IMEC

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PW & HPW Generation

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➢ PHARMA : Purified Water Generation
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VWS: Business Approach

SERVICE

VALUE

RESPONSIBILITY

Wait for the case Study!!
What are we talking about?

- Water Most commonly used raw material for WFI generation, Bio reactors, cleanings, Sinks, washer units, pre-cleanings,
- Ingredient made on site
- Purified Water & WFI generation is part of manufacturing - critical utilities
- Assurance of supply & regulatory compliance are the key drivers
- Continuous investment in service needed to ensure ongoing compliance
Pharma: Purified Water

✓ Pharma industry heavily regulated
✓ Key process water application is 'Critical Water Utilities'
✓ Strong drivers for:
  ✓ Process security
  ✓ Compliance assurance
  ✓ Service
Pharma: Purified Water

What about the Specifications?

✓ From “Potable Water” to:
  ✓ US Pharmacopeia – USP-
  ✓ European Pharmacopeia – Ph Eur-
  ✓ Japanese Pharmacopeia – JP-
  ✓ Some Others......
Pharma: Purified Water
USP Monograph

- Conductivity: < 1.3 μS/cm at 25°C in-line or Table*
- TOC: < 500ppb (Online or off)
- Bacteria: < 100 cfu/ml**

*Non-temp. compensated conductivity measurement
**Non-mandatory, generally considered appropriate Action Level
Pharma: Purified Water
Ph Eur Monograph

- Conductivity: < 4.3 μS/cm @ 20°C in-line or Table *
- TOC: < 500ppb
- Bacteria: < 100 cfu/ml **
- Nitrates: < 0.2 ppm
- Heavy Metals: < 0.1 ppm

* Non-temp. compensated conductivity measurement - but more relaxed than USP.
** Appropriate action limit under normal conditions
Feed water quality - spots samples and annual averages, plus free chlorine and FI/SDI.

Treated water specification - for ALL chemical and microbiological parameters.

Average hourly flow rate, total daily volume, size/duration/frequency of any demand peaks.
Pharma: Purified Water
System Design - Significance of Demand Flowrate

- Generation system usually sized on average hourly flow rate (daily volume over 20 hours).
- BUT it must be large enough to replenish tank between demand peaks.
- Distribution system sized on peak demand flowrate + 25 - 50% return flow.
- Pipework diameter sized to give a velocity of 1 - 3 m/s wherever practical.
Pharma: Purified Water
System Design - Typical
Pharma: Purified Water
Design Practices - Pretreatment -

✓ Pretreatment includes filtration, softening & adsorption processes.
✓ Chemical dosing not preferred. Not Allowed!
✓ Adoption of distribution system design parameters at front end is now standard.
✓ Focus on control of microbial growth rate.
✓ Heat sanitisable treatment units increasing
Pharma: Purified Water
Design Practices - Main treatment:

- RO&CDI, 3 bed DI or twin pass RO processes
- Philosophy is to “overpurify” to avoid treatment in the distribution system
- Main processes and polishing are combined before the tank
- Heat Sanitisation used wherever possible
- Trend is to reduce effluent volumes
Pharma: Purified Water
Typical Design PW Generation

Hot Water Sanitisable Design
Pharma: Purified Water
Design Practices - Storage-

- Tank is the microbiologically weakest link.
- Stainless steel, vacuum rated tanks of minimum volume preferred.
- Spray ball vs dip tube inlet debate.
- Ozone can be used continuously to control bacteria in the water and air in tank.
- Tank sizing should be determined by demand profile, not a nominal retention time.
Pharma: Purified Water
Design Practices - Distribution System

✓ Minimise treatment processes in the loop - bacterial control only.
✓ Sanitisation by heating (high energy).
✓ Sanitisation with ozone (low energy).
✓ Variable speed drives on pumps.
✓ Greater quality/flow/pressure monitoring
Pharma: Purified Water
Design Practices - Importance of Recirculation

✓ Essential to minimise microbial re-growth.
✓ Minimum velocity 1m/s must be achieved.
✓ Continuous cooling may be needed if demand is high and/or intermittent.
✓ Need to consider peak demand AND zero demand conditions.
Pharma: Purified Water
Design Practices - Future Design Trends -

- Permanently hot distribution systems
- Storage tank elimination by managing demand
- “Cleaner” pretreatment for potable water (UF,..)
- Nitrogen blanketing of storage tanks
- Tightening quality standards (regulatory or clients’ own)
- Reclamation of (clean) effluent
- Reduction of effluent volume (RWD- Veolia Concept)
- Reduction of the Carbon footprint
Pharma: Purified Water
Design Practices - Conclusions

- Pharmaceutical system design presents chemical and microbiological challenges
- Current quality limits are readily achievable
- Maintaining water quality is the major challenge
- Though many processes could be used, some clear industry preferences have emerged
Pharma: Purified Water
VEOLIA EXPERTISE - End to End Water Management
Pharma: Purified Water
VEOLIA Standard Solutions

[Diagram showing comparisons between different water treatment systems]
ORION™ From 2 to 15 m³/h
Pharma: Purified Water
VEOLIA Main Standart PW Generators

IonPro™ LX MKII From 0,5 to 1m³/h
Pharma: Purified Water
VEOLIA Main Standart WFI, CS, Generators

MED - Multiple Effect Distiller
VCD - Vapour Compression Distiller
CSG - Clean Steam Generator
Pharma: Purified Water
VEOLIA Turnkey PW Plant
Scope of Supply: PW Generator Unit

- 3* Orion 6000 TTS
- PW Flow Rate: 5,7m³/h
- With ZWD and Energy saving Concept.
- PW specifications more stringent than USP Requirements
- Delivered in 2013
RWD and High Quality Water Recirculation Concept
# The Results - Consumptions

<table>
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<tr>
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<th>Standard ORION</th>
<th>Zero Discharge Recirculation</th>
<th>+ High Quality Recirculation</th>
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</thead>
<tbody>
<tr>
<td>Total annual <strong>project</strong> production time</td>
<td>xx h/a</td>
<td>xx h/a</td>
<td>xx h/a</td>
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<tr>
<td>Total annual <strong>project</strong> standby time</td>
<td>xx h/a</td>
<td>xx h/a</td>
<td>xx h/a</td>
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<tr>
<td>Annual <strong>project</strong> process water capacity</td>
<td>57,726 m³/a</td>
<td>57,726 m³/a</td>
<td>57,726 m³/a</td>
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<tr>
<td>Annual <strong>project</strong> feed water demand</td>
<td>91,814 m³/a</td>
<td><strong>73,761 m³/a</strong></td>
<td>73,761 m³/a *)</td>
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<tr>
<td>Annual <strong>project</strong> drain water</td>
<td>34,088 m³/a</td>
<td>16,035 m³/a</td>
<td>16,035 m³/a *)</td>
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<tr>
<td>Annual <strong>project</strong> power consumption</td>
<td>267,329 kWh/a</td>
<td>267,329 kWh/a</td>
<td><strong>190,317 kWh/a</strong></td>
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</tbody>
</table>
The Results - Carbon Foot Print

- Carbon footprint for water, waste water and energy in kg-CO$_2$/a
  - Tab water: 0.32 kg-CO$_2$/m$^3$
  - Waste water: 0.05 kg-CO$_2$/kg !!!
  - Energy: 0.26 kg-CO$_2$/kWh

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<thead>
<tr>
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<th>Standard ORION</th>
<th>Zero Discharge Recirculation</th>
<th>+ High Quality Recirculation</th>
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<tbody>
<tr>
<td>Feed water</td>
<td>29,380</td>
<td>23,604</td>
<td>23,604</td>
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<tr>
<td>Waste water</td>
<td>1,704</td>
<td>802</td>
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<tr>
<td>Energy</td>
<td>69,506</td>
<td>69,506</td>
<td>49,482</td>
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<tr>
<td>Total:</td>
<td>100,590</td>
<td>93,911</td>
<td>73,888</td>
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<td>%age:</td>
<td>100%</td>
<td>93%</td>
<td>73%</td>
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The Results - Operationnal Costs

Operational costs for water, waste water and energy in €/a

- Tab water: x.xx €/m³
- Waste water: x.xx €/m³
- Energy: x.xx €/kWh

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<th>Standard ORION</th>
<th>Zero Discharge Standby</th>
<th>+ High Quality Standby</th>
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<tbody>
<tr>
<td>Feed water</td>
<td>☺</td>
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<tr>
<td>%age:</td>
<td>100%</td>
<td>83%</td>
<td>78%</td>
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</table>
What are we talking about?

- UPW standing for Ultra Pure Water
- HPW standing for High Purified Water

Design case by case according Customer specifications and requirements

Most of the time for final cleaning and/or washing production components (Microprocessors, Si or Ge electronic component, IC,...)
Microelectronics Industries

Typical UPW quality

- TOC < 0.5 ppb
- Resistivity to 18.2 mega ohm
- Boron < 5 ppt
- Silica < 500 ppt
- DO < 1 ppb
- Sodium < N.D. (<5ppt)
- Chloride < N.D.
- Bacteria < 1 CFU/L
Cost effective installation
Added-value
Fast track
Large scale project
After-sales support
Reliability
Project build in phase
Microelectronics Industries
Typical UPW System

Pretreatment / Make-up
- Raw water tank
- Multimedia filters
- Activated carbon filters
- RO pre-filters
- Two-pass RO
- RO product tank
- TOC UV
- Membrane degasifier
- CEDI
- Primary mixed bed
- Reuse tank

Primary System
- RO product tank
- Membrane degasifier
- CEDI
- Primary mixed bed
- Scrubber/Cooling tower

Polishing System
- UPW tank
- TOC UV
- Heat exchanger
- Membrane degasifier
- Polish mixed bed
- Cold DI UF
- Recovery HE
- Hot DI UF
- Cold DI loop return
- Cold DI loop supply
- Hot DI loop return
- Hot DI loop supply
Stringent Process Water’s specifications

- High quality standards for design, equipment and material.
- Case by case Design
- Can be compared with the philosophy of the “Pharma World”
- Exception for the selected material of the storage and distribution section (No SS; preference for PVDF and or PP)
Microelectronics Industries
Case Study - BELGIUM

Scope of Supply: HPW Generation, storage and distribution

- 2* HPW generators D&B at 4 m³/h
- Tech: Soft./Filtration/ph Correction/RO/CDI/UV
- 3* Storage and distribution loop @ 8-10-25 m³/h
  - Fine filtration
  - DI bed
  - UV
  - Material: PVDF
- Delivered in 2001
UPW treatment plant

→ Design & construction of UPW treatment plant. Veolia Water BOT contract

→ Capacity makeup: 111m³/h, polishing plant: 4 x 37m³/h, CEDI-VNX: 120m³/h

→ Use of Aquamove™ MORO during the commissioning of the project, 24 m³/hr

→ Technology: ACF, MMF, RO, CEDI-VNX
→ Delivered in 2007
→ Singapore
Thanks for your Attention

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