The Growing Challenge of Water Management in Industrial & Commercial Infrastructure

Focus on Cooling Tower Applications

Unleashing the power of nature to revolutionize industrial processes

Challenges

The Global Water Challenge

- **Increasing infrastructure = water intensive processes**
- **Climate change is intensifying water stress globally**
- **Water scarcity is a critical challenge in industrial operations**

Regulatory Landscape

- New EU Standards:

- Stringent CSRD requirements for sustainability
- Industries pushed towards more sustainability

- Traditional Cooling Systems:

- Resource-heavy, inefficient, and increasingly unsustainable

Key Point: Industries must act now to comply with regulatory changes

The Impact of Cooling Towers

Cooling towers vital for industrial cooling but pose significant challenges:

15-20% of Total Industrial Water Usage: In industrial settings, cooling towers account for significant water consumption **(up to 8% of total fresh water usage)**

Current systems lead to pollution, waste and inefficiency

Cooling Towers as a Critical Component of Infrastructure

- Necessary for maintaining industrial processing
- Major contributor to water usage and pollution
- Heavily dependent on chemicals
- Large contributors to CO2 emissions

Environmental and Cost Pressures:

- Rising operational costs due to water scarcity.
- Increased scrutiny due to environmental regulations
- Further research in chemical evaporation concerns

The Need for Innovative Solutions

Water Savings as a Priority

New technologies are essential to optimize water use in cooling systems, directly improving sustainability KPIs

Urgent Action Required

Tackle cooling tower challenges to ensure long-term environmental and operational sustainability

- Drastically reduce water use in cooling operations
- Align with regulatory standards and enhance sustainability KPIs
- Minimize dependency on chemicals

Next Steps for Industry

- Adopt innovative cooling technologies
- Ensure compliance while conserving water

INDUSTRIAL VORTEX GENERATOR - IVG

Harnessing Nature to improve industrial processes
Industrial Vortex Generator (IVG)

Scalable – Modular IVG-CT solution:

Point-of-source wastewater treatment for reuse

Fully Modular water treatment application based on patented Vortex Process technology (VPT) for improving sustainability of Industrial Water processes.

Plug and play
Ease of deployment

Cost Savings
ROI < 3 years

Water quality and quantity agnostic

Chemical-free
in-situ process

Long life-span
15+ years
Reduced maintenance

Local assembly
Easy maintenance

24/7 Monitoring
Full remote control

Space Savings
Small footprint

Industry agnostic

Industrial Vortex Generator IVG – CT

Nature-Driven Solutions for a Sustainable Industry.

Unleash the Force of Nature Harnessing the Power of the Vortex

Vortex Process Technology
VPT

Industrial Vortex Generator
IVG

Removes Air Bubbles

Decreases Viscosity (up to 20%)

Increases density (up to 5%)

Creates Cavitation

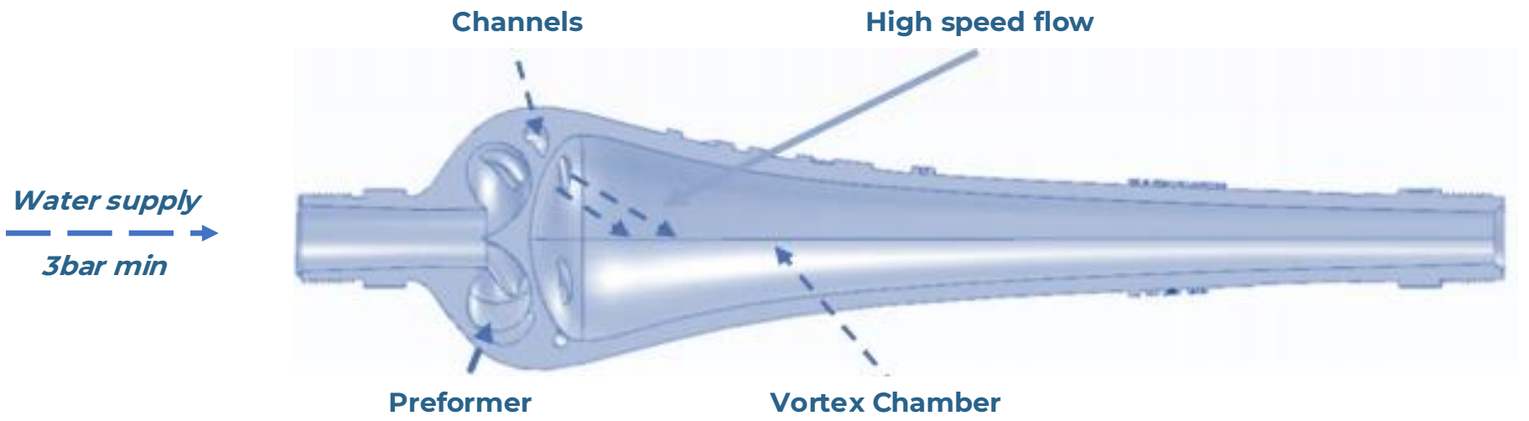
Crystalizes Calcium, Iron & Manganese

Reduces water consumption

Reduces energy

No need for chemicals

Focus on VPT:
Transformation of the water inside the vortex chamber



STEP 1

The microbubbles in water are sucked into the chamber at very low pressure, they migrate to the center where the pressure is lowest, then are accelerated due to the pressure gradient.
The bubbles expand and combine in the center, which has very little pressure.
A powerful hydrodynamic force creates cavitation which changes the balance of the water and affects the calcium crystals in the water.

STEP 2

Controlled cavitation leads to the formation of limestone particles.

The process produces a micro zone at low pressure and high temperature (the solubility of $CaCO_3$ decreases), causing the reaction of calcium ions and dissolved carbonate and the formation of crystals of colloidal calcium carbonate. The cavitation phenomenon acts on the pH by increasing it.

STEP 3

This phenomenon allows the particles to act as incubators so that the dissolved calcium and carbonate ions aggregate rather than attach to metal surfaces.

The limestone particles already formed fragment when they pass through pressure gradients undergoing shear forces

STEP 4

Calcium bicarbonate ($CaHCO_3$) in water is forced to precipitate as calcite ($CaCO_3$) - mainly aragonite crystals with minimal scaling properties - do not crystallize on hot surfaces

Feedback and benefits observed on installations equipped with IVG-CT

The solution is deployed in > 150 chemical-free installations in the BeNeLux and United States

Up to 50%
Water savings

- Operation of higher COC within cooling towers
- Water savings thanks to lower make-up water volume
- Up to 100% purge water can be reused for other purposes such as irrigation, and reduced discharge into sewers

6 to 8 %
Energy savings

- Optimization of heat exchanges
- Maintenance reduction and prevention of components of cooling towers
- Onboard energy: additional kWh / kW upstream / downstream the savings made by reducing pumping and water treatment

100%
Reduction in chemical usage

- Reduction of operational costs related to the purchase of chemicals and reduction of maintenance costs (cleaning)
- Reduction of toxic elements in purge water
- More sustainable: tends towards a circular economy

Substantial operational cost reductions (ROI < 3 years)

- No chemical costs
- As no chemicals - no discharge costs
- Reduced maintenance costs Increase of life expectancy of installation
- Compliance with ESG reporting
- Increase in sustainability
- Substantial reduction of CO_2 footprint

Client References

+150 commercial deployments in BeNeLux and US

Currently 50% of new business is repeat sales with existing customers

MoU signed with AirProducts - LambWeston

Current Pipeline > 50 installations by 2028 (based on only 2 clients)

Conversation rate:
100 % retrofit installations
100% chemical free

Heineken
flevolof PuYen
smartdc PERFORMANCE DATACENTERS
VRIESHUIS
Van Kesteren SCHILDERS
Grolsch
VITELCO YOUR PARTNER IN VEAL
MARRIOTT
AMGEN
vansoest chocolatier amsterdam
FrieslandCampina
Firma Oostende DE STAD AAN ZEE
VCA, Asten
KRUININGEN
Rijkevorsel
HUNTSMAN Enriching lives through innovation
vansoest chocolatier amsterdam
City of Hope
LambWeston SEEING POSSIBILITIES IN POTATOES
Community Icerink, Breda
AIR PRODUCTS

Feedback and benefits observed on installations equipped with IVG-CT

Lamb Weston Meijer – IVG20-CT Pro skid

Type of industry: Food industry - Potato processing

2nd largest world producer of frozen potatoes (800,000 tons in Europe and 4 million tons worldwide per year)

Type of cooling and cooling towers: Evaporative condensers for ammonia cooling

IVG technology: 3 x IVG20-CT - Power consumption: 12 kw

	Before installation	After installation
Evaporation capacity in MW	24 MW	24 MW
Water evaporation	37,20 m3/h	37,20 m3/h
Water consumption	68,20 m3/h	42,51 m3/h
Cooling water thickening	Factor 2,2	Factor 10
Chemicals used	28 640 kg	0 kg
Reduction in chemicals		100%
Pay Back		2,2 years

Objective: to become circular by 2025

The target for 2025 is a 50% reduction in direct water consumption and a 30% reduction in direct energy consumption per ton of final product.

Lamb Weston Meijer has decided to no longer use process chemicals at the site.

Since 2019, several additional IVG-CT have been deployed for the final cooling towers to allow all facilities to operate without the use of chemicals. We are currently in the process of installing our 8th application.

Given the fantastic results we were able to achieve, Lamb Weston has requested that by Q4 2023 their 50 sites should start to be equipped with our IVG-CT application (deployment in progress)

Water specs before IVG (2015)

Analysis report				
Description		**Make-up**	**Cooling Water**	**Limits**
pH	pH	7,45	8,8	7,0 - 8,9
conductivity	mS/cm	551	1156	2.400
total hardness	°dH	7,8	16,4	2 - 29
toal hardness	ppm $CaCO_3$	139	292	36 - 516
chloride	ppm Cl^-	37	79	300
COC based on	conductivity	-	2,10	-
COC based on	chloride number	-	2,12	-
Metal				
Iron	ppm Fe	0,00	< 0,1	< 1,5
Zink	ppm Zn	0,00	< 0,1	< 1,5
Biological activity				
Time between sampling			< 48 uur	< 48 uur
Amount filtered	in ml		250	500
Germination count in	kve/l		< 100	<10.000
Legionella according to ISO			< 100	N.v.t.
Legionella serotype			n.v.t.	
Color sampling			clear	clear

Water specs after IVG-CT WWR+BWR (2023)

Analysis report				
Description		**Make-up**	**Cooling Water**	**Limits**
pH	pH	6,7	8,3	7,0 - 8,9
conductivity	mS/cm	178	1438	2.400
total hardness	°dH	1,4	11	2 - 29
toal hardness	ppm $CaCO_3$	25	202	36 - 516
chloride	ppm Cl^-	11	90	300
COC based on	conductivity	-	8,08	-
COC based on	chloride number	-	8,14	-
Metal				
Iron	ppm Fe	0,00	< 0,1	< 1,5
Zink	ppm Zn	0,00	< 0,1	< 1,5
Biological activity				
Time between sampling			< 48 uur	< 48 uur
Amount filtered	in ml		250	500
Germination count in	kve/l		< 100	<10.000
Legionella according to ISO			< 100	N.v.t.
Legionella serotype			n.v.t.	
Color sampling			clear	clear

The germ number checks indicate that the cooling water remains well within the set margins, and no legionella was found in any of the samples that were taken.
It can be concluded that both visually and during analysis no limescale, corrosion and/or biological contamination was found on the warmth heat exchangers during the warranty period.
The passivation period also expired successfully.

Datacenter
AMSTERDAM

IVG-CT 60	Before	After
Evaporative power in MW	35	35
Evaporation in M^3/h	55	55
Water usage in M^3/h	95	62
COC	2.0-3.5	6.0-8.0
Chemical use in kg / year	15.780,00	0 kg
Blowdown on	sewage	surface water

Water savings

-35,0%

ROI

2.7

CHEMIcal savings

100%

CO2 drop

83%

DATACENTER – IVG60-CT COOLWATER SKID

Amgen –
IVG20-C NANO12 Pro CoolWater skid

Type of industry	Pharmaceutical
Cooling type and cooling towers:	open coolingtowers for cooling chillers
Before IVG installation	
Evaporative capacity in MW	20 MW
Water evaporation	31,00 m3/hr
Water consumption	62,00 m3/hr
Cooling water thickening (COC)	Factor 2.0
Chemical consumption (annual)	26.040,00 kg
Discharge waste water on:	Sewage connection WWTP
After IVG installation	**2016**
Evaporative capacity in MW	20 MW
Water evaporation in m3 / hr	31,00 m3/hr
Water consumption in m3 / hr	34,44 m3/hr
Decrease water consumption in%	**- 44,44%**
Cooling water thickening (COC)	Factor 10.0
Chemical consumption	0,00 kg
Decrease chemical consumption in%	**- 100%**
Return on Investment	**3 years**
IVG technology	IVG20-C NANO12 Coolwater PRO
Absorbed power	22 kW
Discharge waste water	Rainwater drainage without discharge costs

Certifications, Recognitions Assessment results

MATCHING

MATCHING or "Materials & Technologies for Performance Improvement of Cooling Systems performance in Power Plants" is a collaborative project, funded by the EU Horizon 2020 program, aims to reduce the cooling water demand in the energy sector.

CAN WE REDUCE THE COOLING WATER DEMAND IN THE ENERGY SECTOR?

Power generation is a sector requiring great amounts of water. Cooling water for energy production accounts, for 45% of total water abstraction in the European Union, second only to agriculture. Water is fundamental for electricity production and with water becoming increasingly scarce, the power industry cannot afford the risk of having to compete for water resources with other industries including agriculture and houshold uses.

This document shows the results of the part of the MATChING project focusing on the implementation of water treatment technologies for reduction of water use in wet cooling towers at fossil fueled power plants. A broad set of technologies are proposed acting on intake, blowdown, and evaporated water.

enel · ENGIE Laborelec · vito · ITM · endesa · Pathema · EDF luminus · Aquo'still

This project has received funding from the European Union's Horizon 2020 program under Grant Agreement no. 688031

Emerging Technologies

Cooling Tower Water Treatment Using Industrial Vortex Generator Technology EPIC/EPRI – Energy and Water Savings

ET17SCE1020

Prepared by:

Electric Power Research Institute (EPRI)
Cypress, Ltd.
H2oVortex S.A.R.L. Luxembourg

July 2020

SOUTHERN CALIFORNIA EDISON®
Energy for What's Ahead™

Certifications, recognitions

- European Commission Horizon 2020 Matching Program
- Swedac Certified
- EPRI - Electric Power Research Institute study report: Study carried out from July 2016 to April 2020 in California on two sites equipped with cooling towers: https://www.etcc-ca.com/reports/cooling-tower-water-use-optimization-epicepri
- Report "The Use of Additives in Open Recirculating Cooling Systems" from the Dutch Ministry of Water
- DAkkS - Deutsche Akkreditierungstelle - accreditation on drinking water tests
- Certificate of conformity for food use - Food and Drug Administration
- IVG Cooling Tower Approved for Utility Incentives in USA
- Certificate: BioCompatibility test Following EC / ISO 10993-1

SWEDAC Certified

EPRI ELECTRIC POWER RESEARCH INSTITUTE

HORIZON 2020

DAkkS Deutsche Akkreditierungsstelle

MATChING

Rijkswaterstaat
Ministerie van Infrastructuur en Waterstaat

Certifications, recognitions

- 2020: Approved by DVGW W270 certification for its compliance with the PA2200 test
- 2020: Accepted in the European Horizon 2020 program for innovations in air-cooling towers
- 2019: Pathema: Receives the “Energy Innovator Award 2019” - the most virtuous supplier in the field of air-cooling towers in Western Europe
- 2015: REALice is referenced as part of the Utility Incentives in the USA and Canada - Recognized among the Top 20 Innovations by Esource
- 2011: Nominated for the “WWF Climate Solver”
- 2009: Nominated at the “Clean Tech Awards” in Sweden

Our solutions are recognized by energy producers in North America and approved for manufacturers to qualify for subsidies

Sweden
Sverige

CLEANTECH HUBS
INNOVATIONS BY SWEDEN

CV ENERGY INNOVATOR AWARDS 2019

Pathema

Most Sustainable Water Cooling Treatments Provider 2019 Western Europe

nationalgrid · NYSEG · TACOMA POWER · Xcel Energy · TORONTO HYDRO · BC Hydro Power smart · SoCalGas · Efficiency Vermont · CenterPoint Energy · PSE PUGET SOUND ENERGY · EVERSOURCE

Various Areas of
Application of our Vortex Process Technology (VPT)

Each individual vertical application is disruptive in nature as it provides game changing enhancements

INDUSTRIAL & COMMERCIAL
IVG -CT (Cooling towers)
Data Centers, Utilities
All Industrial: Oil & Gas, …
Manufacturing: F&B, …
Hotels, Residential & Commercial

ICE MAKING –REALIce©

Ice rinks

COMMUNITIES
FlowMixer

Rivers, ponds, lakes
Treatment plants
Aquaculture

Various Areas of
Application of our Vortex Process Technology (VPT)

Each individual vertical application is disruptive in nature as it provides game changing enhancements

AGRICULTURE IVG-IR

Irrigation - Greenhouses
Crops, Cannabis
Indoor-Vertical Farming
Slurry treatment - Biogas

WATER TREATMENT
IVG-PW

Potable water
Desalination

WATER TREATMENT
IVG-AS (Anti Scaling)

Residential & Commercial

H2oVortex Group organisation

- H2oVortex Group organization is a combination of three individual companies working together in full symbiosis/partnership model.

- Overall HQ based in Luxembourg - incorporated in 2008
- Activities: Sales & Marketing, Business Development, Strategy, Projecting

- Research & Development
- In Sweden executed through Watreco
- In the Netherlands through Pathema

- Manufacturing of IVG in Sweden under Watreco through 3D printing process
- Engineering in the Netherlands executed by Pathema
- Assembly performed by Turbine in the Netherlands.

- Ease of assembly facilitates relocation to local markets

- H2oVortex' main activity is to substantially enhance sustainability KPIs by Saving Water, Energy & Chemicals

CORE TEAM

Present team is comprised of a total of 17 people spread over 3 locations: Luxembourg – Tilburg (Netherlands) – Malmö (Sweden)

Håkan Grönlund

- **Born 1959: Head of International Business & Co-founder H2oVortex**
- During his professional career worked both nationally and internationally in areas of IT and Telecom. Holding different executive management positions such as CEO, Marketing & Sales Director. Has been with companies like WM-Data, Owell/IBM and ComputerLand.
- Since 2008 active in a number of company projects within environmental technology/cleantech as well as building the distribution network of H2ovortex
- Qualifications: BAC Economy, Marketing. Military Background in the Swedish Paratroopers as Captain
  Speaks, Swedish, English, French and German.

Alain Mestat

- **Born 1966: Business development, Marketing, Finance**
- Over 25 years of experience within the financial industry. For 13 years he was a Director with the Edmond de Rothschild Group in Luxembourg. Prior to this Founder and Managing Director of Advena Management (Boston-Jeddah) multi family office.
- Since 2012 Alain has set up various financial advisory companies with a primary focus within sustainable Green Finance. Active private investor in several Swedish based clean tech companies where he held various Executive Board positions
- Bachelor and Masters from Brandeis University (Boston) in International Economic and Finance. Alumni of INSEAD. Alain is a certified Independent Board Director (NED) and sits on several international boards.
- Speaks English, French, German and Luxembourgish.

Mark Boeren

- **CEO Pathema – H2ovortex Head of Engineering - CTO**
- After studying Knowledge Engineering at the University of Maastricht, Mark Boeren founded Pathema BV in 2008 together with his uncle and father. After several innovation awards, Pathema BV finally won the 'Water innovator of the year award' in 2017 with its chemical free VPT technology cooling water treatment, as well for 2019. Extensive technical knowledge in Water and Engineering.
- Since 2014 Mark and his team of 12 engineers have been the quasi exclusive engineering and implementation partners of H2ovortex.

Anders Lindskog

- **Born 1959: CEO, Chairman & Co-founder Watreco**
- Worked both nationally and internationally in areas of telecom, media, IT/internet, holding different executive management positions such as CEO, VP, Marketing & Sales Director, Area Director and Transaction Director.
- Has been with companies like Telia, Ericsson Mobile Communication, Netch Technologies, NST, Topcom and Skarpa.
- Since 2002 Anders has been active in a number of company projects within environmental technology/cleantech.
- Qualifications: BEE, European Diploma Marketing, MBA and Corporate Governance from University of Lund.
- Speaks, Swedish, English and German