

# Wastewater reuse for industrial applications in cooling towers

*Tuesday 3<sup>rd</sup> November 2015*

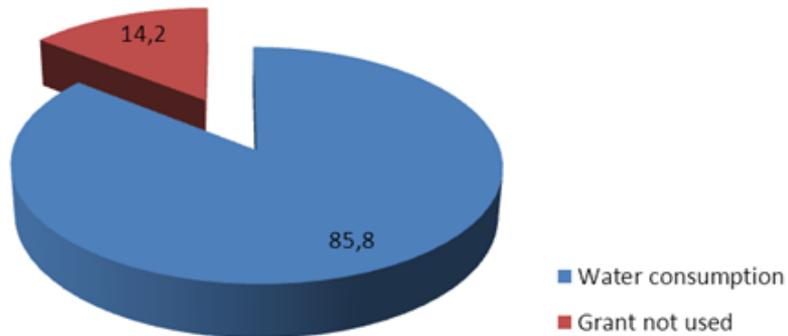
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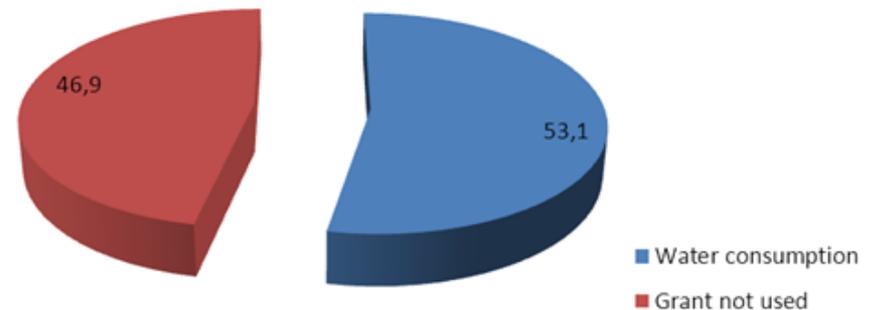
# Tarragona Region

- Tarragona is a seasonal water stressed region that uses Ebro River water for Municipal and Industrial applications
- Industrial Water Rights are mainly used in Cooling Towers inside Petrochemical Complex

## Municipal Water Rights (%)

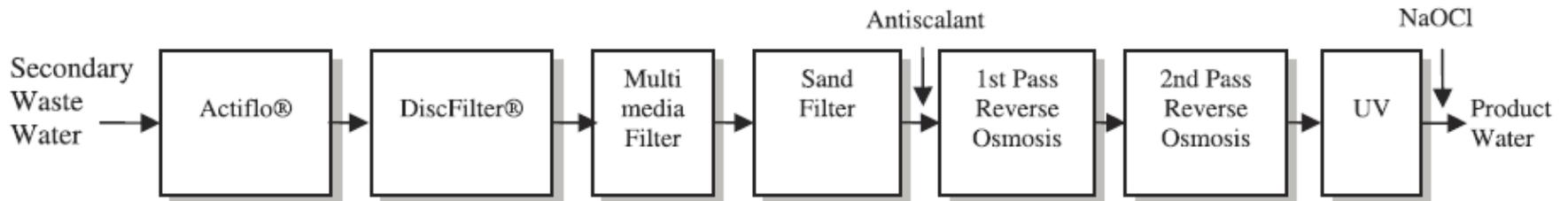


## Industrial Water Rights (%)



# Camp de Tarragona Advanced Water Reclamation Plant

- Reclamation Plant is designed for 19,000 m<sup>3</sup>/d of permeate water from Tarragona and Vila-seca Wastewater Treatment Plant. It is owned by ACA and operated by Veolia and AITASA
- Reused water is blended with Ebro River water in order to provide make-up cooling water for the Tarragona Petrochemical Complex Plants



# Camp de Tarragona Advanced Water Reclamation Plant

- Pretreatment consist of Veolia Actiflo technology
- First pass uses DOW FILMTEC™ BW30XFR-400/34i extra fouling resistant membranes
- Second pass uses DOW FILMTEC™ LE-440i low energy membranes



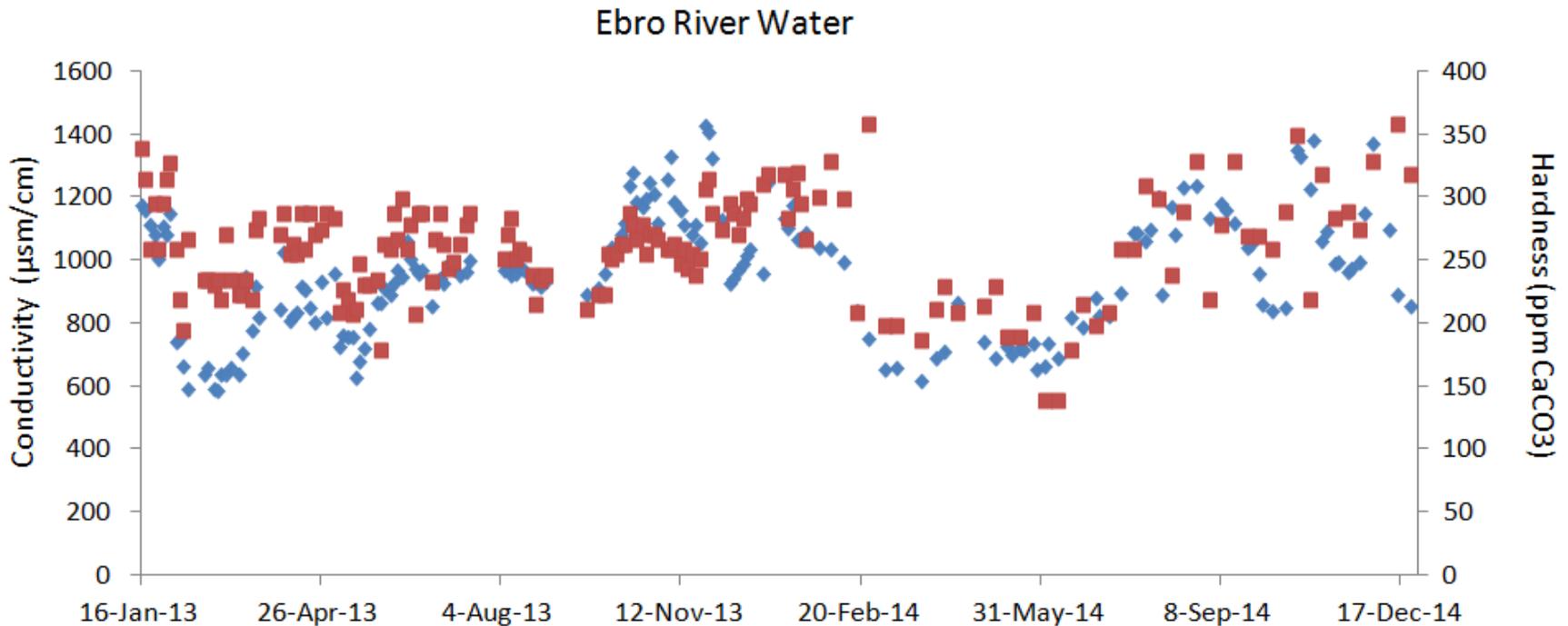
# Wastewater Reuse Strategy

- Pipe is built to blend RO permeate with Ebro river water and provide make-up water to North petrochemical production complex (Ethylene Cracker) in La Pobla de Mafumet (Tarragona). Current blending ratio is 40% reclaimed water, aiming to 90%
- Pipe is being build to blend RO permeate with Ebro river water and provide make-up water to South production complex (Poliolefins and Polyols/Polyglycols Plants)



# Reverse Osmosis Permeate vs River Water

- Reverse Osmosis permeate offers superior and more stable quality
- A water demineralization is available to supply 30 m<sup>3</sup>/h of highly demineralized water (0.2 μS/cm) to the petrochemical park



## Reverse Osmosis Permeate vs River Water

- Reverse Osmosis permeate offers superior and more stable quality
- This allows increasing Cooling Tower concentration cycles from 4 to 7 without increasing scaling or corrosion tendency

Compound	Ebro River	RO Permeate
Conductivity ( $\mu\text{S}/\text{cm}$ )	950	19
Cl (mg/L)	95	2.9
CaCO <sub>3</sub> (mg/L)	260	< 0.1
SO <sub>4</sub> (mg/L)	160	0.02
NH <sub>3</sub> (mg/L)	0.1	< 0.8
PO <sub>4</sub> (mg/L)	0.1	< 0.002
TOC (mg/L)	1.2	< 0.3

# ■ Main Challenges for Reused Water

## Highly corrosive water

- Mild steel corrosion due to lack of buffer capacity in the presence of Cl and oxygen
- Low calcium prevents normal corrosion inhibition mechanisms
- Copper corrosion due to ammonia

## Microbial activity

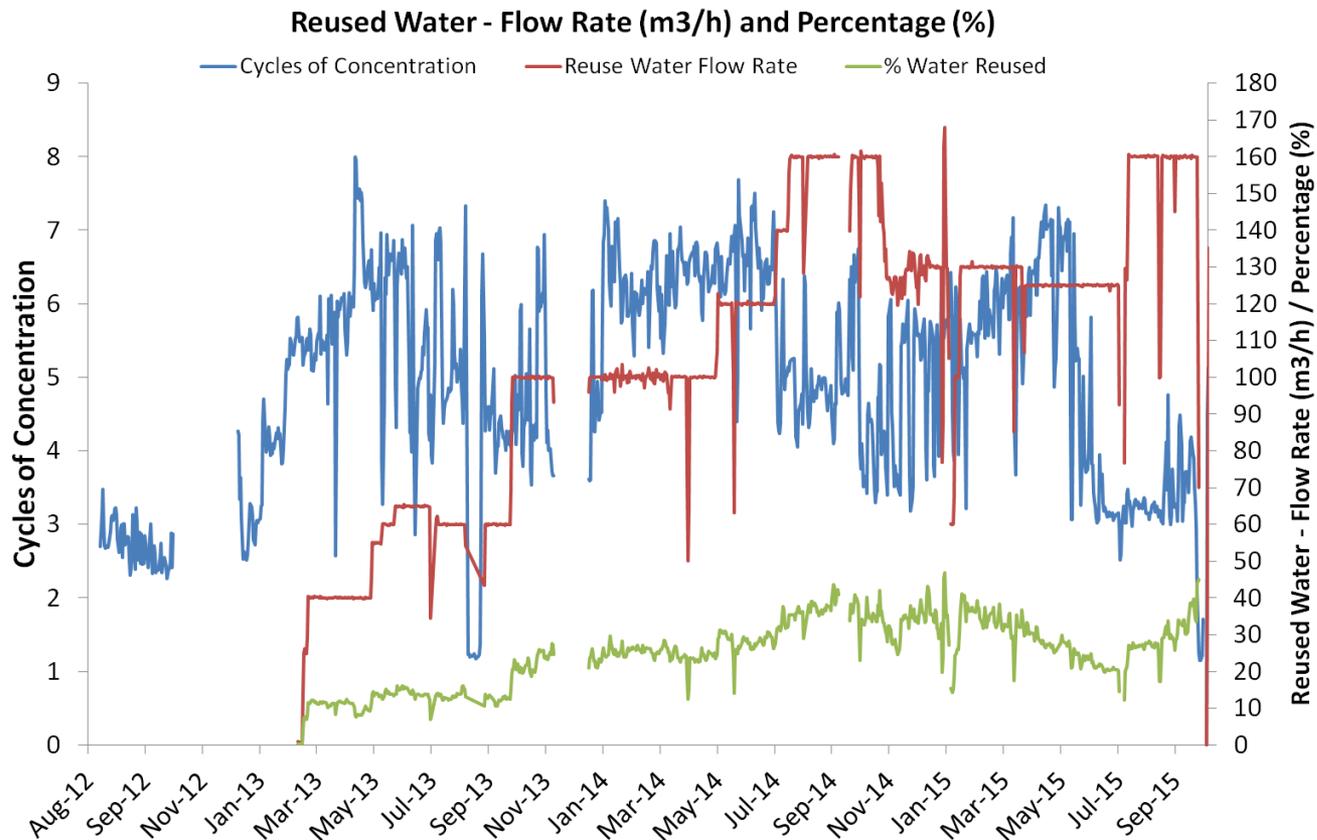
- Microbiological growth due to high nutrients and organic content
- Chloramine formation lowering biocide activity

## Highly variable make up water

- High cycles possible due to low salt content
- Cycles limited by leaks, upsets, etc. (quick variation in cycles with a leak)

# Reclaimed Water Phases

- The Reverse Osmosis make-up water presented 3 phases:
  - Initial step is between 40-60 m<sup>3</sup>/h (15%)
  - Then moves up to 100 m<sup>3</sup>/h (25%)
  - Finally reach 160 m<sup>3</sup>/h (40%)



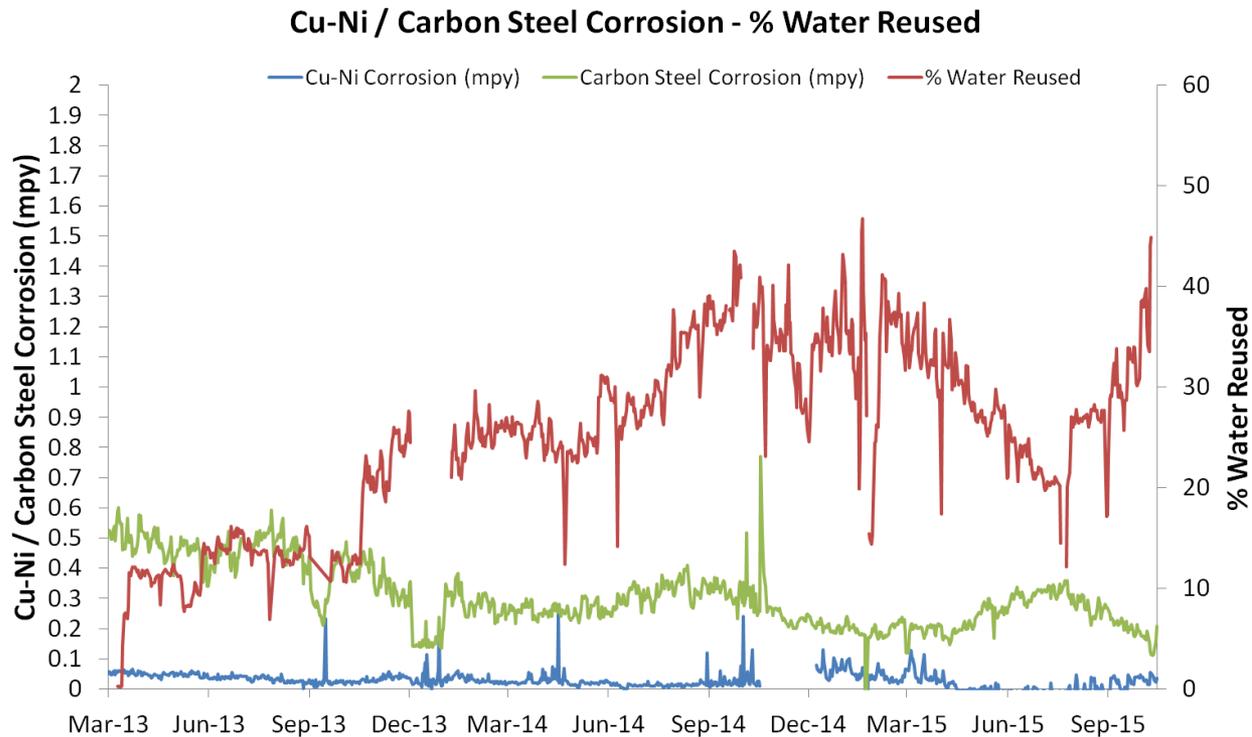
# Cooling Towers Concentration Cycles

- The Cracker cooling tower ran on 100% Ebro river water at 4 cycles prior to the gradual change to 160 m<sup>3</sup>/h of RO permeate at 7 cycles
- Increase in concentration cycles during high municipal demand during summer due to higher evaporation reduces consumed water by 110 m<sup>3</sup>/h (22%) and a sewage reduction of 76 m<sup>3</sup>/h (49%)

Compound	Ebro	RO Permeate	Ebro x 4	Permeate x 7
Conductivity (µS/cm)	950	19	3,800	135
Cl (mg/L)	260	2.9	1,040	21
CaCO <sub>3</sub> (mg/L)	95	< 0.1	380	< 1.0
SO <sub>4</sub> (mg/L)	160	0.02	640	0.07
NH <sub>3</sub> (mg/L)	0.1	< 0.8	0.4	< 5.0
PO <sub>4</sub> (mg/L)	0.1	< 0.002	0.4	< 0.02
TOC (mg/L)	1.2	< 0.3	4.8	< 2.0

# Corrosion Study

- Nalco Champion 3D TRASAR® Technology allows to run at higher cycles of concentration without affecting corrosion and scaling
- Carbon Steel and Copper-Nickel corrosion is not affected by using Reverse Osmosis permeate water as both are kept negligible (<1 mpy and < 0.1 mpy respectively)



## Microbiological Study

- Reverse Osmosis Permeate is a safe water
- Ammonia is just found in traces levels
- Total Organic Carbon (TOC) is below recommended limit of 50 ppm
- Aerobic Bacteria are below recommended range of < 10,000 UFC/mL
- Legionella concentration is below minimum range of 40 UFC/ml

	River Water (100%)	River Water (60%) + Reclaimed Water (40%)
Cooling Water NH3 (mg/L)	0.05	0.03
Cooling Water TOC (mg/L)	19.3	21.0

## Key Takeaways

- Reclaimed water can be used in the industry instead of pre-treated river water with a positive impact in the environment as it does not hydraulically stressing rivers
- Stable operation of the cooling tower is achieved since starting blending reclaimed water as make-up water in the Dow Tarragona Ethylene Cracker Cooling Tower
- Reclaimed water is used up to 160 m<sup>3</sup>/h (40%). Depending on the season this frees up more than 200 m<sup>3</sup>/h of water rights for the municipality. Cooling Tower Blowdown discharge is reduced by 76 m<sup>3</sup>/h (49%)
- Nalco Champion 3D TRASAR® Technology allows to run at higher cycles of concentration without affecting corrosion
- Using reclaimed water from a Wastewater Treatment plant that has undergone a Reverse Osmosis filtration step present no health concerns when compared with conventional pre-treated river water



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**Thank  
You**

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