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## Treated water quality

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**ABB**



## Questions

- What will the treated water be used for?
- Where do you find out what quality is required?
- What are the important quality parameters that you should be identifying?
- Can the water quality be too good?
- How do you satisfy multiple duties, each with their own specification?
- What are the consequences of getting it wrong?
- Which determines the treatment technology – raw water quality or treated water quality?

## What water quality do you need?

- For most people, water is water is water
  - Potable water is “pure”
  - Cooling water is the same as boiler water
  - The process uses whichever supply of water is closest
  - If the water treatment plant is not working, you use whatever water is available until it is mended
- Sadly this applies to most engineers and chemists too
  - There is very limited formal training
- It is only when you work in Utilities or specific production processes that you learn differently...

## What will the water be used for?

- Many of you will work in the Power sector, but consider a wider application
- Utility operation
  - LP / MP / HP / VHP steam raising
    - Process heating
    - District heating and cooling
    - Power generation
  - Cooling system make-up
  - Environmental systems make-up – e.g. scrubbers

- Process duties
  - Electronics
    - wafer manufacture
  - Pharmaceuticals / Healthcare
    - water for injection
    - manufacturing processes
  - Fine chemicals manufacture - manufacturing
  - Food
    - product washing
  - Brewing
    - beer making
  - Dyestuffs
    - manufacturing
  - Heavy chemicals
    - process cooling / steam raising
- Do all these duties require the same quality of water?

## Where do we find out what water quality is required?

- Standards exist for some of these duties, e.g.
  - Steam raising – EPRI, VGB, EN, ASME, JIS, etc
  - US Pharmacopoeia, European Pharmacopoeia
  - Government standards – food processing
  - Shared industry sector experience – heavy chemicals, brewing (“Burtonisation”),
  - Manufacturer’s guidelines / warranties,
  - Product specification, etc
- But often standards are internally set and reflect past experience
  - Fear of changing – even to “improve” water quality

- Industry sectors always believe that their requirements for water quality are different from anyone else
  - Which is true, but...
  - From water treatment perspective, it is likely that many of the same treatment processes will be used in producing water for different duties
  - So the same treatment process may serve a range of duties
  - As long as we can define what water quality we really need...

## Water quality parameters

- What should we be specifying?
- “Standards” will indicate parameters known to be important for the specific duty e.g.
  - Sodium, Potassium
  - Calcium, Magnesium
  - Iron, Copper, Nickel
  - Chloride, Sulphate, Nitrate
  - Alkalinity
  - Silica
  - TDS / Conductivity / Acid Conductivity
  - pH
  - Colour
  - TSS / Turbidity / Colloids
  - Bacteria, Viruses, Pyrogens
  - TOC, Organic matter
  - Taste
  - Oil & Grease
- Not all of these impurities can or will be removed by ion exchange



## Common water systems

- It is quite common to have different water duties on a plant demanding different qualities of treated water
- Should this demand be met by having different treated water qualities available - or is it better to provide one quality for all duties?
- Some are tempted to consider only the minimum water quality needs, i.e. what the system can tolerate, considering this to be the cheapest option
- However it is important also to consider what benefit might result from using better water quality
  - In most cases, improving the treated water quality will do no harm and may be beneficial

## Potential benefits of using better water quality

- Typical benefits from improved water quality include
  - Remove need to install “intermediate” water purification processes, distribution systems, control systems, etc.
  - Reduced water consumption by minimising discharge
  - Reduced cleaning / maintenance / inspection
  - Opportunity to minimise chemical treatment, e.g. pH control, antiscalants
  - Opportunity to simplify control system
  - Opportunity to reduce routine analysis
  - Opportunity to treat the waste water from the system locally to recover raw materials and product before further contamination
  - Opportunity to recover water for reuse / recycle
- If these opportunities are not introduced at the feasibility stage in the project, it is unlikely that they will be viable at a later stage.

## But beware...

- In some circumstances it is possible for the water quality to be “too good”
- Imagine if demineralised water were used to make your beer instead of raw water?
- Or reverse osmosis was used to remove the colour from water used to make whisky?
- Would you prefer your bottled water to contain well water or reverse osmosis water?

## What water qualities do you need?

- It is not practical to produce a wide range of different water qualities to suit each individual water duty
- Recommend producing a simple table identifying the various duties with a simple descriptor of the necessary limitations
  - Table should identify specific plant items and generic duties
- Simple descriptors can be used to focus any further consideration, e.g.
  - Not suitable; Possible; Suitable; Better than needed; etc

## Example of Screening Table

Duty	Requirement	Options					
		Softened water	DeAlk + Softener	Reverse Osmosis	Twin Bed Demin water	Polished water	EDI
12 MPa Boiler	VGB Standards	No	No	No	No	Yes	Yes
3 MPa Boiler	ASME standards	Possible	Possible	Possible	Yes	Yes	Yes
1.2 MPa Boilers	Manufacturers standards	Yes	Yes	Yes	Yes	Better than needed	Better than needed
Closed Circuit Cooling System	Low TSS, Low TDS, Disinfected	Possible	Possible	Yes	Yes	Better than needed	Better than needed
Caustic scrubbers	Low hardness	Yes	Yes	Possible	Possible	Better than needed	Better than needed
Acid scrubbers	Low calcium?	Yes	Yes	Better than needed	Better than needed	Better than needed	Better than needed
Etc							
Etc							

- Based on this table, the purest” water required for the new plant can be established
  - Most likely to be for steam raising, but
  - Some process duties demand even better water quality
    - Or “different” purity parameters
- Next consider whether this quality of water could be beneficially used for other less demanding duties, e.g.
  - Demineralised water for LP steam raising
  - Demineralised water for closed circuit cooling system make-up
  - Softened water for caustic scrubber duties
  - Demineralised water for product washing, etc.
- Aim to limit the number of different treated water qualities to 2, maximum 3

- Aim is to establish balance between
  - Number of different water qualities available on the plant and
  - Capital cost of installing additional water purification equipment, distribution systems and control systems and
  - Future operating costs per m<sup>3</sup> water consumed and
  - Beneficial impact (if any) of using better than required water quality
- Rare to see more than 3 purified water qualities used on single plant
- Based on this information, it should be possible to identify each water duty against a specific water quality.
- This information is then used to develop outline specification and sizing for each water purification process.

## Consequences of getting it wrong

- The Standards we work to are designed to protect us against the consequences of getting it wrong
  - At the production stage:
    - Equipment failures due to corrosion
    - Heat transfer limitations due to scaling or fouling
    - Microbiological growth
    - Failed batches and off-specification product
    - Non-compliance with manufacturing standards
  - Or at the wider stage:
    - Lost business due to poor quality product, failure to supply
    - Personal injury and fatalities
    - Civil and criminal proceedings



## Treated water quality determines process selection

It is the treated water quality that ultimately determines the water treatment process, not the raw water quality

- It may limit your choice of raw water source
  - Potential contamination
  - Variability, especially seasonality
- ~~It may~~ It should determine what pretreatment stage(s) will be necessary for the selected raw water quality – alongside the treatment technology used
  - Clarification?
  - Media filtration or membrane filtration?
  - Carbon filtration?

- Treated water quality will determine whether ion exchange is a suitable technology
  - Or whether alternative technology such as membranes would be more suitable
  - Ion exchange is not suitable for brackish water or sea water treatment
  - Ion exchange is not designed to remove suspended solids, colloids, bacteria or viruses – and will only partially remove organic contamination (TOC)
  - **Water quality must take priority over cost of production**
    - The Standards represent a wealth of experience of knowledge

## Objective

- To define a water quality (or more than one?) which meets the specification for the most demanding duty
- Do not expect the OEM will do this for you – it is not their job!
- Consider all quality parameters – not just a selection
  - Even if you think they are not relevant
- If you are not purchasing a complete treatment train (pretreatment + treatment + polishing), share the details of the other unit operations with the OEM
  - It will affect the final design
- Once you have defined the water quality, it is time to start talking to the OEM...



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