Working with irrigation water

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Agriculture

The challenge

- Globally the quality of irrigation water from rivers, dams and boreholes has deteriorated.
- Irrigation water has become more contaminated with chemicals, salts, chlorides, and various heavy metals, bacteria and organic matter.
- All of these accumulate as biofilm or scale deposits lining the irrigation system and result in blocked, dirty and ineffective irrigation systems.

Dirty and blocked irrigation systems!

- Clog and reduce filter efficiency
- Increase filter cleaning, backwashing cycles and workload
- Clog and line pipes, increasing pressure and lowering water flow efficiency
- Extend irrigation time / cycles
- Increase workload of pump
- Clog nozzles / drippers / micros which lead to variable water discharge rates
- Complicates water scheduling
- The irrigation system cannot operate according to the specifications of the original design
- Increase labour, maintenance and electricity costs

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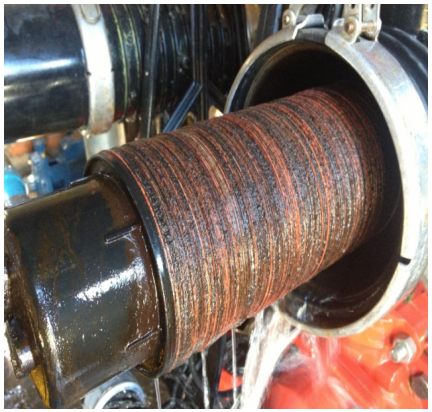
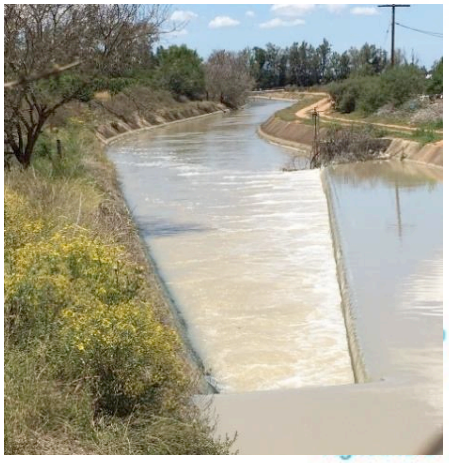
The challenge

- The water requires treatment and the irrigation systems must be cleaned and maintained.
- Compaction, mineral availability and disease problems in pots/bags/soil and plant growth effects.
- My water is fine!!!!!!!!!!!!!!!!
- Lack of understanding of what is in water, how water works how to interpret results and impact of the irrigation water on production and business.

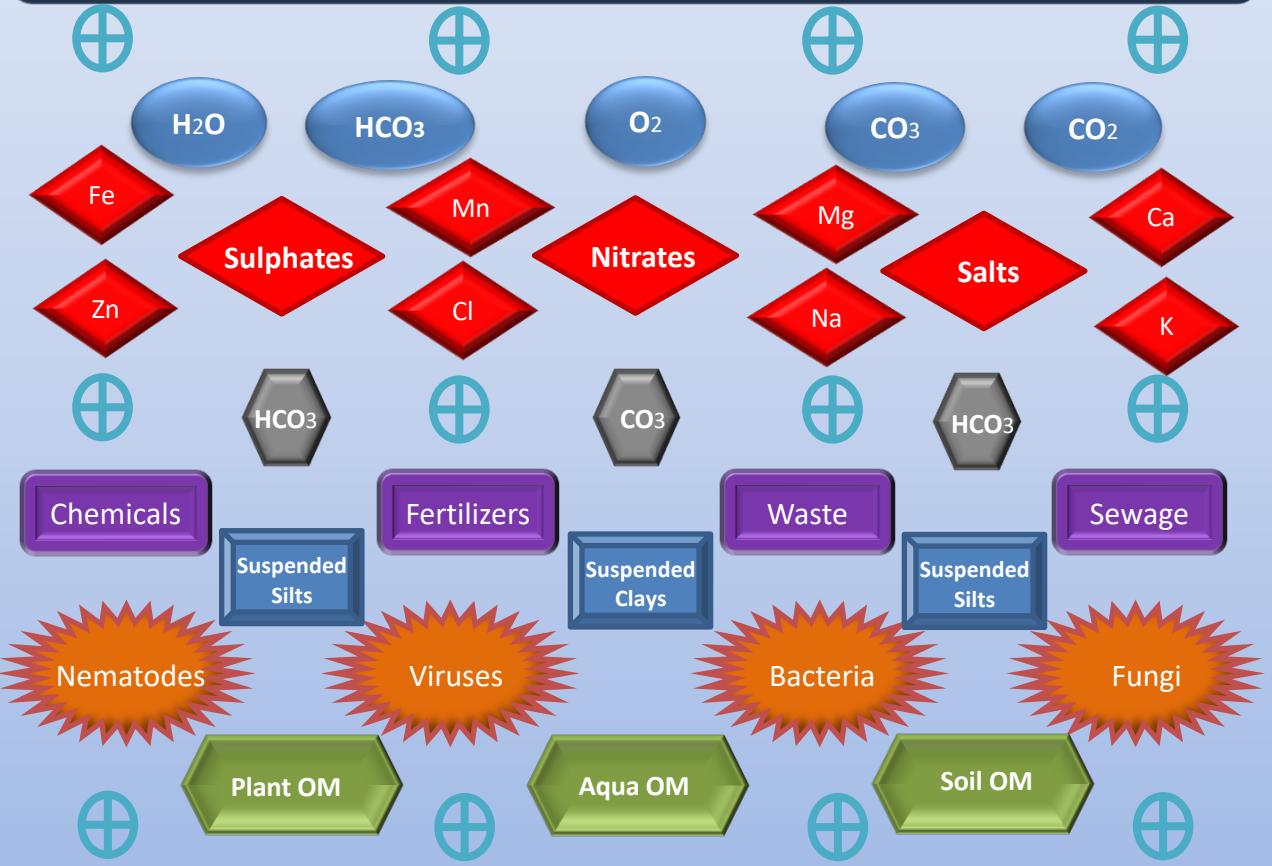
The challenge

- Many of the current available water treatment options for irrigation water come at an exorbitant price, focus on only one or two aspects of water treatment and do not address the diversity of problems associated with irrigation water quality.
- Need a comprehensive solution to address diverse water challenges in the most cost-effective manner.



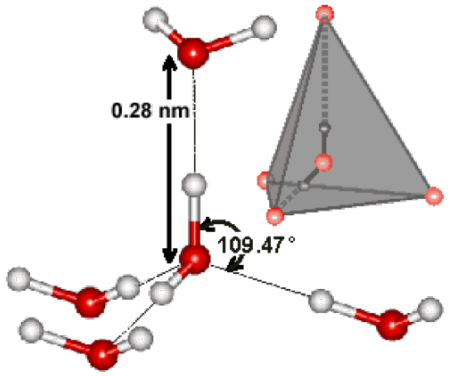


What is in irrigation water?



LETS LOOK AT WATER

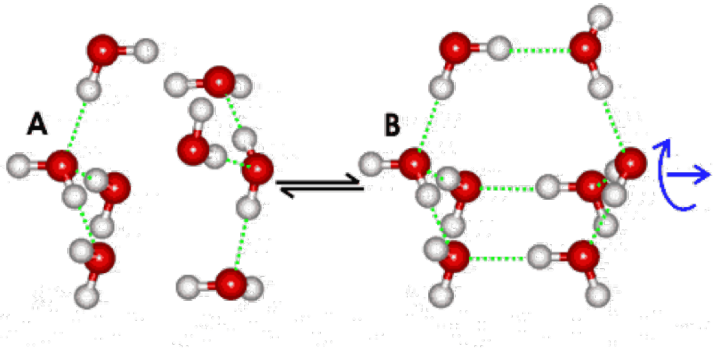
The favoured configuration of water molecules is a hydrogen-bonded cluster in which four H_2Os are located at the corners of an imaginary tetrahedron.

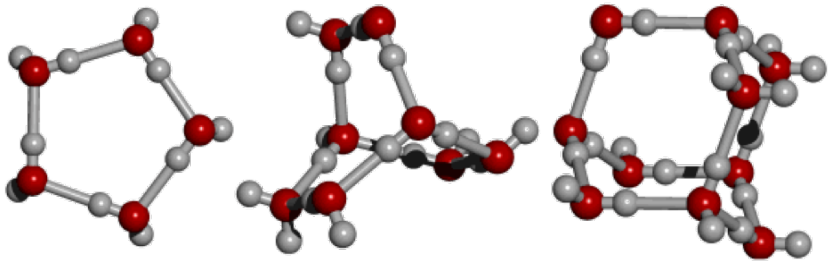


But

- The individual hydrogen bonds on each cluster, are continually breaking and re-forming. Thus the cluster is subject to continuous change.
- This happens every 10^{-12} to 10^{-15} seconds.

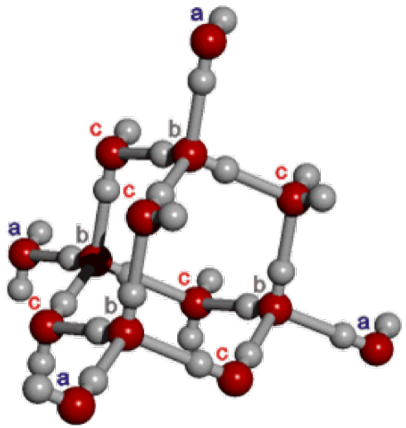
LETS LOOK AT WATER





The structure rotates and varies according to water phase

LETS LOOK AT WATER



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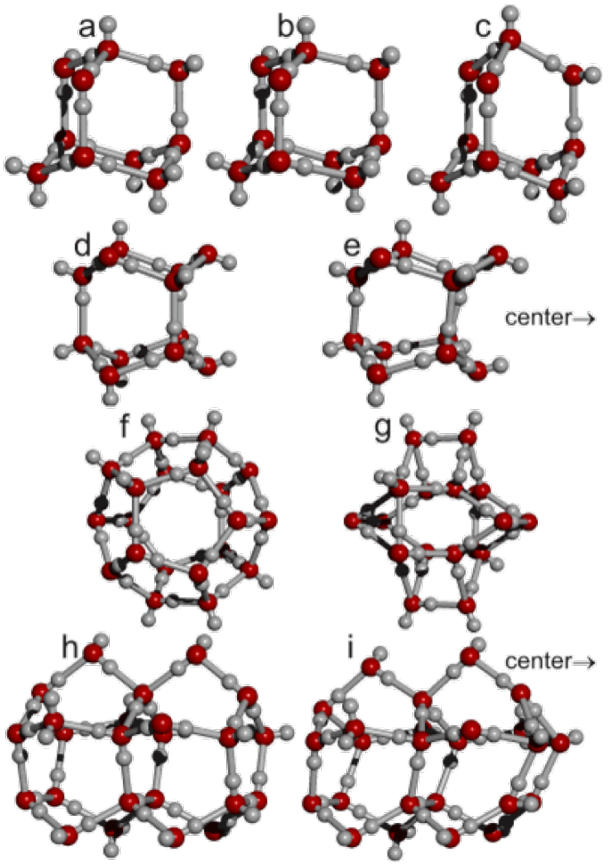
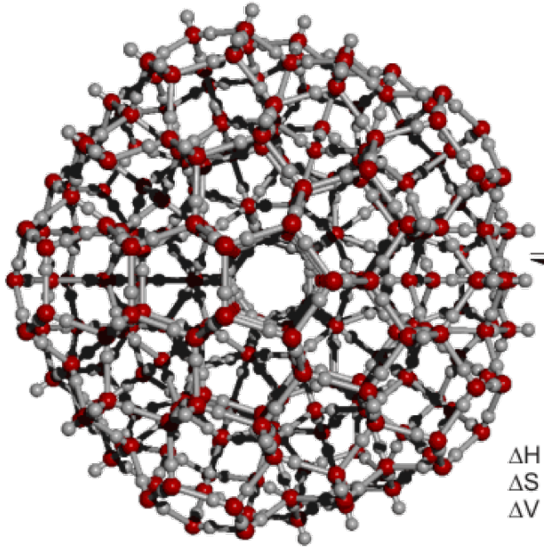
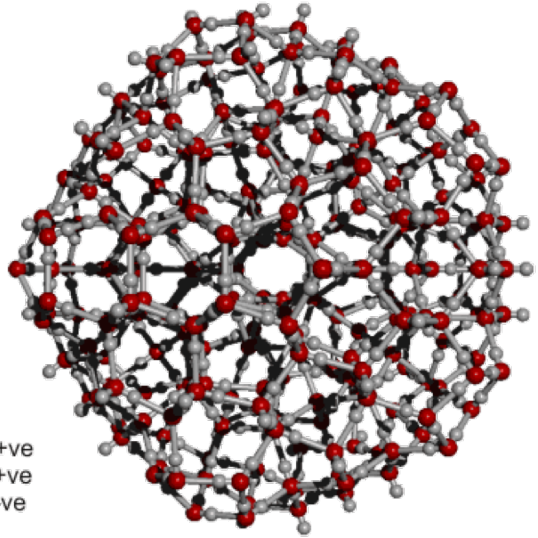


Expanded structure (ES)



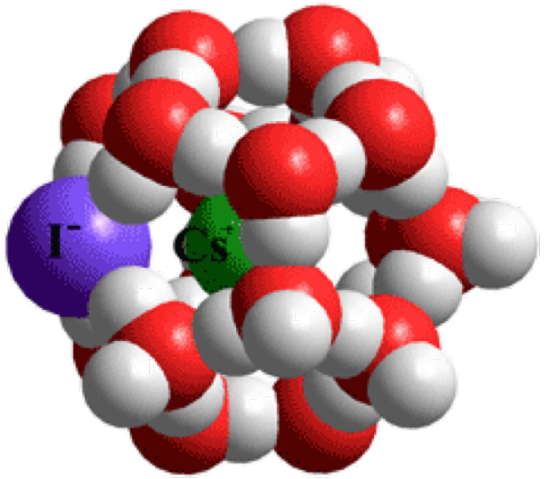
Collapsed structure (CS)

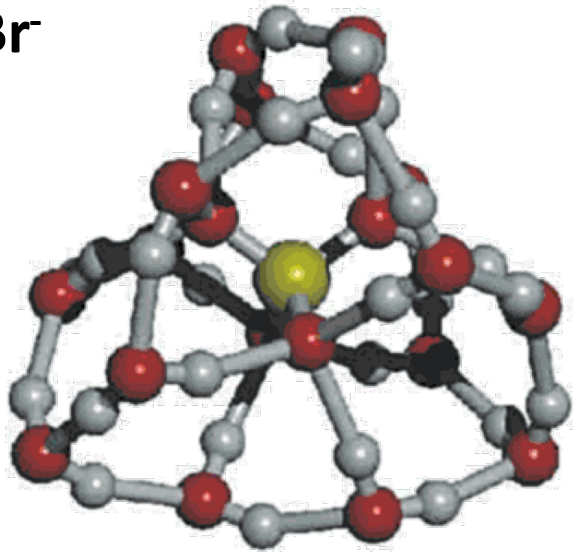


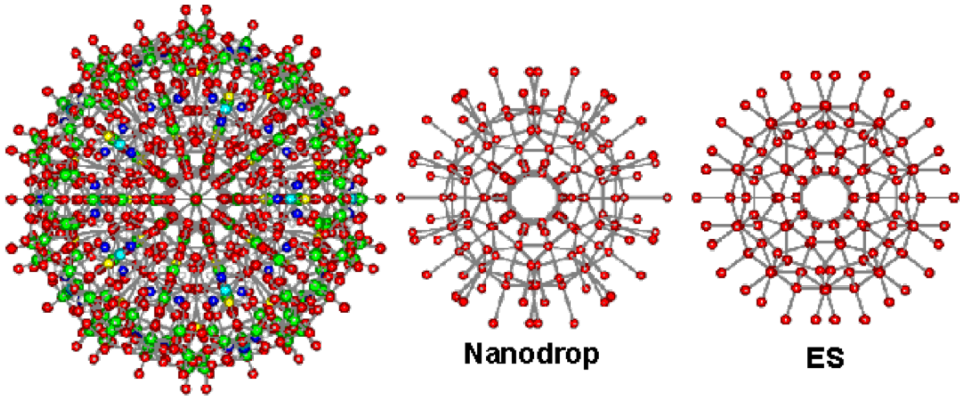
ΔH is +ve
ΔS is +ve
ΔV is -ve

What happens with salts?

20 H_2O molecules form a water clathrate around ions Na^+, K^+ , Cs^+, Ca^{2+}, Cl^- , Br^-







But remember, no matter what the instant time chemical structure in any solution -

- The molecules undergo rapid thermal motions and break apart every pico to femto second.

Water is dynamic and complex

Wilcox Water Classes

Class	Description	Quality	Measurement
Salinity (EC)			
C1	Low conductivity	Excellent	$EC \leq 250\ {}^{\mu\sigma}/_{cm}$
C2	Medium conductivity	Good	$250 < EC \leq 750\ {}^{\mu\sigma}/_{cm}$
C3	High conductivity	Average	$750 < EC \leq 2250\ {}^{\mu\sigma}/_{cm}$
C4	Very high conductivity	Not usable	$EC > 7500\ {}^{\mu\sigma}/_{cm}$
Sodium Hazard (SAR)			
S1	Low alkalinity	Good	$SAR \leq 10$
S2	Medium alkalinity	Average	$10 < SAR \leq 18$
S3	High alkalinity	Problematic	$18 < SAR \leq 26$
S4	Severely alkaline	Very Bad	$SAR > 26$

WATER RESULTS

- Eastern Cape Results.xlsx
- Variable E.Coli
- High pH, Na, Cl
- Ratio of Ca:Mg
- SAR ok but how much Na, Ca, Mg, Cl are we applying per ha per annum.
- We have not touched on Fe and Mn challenges?
- This is just chemical – what about the bacteria, algae, suspended solids, chemical contaminants?

What is the impact of the salts in your irrigation water?

Estimates of amounts of salts deposited on irrigated lands per ha per annum

EC (dS/m)	WATER CLASS	AV TDS (ppm or mg/L) (EC x 640)	Kg of salts applied/ha/annum — Cubic m of water applied/ha/annum 2500	5000	7500	10000
0,25	1	160	400	800	1 200	1 600
0,5	2	320	800	1 600	2 400	3 200
0,75	2	480	1 200	2 400	3 600	4 800
1	3	640	1 600	3 200	4 800	6 400
1,25	3	800	2 000	4 000	6 000	8 000
1,5	3	960	2 400	4 800	7 200	9 600
1,75	3	1 120	2 800	5 600	8 400	11 200
2	4	1 280	3 200	6 400	9 600	12 800
2,25	4	1 440	3 600	7 200	10 800	14 400

Agriculture

How can one handle water?

At what point does one theoretically start running into real problems:

- EC >750 μmhos/cm, 75mS/m, 0,75 dS/m
- TDS > 600 mg/L
- Chloride anion >140 mg/L (<70)
- SAR >18 (1-3)
- Total hardness >150 mg/L (<150)
- Suspended solids > 100 mg/L (<30)
- Ca >100 mg/l (50-100)
- Mg > 30 mg/L (<30)
- Na >115 mg/L (<70)

The reality is a lot lower than these figures

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How can one handle water?

Depending on the challenge and requirements:

1. Sand, disc or diaphragm filters
2. Settle suspended material with flocculation?
3. Disinfect with ozone, chloride, peroxide or optimize water quality with the Puricare AOP.

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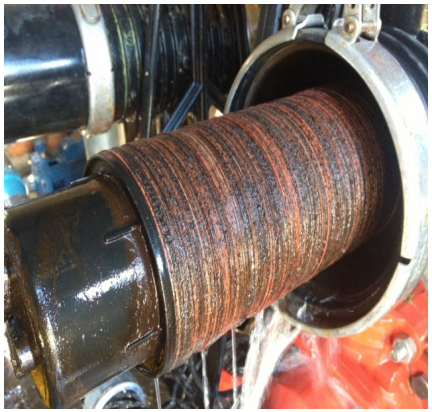
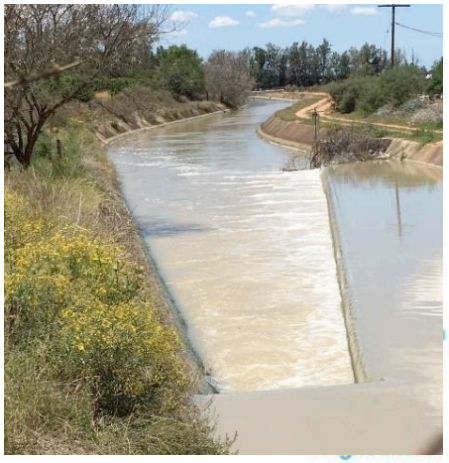
The challenge

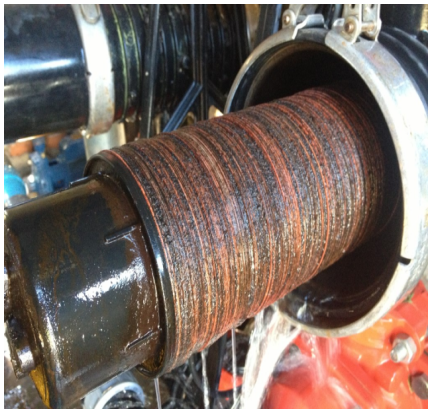
- Exorbitant price
- Focus on only one or two aspects of water treatment
- Don’t address the diversity of problems associated with irrigation water quality.
- Need a comprehensive solution to address diverse water challenges in the most cost-effective manner.

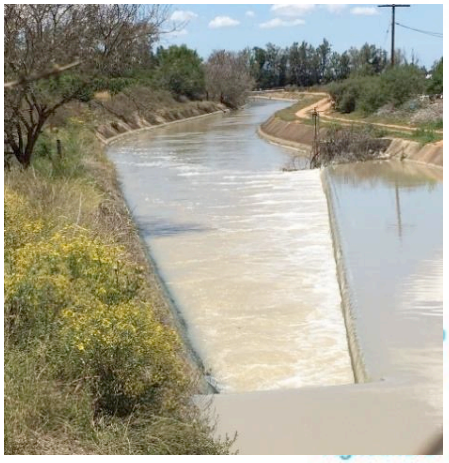




Common industrial oxidizers & potential relative to chlorine

Oxidant	Oxidation potential (mV)	Oxidation relative to chlorine
Fluorine	3,050	2,25
Ozone - nurseries	2,070	1,52
Hydrogen peroxide - nurseries	1,780	1,31
Potassium permanganate	1,680	1,25
Chlorine dioxide -nurseries	1,570	1,15
Chlorine (as Hypochlorite) - nurseries	1,360	1,00
Bromine	1,070	0,7





Consideration	Chlorine	Ozone	UV	Peroxide	Ozone & peroxide
Equipment reliability	Good	Good	Medium	Good	Good
Complexity	Less	More	Medium	More	More (P-AOP V complex)
Safety concerns	Low to High	Low	Low	Medium	Medium (P-AOP low)
Bacteria & pathogens	Good	Good	Good	Good	V Good
Chemical oxidation	Medium	Good	Medium	Good	V Good
By-products	High	Low	Low	Low	Low
Residual	High	None	None	None	None
pH dependency	High	Low	None	Low	Low
Maintenance	Low	Medium	Medium	Low	Medium (P-AOP low)

The solution depends on the challenge, water volume & cost

	Low volumes (10-30 m3/hr)	High volumes (>30 m3/hr)
• Biological & physical challenge		
• Flocculation	(R)	(RRR)
• Filtration		
• Macro to nano filtration	(RR-RRRR)	(RR-RRRR)
• Ozone and peroxide AOP's	(RR)	(R)
• Biological & chemical challenge	Low volumes (10-30 m3/hr)	High volumes (>30 m3/hr)
• Disinfection/Sanitation		
• Chlorination	(RR)	(RRR)
• Other chemicals	(RRR)	(RRRR)
• Ultraviolet radiation	(RRR)	(RRRR)
• Oxygenation/Aeration	(R)	(R)
• Ozonation	(RR)	(RRR)
• Peroxide	(RR)	(RRR)
• Ozone & peroxide AOP	(RR)	(R)
• Reverse osmosis	(RRRRR)	(RRRRRRR)
• Ozone and peroxide AOP's	(RR)	(R)

What we do

Through the treatment of irrigation water, Puricare® offers a proven, reliable and cost effective way to improve water quality and clean and maintain irrigation systems.

40 000 ha since 2012!!

Durable • Proven • Economical

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Puricare unit

- Utilises low doses of UV ozone and hydrogen peroxide as part of our own advanced oxidation process (the P-AOP).
- Works in irrigation water as it enters and travels through the irrigation system.
- Amongst other things this water treatment process generates radicals (e.g. ozone and hydroxyl radicals) which act as oxidants in the irrigation water.
- These oxidants break down pollutants, organic and inorganic compounds, organic matter, reduce specific aspects of hardness, oxidise some heavy metals,

  reduce counts of pathogens etc..

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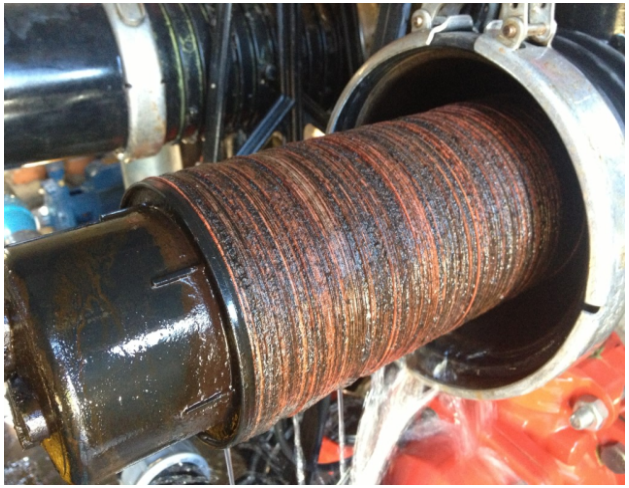
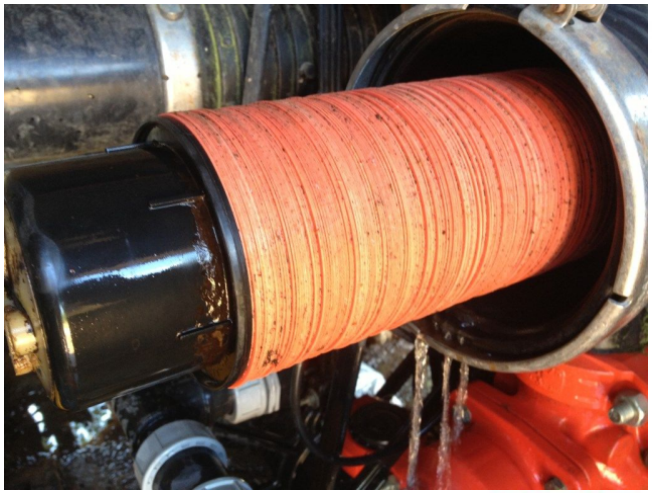
Benefits – clean irrigation systems

All the advantages of continuously cleaned filters and irrigation systems

- Uniform water and fertiliser delivery.
- Better water use efficiency.
- Management advantages – water, electricity, maintenance, time & labour cost savings.





Benefits – better water quality!

There are numerous advantages of treating irrigation water with the P-AOP:

- Given all the interactions at a chemical and biological level – the water tastes, looks and smells better.
- Various aspects of water pH, hardness and salinity can be improved and ion combinations improved. Salt deposits are slowly broken down and don't reform.
- Chlorides, iron & manganese are oxidised and pass through filters. The end form is less available and less toxic in root zones.
- Toxic chemicals from industrial, agricultural waste and sewerage treatments are broken down into less harmful forms.
- Counts of various waterborne pathogens and microbes (e.g. algae, *E.coli* & other bacteria) can be reduced.

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Benefits – protect capital investment!

Our technology will optimize the life expectancy of an irrigation system…

Proven where it matters most

- on >40 000 ha

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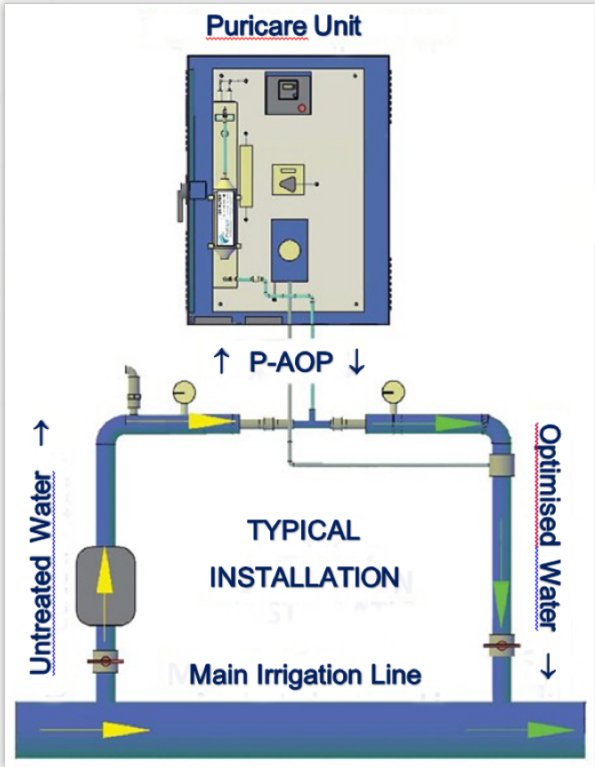
Complete solution



- **The Puricare unit is easy to install and run - in any irrigation system.**
- **A cost effective product** – affordable once off capital layout per hectare, life expectancy of the unit of 10 years or more, one unit treats ± 25 hectares, very low monthly running costs (cheaper than continuously applied chemical solutions).

Our technology is easy to install, effortless to manage and cost effective to maintain!

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Thank you!!!

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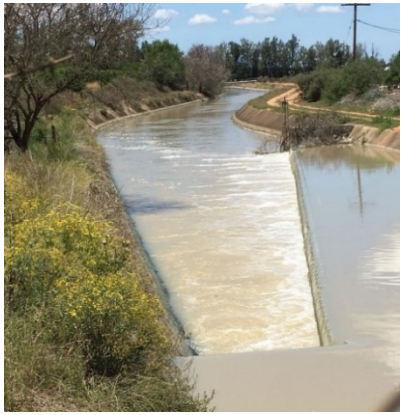
Fact Sheet 1 – Puricare treatment of irrigation water quality

Globally, irrigation water sourced from rivers, dams and boreholes has become more contaminated with chemicals, bacteria, salts, chlorides, various heavy metals etc.. Many of the current available water treatment options for irrigation water come at an exorbitant price. They only focus on only one or two aspects of water treatment, do not address the diversity of problems associated with irrigation water quality, and various challenges associated with irrigation water influence their efficiency.

Puricare's water treatment (P-AOP) provides a comprehensive solution to address diverse water challenges in the most cost effective manner.



Puricare's water treatment (P-AOP), utilising low volumes of UV ozone and hydrogen peroxide technology, causes the following chemical, biological and physical changes in irrigation water:

- ✓ High water pH can be lowered
- ✓ Effects of salinity are reduced
- ✓ The formation of more beneficial salts are favoured e.g. calcium carbonate conversion to calcium sulphates is promoted
- ✓ Chlorides and heavy metals (e.g. Iron & Manganese) are oxidised to less available forms, thus reducing toxicity
- ✓ Toxic chemicals from industrial, agricultural waste and sewerage treatments are broken down into less harmful forms
- ✓ Oxidised particle or precipitate sizes are reduced to a nanoscopic scale
- ✓ Counts of various waterborne pathogens and microbes (e.g. algae, E.coli & other bacteria) will be lessened
- ✓ Turbidity is reduced and organic matter broken down
- ✓ Water tastes, smells & looks better

References:

- *Alternative Disinfectants and Oxidants. EPA Guidance Manual. EPA 815-R-99-014 April. 1999.*
- *Comparison of bacterial growth in treated and untreated irrigation systems - 2015. Puricare Technical Case Study. Ref.B15.*
- *Effects of Puricare's Water Treatment Technology (P-AOP) regarding the cleaning and maintaining of irrigation systems. Puricare Technical Case Study. Ref.B1a.*
- *How to include Puricare's Water Treatment Technology in relevant GlobalG.A.P. V5 control points – Advisory Document (for producers). Ref.A11.*
- *Irrigation Water Quality Guidelines Adapted for Puricare – Technical Document. Ref.A8.*
- *Irrigating with saline water. Puricare Technical Case Study. Ref.B9.*
- *Ozone reactions with inorganic and organic compounds in water. Portjanskaja E. Ozone Science and Technology. 2008.*
- *Peroxone (Ozone/Hydrogen peroxide). EPA Guidance Manual. Chapter 7. EPA 815-R-99-014 April. 1999.*
- *Puricare Technology in Agricultural Irrigation Water 2016 – Technical Document. Ref.A4.*
- *Puricare Treatment of Saline Irrigation Water – Technical Document. Ref.A5.*
- *References used in the Development, Research and Verification of the Proprietary Puricare Advanced Oxidation Process (P-AOP) - Technical Document. Ref.A9.*
- *The use of Puricare Technology in Biological and Organic Production Systems 2016 – Advisory Document. Ref.A6.*

Fact Sheet 2 – The irrigation system is clean

The source and quality of irrigation water determine the amount of physical, biological and chemical sediment or scale deposited and encrusted into the filters and irrigation system, and the cleaning and management thereof. Various combinations of silts, clays and organic matter (physical sources), bacteria and algae (biological sources) and salts and minerals (chemical sources) in the irrigation water form these deposits. They create a lining in the irrigation pipes and can cause partial or complete plugging of the emitters.

The Puricare water treatment (P-AOP) works in the water delivered by the irrigation system and acts directly on the biological and chemical deposits, completely breaking them down and inhibiting any further deposit formation, keeping the irrigation system constantly clean in an environmental friendly manner.

The main advantages of a Puricare cleaned irrigation system:

- ✓ **Uniform water & fertiliser delivery**
- ✓ **Less flushing & backwashing required**
- ✓ **Cost savings in labour, maintenance & electricity**
- ✓ **Low running costs**
- ✓ **Peace of mind with an irrigation system that is automatically & continuously cleaned**

References:

- *Comparison of bacterial growth in treated and untreated irrigation systems - 2015. Puricare Technical Case Study. Ref.B15.*
- *Effects of Puricare's Water Treatment Technology (P-AOP) regarding the cleaning and maintaining of irrigation systems. Puricare Technical Case Study. Ref.B1a.*
- *GlobalG.A.P. Audit Document 2016 – Advisory Document (for GG auditors). Ref.A7.*
- *How to include Puricare's Water Treatment Technology in relevant GlobalG.A.P. V5 control points – Advisory Document (for producers). Ref.A11.*
- *Puricare Technology in Agricultural Irrigation Water 2016 – Technical Document. Ref.A4.*
- *Puricare Treatment of Saline Irrigation Water – Technical Document. Ref.A5.*
- *Rooiland Farm – 2012. Puricare Technical Case Study. Ref.B10.*
- *The use of Puricare Technology in Biological and Organic Production Systems 2016 – Advisory Document. Ref.A6.*

Fact Sheet 3 – Soil aeration the Puricare way

For various reasons our agricultural soils have become more compacted, soil health has declined, soil productivity is challenged and soil maintenance & restoration have become a crucial aspect of sustainable farm production. A key component of any soil restoration process is to improve soil aeration so that all the biological processes can occur and soils can function as they should.

For every 10 cm of deeper roots an extra 1000 m^3 of healthy soil can be farmed and utilised per hectare. This has very positive implications on crop resilience and potential, as well as reduced production risk and costs. How does the Puricare water treatment (P-AOP) do this in soil? We treat the irrigation water to optimise quality, the system is cleaned and the benefits of the optimised water are passed onto the soil.

Improving soil aeration with the Puricare Soilcare Unit

With thousands of hectares under Puricare treatment in South Africa and repeated evidence of better soil aeration, the most obvious benefits always recorded are:

- ✓ **Deeper & more prolific feeder root growth**
- ✓ **Improved water infiltration & water use**
- ✓ **Increased mineral availability & better base saturation ratios**
- ✓ **Better soil health**

Through various natural reaction processes in the water, soil solution and soil; clay dispersion is reduced, pore size between soil particles increased, oxygen is released in the soil and thus soil aeration improved. At the same time soil biology begins to work and all these natural processes promote soil and crop productivity. The Puricare Soilcare Unit is the most cost effective way to continuously aerate soil in the global agricultural industry today.

References:

- *A Brief Review of Soil Aeration – Advisory Document. Ref.A13.*
- *Puricare Technology in Agricultural Irrigation Water 2016 – Technical Document. Ref.A4.*
- *Puricare Treatment of Saline Irrigation Water – Technical Document. Ref.A5.*

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