CASE STUDY

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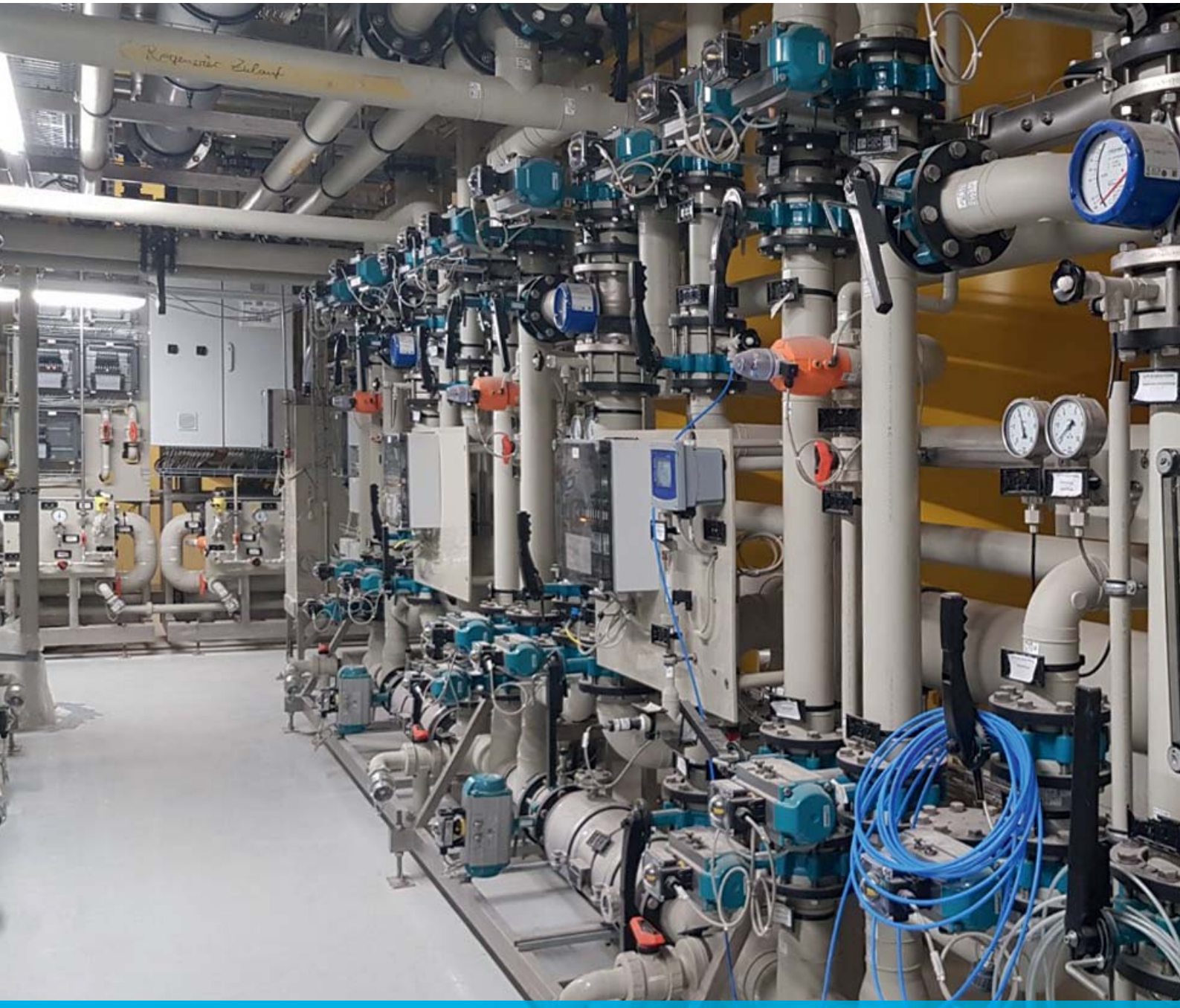

High-End UPW Plant for the Semi-Conductor Industry

Semiconductor production in Central Europe

Receipt of order:	June 2019
Installation start:	May 2020
Commissioning:	November 2020 – March 2021
Acceptance of entire plant:	July 2021

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Project overview

The task was to execute a high-end ultrapure water plant for the treatment of well water for a notable semiconductor producer in Central Europe.

The scope of supply included design, instrumentation and control, installation and commissioning. The plant is designed for a consumption line of 200 m³/h of cold ultrapure water, expandable to 300 m³/h, as well as hot ultrapure water (HOT-DI plant) of 50 m³/h, expandable to 100 m³/h.
The intended cold loop capacity is 300 m³/h, expandable to 450 m³/h, the HOT loop capacity is 75 m³/h, expandable to 150 m³/h.

Our client demands maximum operational safety. This is realised by a sophisticated redundancy concept, which in particular includes redundant components and double pipe routing.

The process technology used in this plant to achieve the required ultrapure water quality has been mastered by H+E for years. The special challenge of the project was to realise a plant of this capacity in the given space and within a short project duration.
Starting a large construction site at the beginning of the Corona pandemic in spring 2020 was another huge challenge.

Despite these conditions, we were able to complete the project completely on schedule, with the high quality standards of H+E and to the satisfaction of our client.

The targeted date for the completion of the commissioning and thus the supply of the consumers by the middle of the year 2021 was realised.

One major problem during the construction phase was to clarify how the installation of prefabricated 75-m³ tanks could be managed in a limited space under time constraints and coordination with other trades that had to be erected at the same time. This required very tight project management. The safe installation of the plant in an earthquake zone as well as the specifications of for minimising vibrations were taken into account in the design and realised in the execution.
The given water specifications were achieved, individual values were exceeded and are reliably achieved in continuous operation.

Pre-filter and membrane degasifier

2 Pre-treatment

The pre-treatment is carried out by means of pre-filters, raw water tanks, raw water pumps, and pre-heating by heat exchangers heated with waste heat from other plant units.

Pre-treatment	
Pre-filter station	100 µm, flow 355 m³/h (expandable to 535 m³/h)
Heat exchanger	Flow 322 m³/h
Raw water tank	Volume 2 x 75 m³
Raw water pumps	Flow 367 m³/h (expandable to 535 m³/h)
Partial deionisation WAC / SAC	Flow 322 m³/h (expandable to 490 m³/h)

Reverse osmosis plant

3 Make-Up

In the make-up plant, the already pre-treated well water is treated further. The supply is 100 % well water in normal operation; in an emergency, city water can be fed in.

Make-Up	
CO_2 and O_2 membrane degasifier combination mode	Flow 310 m³/h (expandable to 485 m³/h)
RO plant	Permeate flow 260 m³/h (expandable to 415 m³/h)
Concentrate RO plant	Permeate flow 34 m³/h (expandable to 55 m³/h)
Permeate tank	3 x 75 m³
Permeate pumps	Flow 260 m³/h (expandable to 415 m³/h)
UV oxidation	Flow 260 m³/h (expandable to 415 m³/h)
Working mixed bed	Flow 260 m³/h (expandable to 410 m³/h)

Working mixed bed

The first process stage of the make-up system is a partial demineralisation, which is designed as a stratified bed filter. Weakly acidic and strongly acidic exchanger resins provide the cation exchange. For an efficient and resource-saving regeneration, this exchanger is regenerated in countercurrent; automatic regeneration is triggered by monitoring the amount of well water. Subsequently, fine filters are used to protect the membrane degassing and the reverse osmosis system.

In the next step, dissolved oxygen and carbon dioxide are removed from the water by membrane degassing. This is done under vacuum conditions. Nitrogen is used as the stripping gas.

The subsequent main demineralisation stage of the partially demineralised water is a reverse osmosis plant with a yield of 85 %.

To minimise wastewater, the reverse osmosis concentrate is treated in another special plant. This system consists of a reverse osmosis unit that is adapted to the high salinity values of the concentrate fed into the main reverse osmosis system. Via an additional filter station, the permeate of this plant is treated in such a way that it can be used for subordinate purposes.

The permeate from the reverse osmosis system is temporarily stored in three large, nitrogen-overlaid permeate tanks of 75 m³ each, which are designed as upright, cylindrical round vessels made of PP, before being passed through a UV system to reduce the TOC value and to disinfect the water.

The direct irradiation of short-wavelength UV light breaks up neutral organic ingredients, which are measured as TOC, and thus transforms them into charged ions. This allows them to be removed by the subsequent mixed bed exchange resins. In addition to TOC reduction, the UV system also disinfects the water. Furthermore, all cations and anions are removed in the mixed bed exchangers. The resistance of the resulting ultrapure water is now in the range of 18 MOhm x cm.

Polisher mixed bed

4 Polishing

Three buffer tanks of 75 m³ each are the buffer for the polishing. The tanks are filled with the demineralised water from the make-up plant. The return flows of the ultrapure water loops as well as the return flow of the pressure maintenance from the feed distributors are also fed into these tanks. To maintain the water quality, these tanks are also permanently overlaid with nitrogen. From the tanks, a pump group with a capacity of 395 m³/h, expandable to 630 m³/h, delivers water for polishing.

A UV system in combination with polisher mixed beds serves to further reduce the TOC value. The polisher mixed-bed system also removes residual ions still present in the water, especially silicate and boron.
Ultrapure water coolers are installed to keep the ultrapure water within the specified temperature values. The heat introduced by the energy input from pumps and UV systems is compensated. Booster pumps are installed to achieve the desired supply pressure.

Polishing

UPW tank	3 x 75 m³
UPW pumps	Flow 395 m³/h (expandable to 630 m³/h)
UV oxidation	Flow 395 m³/h (expandable to 630 m³/h)
UPW cooler	Flow 395 m³/h (expandable to 630 m³/h)
UPW booster pump	Flow 395 m³/h (expandable to 630 m³/h)
Polisher mixed bed	Flow 395 m³/h (expandable to 630 m³/h)
Ultrafiltration cold	Filtrate flow 300 m³/h (expandable to 450 m³/h)
HOT-DI plant 70 °C	Flow 80 m³/h (expandable to 160 m³/h)
Ultrafiltration hot	Filtrate flow 75 m³/h (expandable to 150 m³/h)

The last stage of polishing is an ultrapure water ultrafiltration. This removes the particles from the ultrapure water. The separation limit of the membranes is 6,000 Daltons. The concentrate of this ultrafiltration (only particle-laden ultrapure water) is cleaned by another ultrafiltration. The filtrate from this unit can be fed directly back into the ultrapure water tank. Only 5 % of the original concentrate quantity remains. This concentrate can be used completely for secondary processes.

The quality of the ultrapure water fed into the cold loops is monitored at the feed distributor. Relevant parameters are monitored and registered online. The supply pressure is maintained by a control valve, which returns the ultrapure water not required in production to the UPW tanks.

A HOT-DI plant was also installed, consisting of a heat exchanger, ultrapure water ultrafiltration, pressure keeping and quality measurements. In the HOT-DI system, ultrapure water is heated to 70 °C for special rinsing processes. To save energy, the HOT-DI is heated in 3 stages:

1. use of the HOT-DI returns,
2. use of a recuperative system,
3. heating water to reach the final specification.

All usable rinsing and measuring waters from the plant are collected and reused.

5 Specification ultrapure water

Specification ultrapure water

Resistance :	> 18.1 MOhm x cm at 25 °C
TOC:	< 1.0 ppb
Metal ions:	< 5 ppt
Boron:	< 50 ppt
Loop flow:	300 m³/h, consumption: 200 m³/h
HOT-DI plant 70 °C:	Flow 80 m³/h

Note:

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