte Ltd

SATS Catering Pte Ltd

British-American Tobacco (Singapore) Pte Ltd

Symrise Asia Pacific Pte Ltd

Concentrate Manufacturing (Singapore) Pte Ltd

Thong Siek Food Industry Pte Ltd

F&N Foods Pte Ltd

Vitasoy International Singapore Pte Ltd

Nestle Singapore Pte Ltd

YHS (Singapore) Pte Ltd

Olam Cocoa Pte Ltd

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Introduction

The Food and Beverage (F&B) Manufacturing is a key contributor to Singapore's manufacturing economy. Manufacturing plants in this sector are typically large water-consumers. More than 60% of the water intake is used for the food manufacturing processes while 13% is used for cooling towers and 10% used for boilers respectively. Water usage breakdown of the sector is shown in Figure 1.

The products produced in this sector can be broadly categorised into the following subsectors – (i) Food Manufacturing, (ii) Beverage Manufacturing, (iii) Flight and Catering Services and (iv) Others (such as food flavours, ice, cocoa butter equivalents and tobacco products). Products produced within each subsector also varies from facility to facility. Depending on the type of food / beverage produced, each subsector / premises uses water differently. Thus, F&B manufacturing sector is a highly heterogeneous sector with non-identical processes which is required for the varied products produced. Consequently, the water used for process as well as the wastewater produced can be of varying qualities.

Due to food safety concerns and societal acceptance, many F&B manufacturing plants do not incorporate water reuse and recycling in their facilities. The current recycling rates ranges from 0% to 15%, with the industry average at 1.8%. However, there are still potential opportunities for companies to explore and improve water efficiency and to recycle / reuse water for non-potable purposes.

PUB is committed to working with and supporting industries to recycle water and raise water efficiency. Interested companies can approach PUB's in-house Industrial Water Solutions Project Unit team or independent consultants to review the feasibility of water efficiency improvements at the premises. Prospective companies with plans to construct new plants or expand their existing plants are also highly encouraged to engage PUB in maximising water saving opportunities before finalising the factory's blueprint.



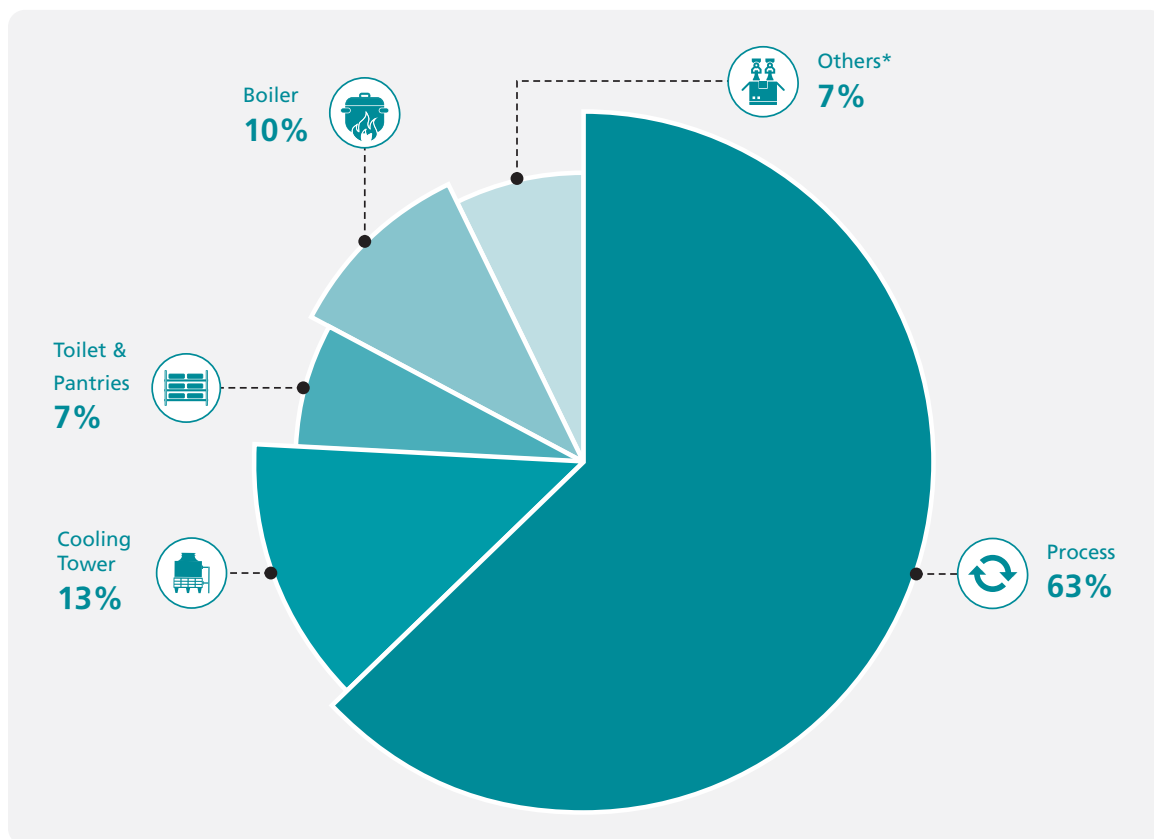


Figure 1: Water Usage Breakdown for the F&B Manufacturing Sector

This guide seeks to share practical and cost-effective approaches, illustrated by actual case studies, to manage water usage in the food and beverage manufacturing plants efficiently. It is not intended to be prescriptive nor does it set an industry standard.

Companies are recommended to read this guide in conjunction with the following standards / references:

- i. ISO 46001:2019 Water Efficiency Management System
- ii. Technical Reference for Water Conservation in Cooling Towers



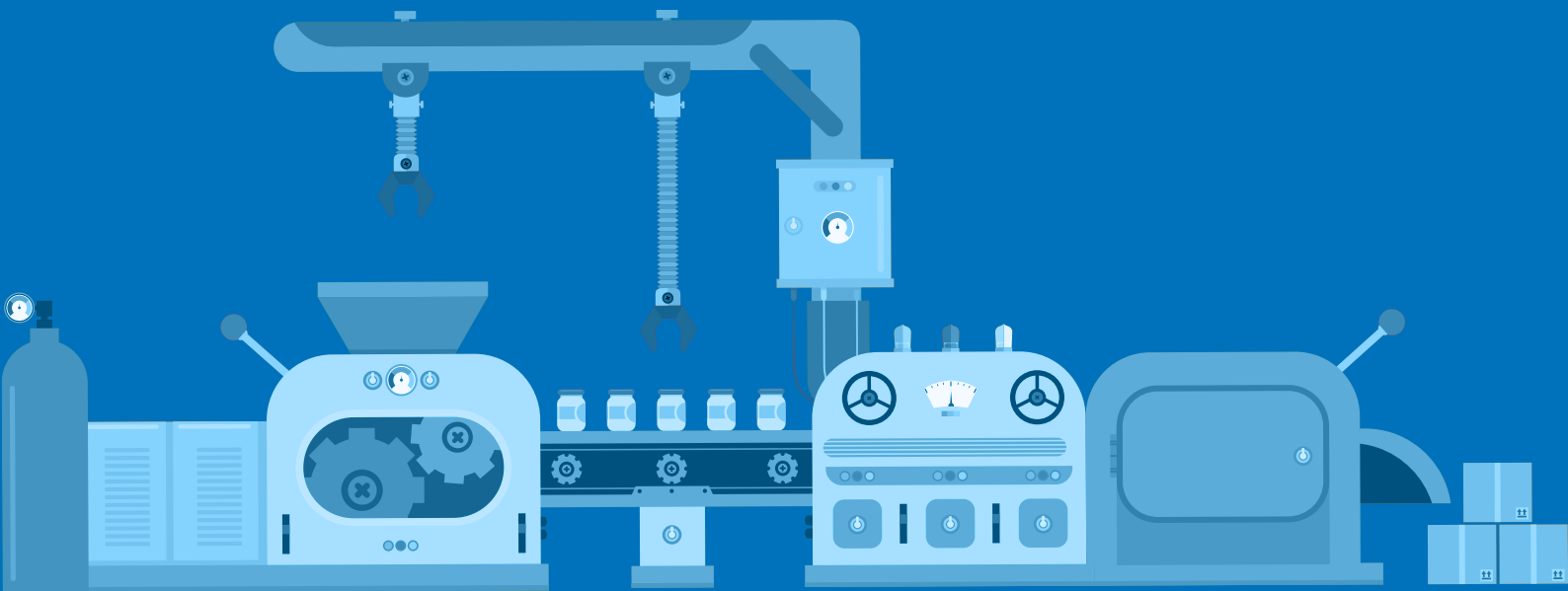
Water Recycling Opportunities

As most of the water is used during the F&B manufacturing processes, it is important for all F&B manufacturing plants to reuse and recycle as much water as possible. Although there are limitations to the recovery of water back to the food processes due to food safety concerns and societal acceptance, the water recovered can be reused and recycled for non-potable water usage areas such as cooling tower, boiler utilities without direct contact to food products and general washing. Some of the low hanging fruits includes optimising cycles of concentration (COC) of cooling tower and re-using steam condensate as boiler feed.

Figure 2 illustrates the recycling opportunities in a typical F&B manufacturing plant.

Steam condensate is ideal for re-use as boiler feed water as not only will it reduce the uptake of potable water / NEWater, it will also lessen the energy required to pre-heat the boiler feed water, due to its heat content. Industries should also explore reclaiming blowdown from cooling towers and treat it with RO system, subsequently re-using it as makeup for cooling towers.

In Section 3 below, we will explore more opportunities that can improve water efficiency in the premises through the 3Rs (Reduce, Replace and Reuse / Recycle).



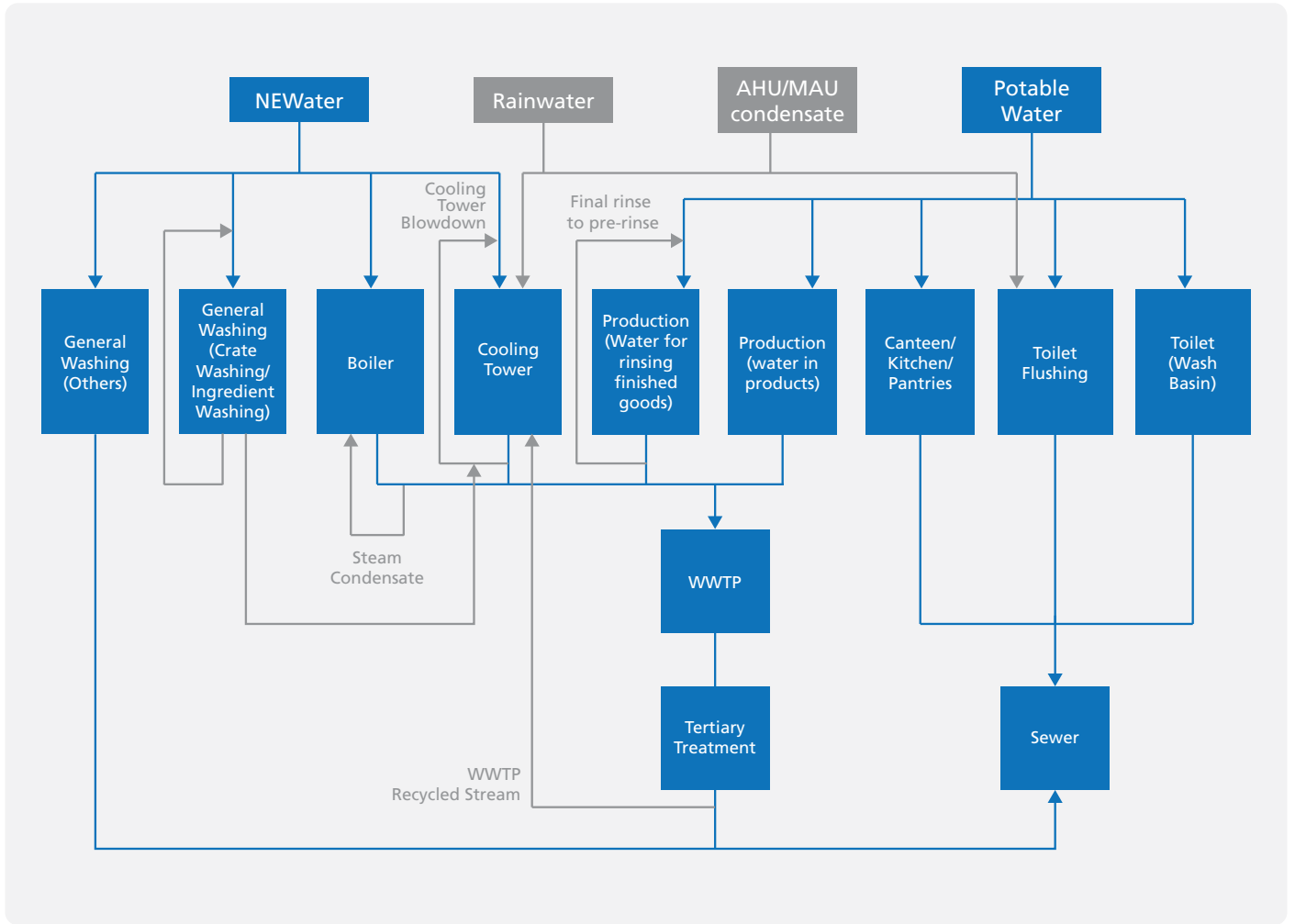


Figure 2: Sample water balance chart with recommended recycling opportunities for typical F&B manufacturing sector



Recommended Water Efficiency Practices

Besides water recycling, the following best practices can be considered to raise the plant's overall water efficiency and reduce water usage. Some examples are detailed in the table below.

For water quality requirements, please refer to Technical Reference for Water Conservation in Cooling Towers: Annex C – Typical Parameters of Potable Water, NEWater and Industrial Water as Makeup water for Cooling Tower.

3.1 COOLING TOWERS

Method	Water Efficiency Opportunities	
	New / Existing Plants	New Plants Only
Reduce	<ul style="list-style-type: none"> Improve cycles of concentration (COC) to minimum of 7 and 10 for cooling towers using potable water and NEWater respectively Install a side-stream filter Install a makeup water or side-stream softening system when hardness is a limiting factor on COC Reduce cooling load by minimising waste heat generated and / or using waste heat for other purposes in the facility 	<ul style="list-style-type: none"> Use of dry cooling instead of cooling towers Install and interlock automated chemical feed system with blowdown controls on large cooling tower systems (more than 100 tons)
Replace	<ul style="list-style-type: none"> Replace potable water or NEWater with harvested rainwater and air-conditioning condensate as cooling tower make-up 	
Reuse / Recycle	<ul style="list-style-type: none"> Recycle cooling tower blowdown back to the cooling tower as make-up, via a combination of Microfiltration (MF) / Ultrafiltration (UF) and Reverse Osmosis (RO) / Nanofiltration (NF) process Recycle wastewater effluent (e.g MBR permeate) as makeup for cooling towers 	

3.2 Boilers / Steam Generation

Method	Water Efficiency Opportunities	
	New / Existing Plants	New Plants Only
Reduce	<ul style="list-style-type: none"> Minimise vented steam. Low-pressure vented steam can be used to drive evaporation and distillation processes, produce hot water, etc. Minimise over steaming of flares by having good controls in place Implement an effective steam-trap maintenance program with regular steam trap survey 	<ul style="list-style-type: none"> Optimise steam distribution by ensuring that steam traps and condensate lines are properly sized to avoid unnecessary venting Minimise boiler blowdown by installing automatic boiler blowdown equipment which maintains a pre-determined level of conductivity in the boiler system
Reuse / Recycle*	<ul style="list-style-type: none"> Divert contaminated condensate to applications requiring lower quality of water, so that clean condensate can be recovered elsewhere Recycle boiler blowdown to cooling tower. Typically done by cascading high-pressure blowdown to low-pressure, before being reused at the cooling tower 	<ul style="list-style-type: none"> Setup facilities to recover water from vented stream Aim to recover more than 90% of condensate. In addition to recovery to the boiler, steam condensate can also be reused at processes, cooling tower, scrubber and general washing as long as the quality of condensate is fit-for-purpose

*For boilers that do not have direct contact with food products.



3.3 PROCESS

Method	Water Efficiency Opportunities
	New / Existing Plants
Reduce	<p>Clean – In – Place (CIP)</p> <ul style="list-style-type: none"> The adoption of smart scheduling to reduce cleaning processes during product changeovers is an alternative way to reduce water consumption use for CIP It is important to ensure that the design of the equipment would prevent any “dead legs” that have the potential to trap food waste and result in more frequent CIP required CIP optimisation should be carried out at the beginning of the plant establishment <p>Water Efficient Equipment</p> <ul style="list-style-type: none"> The adoption of water efficient equipment such as commercial dishwashers and high-pressure water jets for removal of stubborn stains on equipment would be a more efficient way of cleaning compared to conventional cleaning methods <p>Others</p> <ul style="list-style-type: none"> Using dry clean methods to remove product waste from equipment / floor prior to manual washing Thaw frozen food in chiller or microwave oven instead of submerging in water
Reuse / Recycle	<ul style="list-style-type: none"> Use recirculating system for CIP instead of a single-pass system, where possible Use final rinse as pre-rinse, where possible Reuse pump seal water for general washing or as cooling tower make-up <p>General washing</p> <ul style="list-style-type: none"> Water used to clean crates and ingredients can be reused for other general washing and non-potable water usage Water used to chill products / defrost ingredients can also be reused for general washing

Additional Water Efficiency Opportunities

Conduct water audit to prioritise opportunities for water efficiency

Engage a consultant to perform thorough water audit to identify and prioritise potential areas of reuse and recycling. Interested companies may approach PUB for the contact of independent consultants.

Install water-saving device

at basin, sink / kitchen, and shower tap / mixer to meet water-efficient flow rates designated by PUB.

Case Studies

Case Study

1

Asia Pacific Breweries Pte Ltd

Established in 1931, Asia Pacific Breweries Singapore (APB Singapore) is a leading brewer in Southeast Asia with a rich long history of success in developing premium beer and cider brands. Its portfolio includes the world-acclaimed Tiger Beer, Heineken, Guinness, Strongbow and many more. APB Singapore is highly committed to achieving a positive environmental and social impact through its Brewing a Better World sustainability strategy. These include lowering carbon emissions, protecting water resources and reducing waste. APB Singapore is part of the HEINEKEN Company.

APB Singapore collaborated with PUB and NUS to develop the 300 m³/day recycling plant to treat wastewater effluent generated by their brewing process, which involves milling, fermentation and filtration. The reclaim plant consists of an Upflow Anaerobic Sludge Blanket (UASB) Reactor, a Membrane Bioreactor (MBR) that utilises ceramic Ultra-Filtration (UF) membrane, followed by a single-pass two-stage Reverse Osmosis (RO) process to reduce total dissolved solids and finally an Ultra-Violet (UV) based disinfection step before usage.

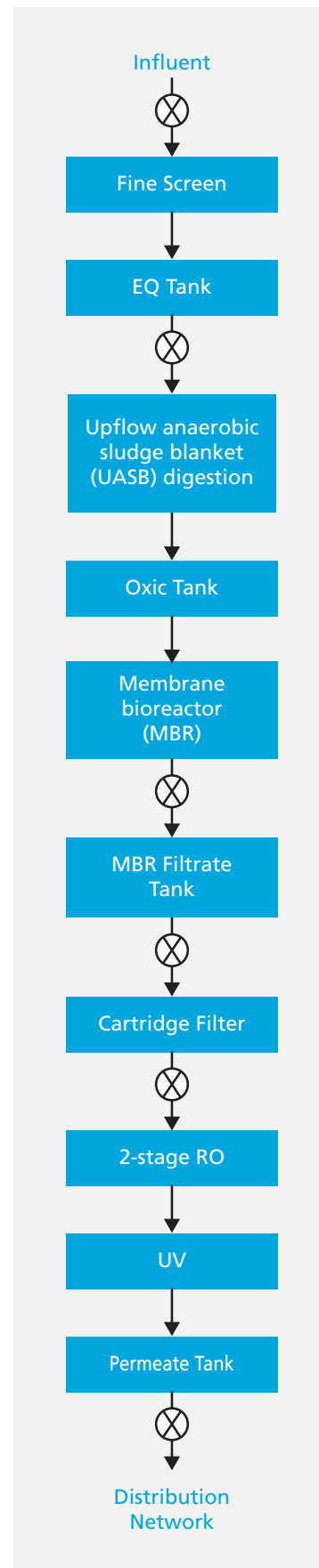


Image 1: Asia Pacific Breweries Singapore facility at 459 Jln Ahmad Ibrahim.

The reclaimed water will have a treated water quality similar to that of NEWater standard and it will be reused for non-potable applications such as cooling tower make-up, general washing and irrigation. Since the beginning of 2019, the Water Reuse Treatment Plant (WRTP) has started reclaiming water and is blended with rainwater for the cooling tower make-up. The cost of the plant amounts to approximately \$1.9 mil and has enabled APB Singapore to achieve a 15% reduction of potable water consumption in the cooling tower.



Image 2: Aerial view of the recycling facilities in APB Singapore.



Case
Study

2

YHS Singapore Pte Ltd

Yeo Hiap Seng (YHS) Pte. Ltd. is a Singapore beverage company and a leading name in the Asian drinks market producing a variety of Asian flavoured drinks. YHS currently produces more than 20 different flavours of drinks to local and overseas markets.



Image 3: YHS Singapore Pte Ltd at 3 Senoko Way



YHS collaborated with PUB and NTU, to develop a 450 m³/day recycling plant to treat wastewater effluent generated by its drink production process. The reclaim plant consists of Anaerobic Bed Filter (ABPF) that has a high organic reduction efficiency followed by Sequencing Batch Reactors (SBR) to degrade organic pollutants and lastly Ultra-Filtration (UF) and Reverse Osmosis (RO) before usage.

The reclaimed effluent is treated to NEWater standard and will be reused for general washing, process cooling, makeup water for boiler and cooling tower. Since its implementation in mid July 2021, YHS was able to recycle half of their treated wastewater.



Image 4: Recycling facilities in premises

Case Study

3

Concentrate Manufacturing (Singapore) Pte Ltd

Concentrate Manufacturing (Singapore) Pte Ltd is a manufacturer of concentrates for PepsiCo's beverages throughout Asia Pacific and North America. With strong support from the management, both locally and globally, the company is committed to ensure sustainable use of water and continuous improvement in water management within its premises.

Since the commissioning of the facility in 2017, the company has been seeking

continuous improvement on its water efficiency and has implemented several water saving initiatives, resulting in a 27% improvement in the company's Water Efficiency Index (WEI) in 2020 compared to the first year of full operation.

Together with a comprehensive control plan, some of the initiatives taken were:



Image 5: Concentrate Manufacturing (Singapore) Pte Ltd at 1 Sunview Way

Optimisation of CIP

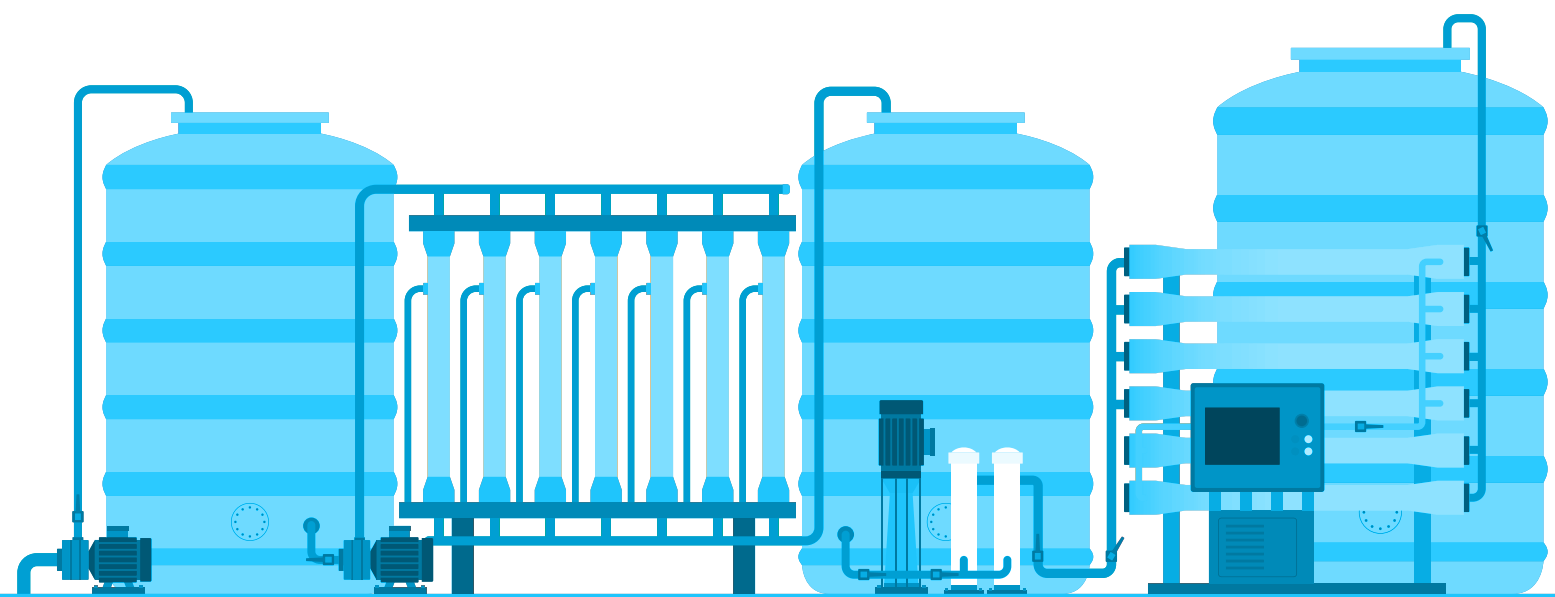
During the initial commissioning phase of the plant, the company carried out an intensive CIP optimisation regime and found out that on average, 95% of water consumed for CIP were used for pre-rinse & final rinse and with the typical rinse volume controlled by standardised timer process, it was observed that excessive water was used. Thus, the company changed the CIP programme from timer based to purge volume based on individual CIP object. With this change, the company not only saw better results in the CIP, but also noted an average monthly water saving of 6% in monthly consumption for CIP and a reduction in downtime of approximately 17%.

In addition, the company also changed the CIP cycles for a typical concentrate plant from the usual 5 steps: Pre-rinse, Caustic Rinse, Intermediate Rinse, Acid Rinse and Final Rinse, to a currently 3 step process: Pre-rinse, Caustic and Inline Sanitation and Final Rinse, with the use of appropriate chemical for each cleaning process.

The company also took further initiative to reduce the treated water consumption by recovering the Final Rinse water with low conductivity in the Pre-rinse tank. Water recovered will be used as Pre-rinse for the next CIP.

Treated Water (TW) and Loop CIP Interval

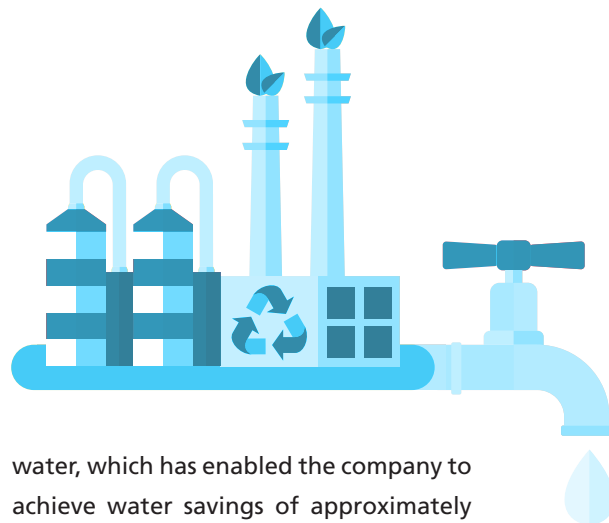
Due to the hot and humid climate of Singapore, the Treated Water (TW) tank for process and distribution loop requires frequent CIP cleaning to prevent microbe growth. This resulted in extra water consumption for CIP of TW tank and its loop. With the improvement of TW circulation using sub loop circulation from once every 3 hours to once every hour, the company was able to prolong the TW tank CIP validity by 400% and achieve water saving of about 60 m³/month.



In 2020, the company implemented another 3 initiatives for its cooling tower, which collaboratively, enabled Concentrate Manufacturing (Singapore) Pte Ltd to further achieve an estimated water savings of 6,800 m³/year.

RO Reject and Backflush Reuse to Cooling Tower

Initially, both RO reject water (~26 m³/day) and Backflushes water from Activated Carbon Filter (ACF) (~40 m³/week) were drained off. With the new initiatives, these RO rejects and Backflush water was redirected into cooling tower as make-up



water, which has enabled the company to achieve water savings of approximately 6,600 m³/year.



Image 6: Drift eliminator extensions before (left) and after (right)

Drift Eliminator Extensions for Cooling Tower

The company recently also implemented the cooling tower drift eliminator extension projects for 2 units of cooling tower. This was done by further increasing the bottom height of the drift eliminator which has a full height of 3 m on both sides of the cooling tower. With this, the company

observed no splashes from the cooling towers and reduced water evaporation losses and make-up water required. With the implementation of the project, the company was able to save approximately 224 m³/year.

The implemented initiatives combined, together with further efforts to enhance COC at the cooling towers has enabled Concentrate Manufacturing (Singapore) Pte Ltd to attain a water savings of more than 12,000 m³/year.

SUPPORT AND RESOURCE

PUB provides funding and technical support as part of PUB's effort to encourage companies to explore ways to improve water efficiency.

For technical support, interested companies may contact PUB's in-house Industrial Water Solutions Project Unit team at PUB_IWSDF@pub.gov.sg.

For information on funding available from PUB including Water Efficiency Fund and Industrial Water Solutions Demonstration Fund, please refer to PUB's website at www.pub.gov.sg.



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