QPINCH

TECHNOLOGY INTRODUCTION

SPOTVIEW

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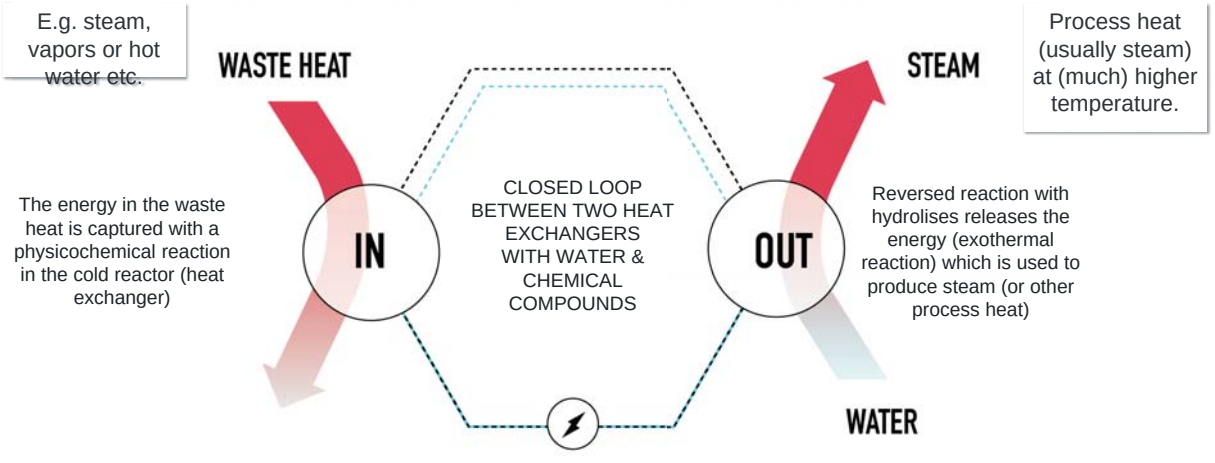
CONTEXT

- Despite process optimizations and continuous search for energy efficiency, a lot of energy is still being lost as waste heat (residual heat from processes and power generation)
- Thermodynamically it is most efficient to make heat with heat. (e.g. more efficient than using it to generate electricity)

WE GENERATE **PROCESS HEAT**
FROM **WASTE HEAT**

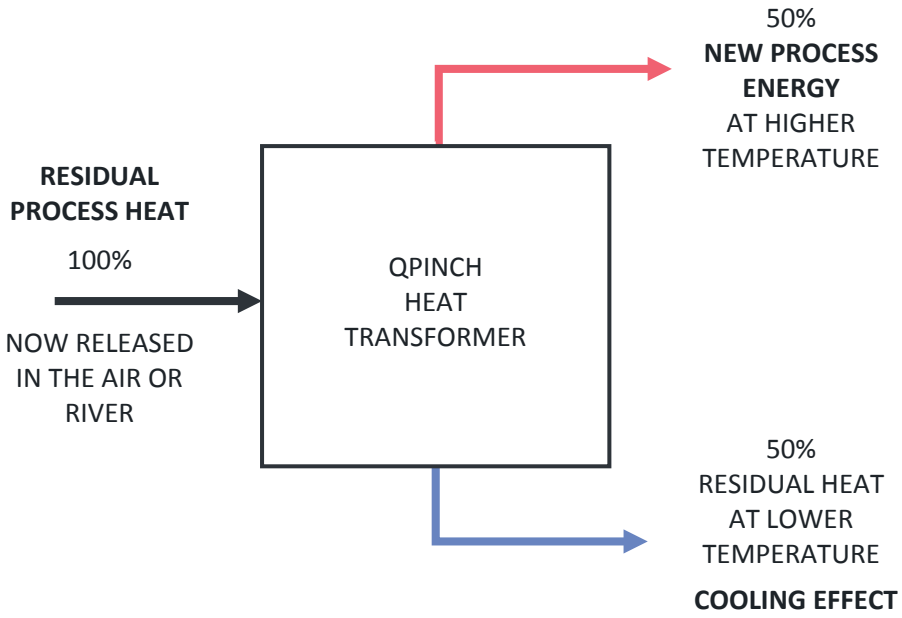
HOW DOES IT WORK

TRANSFORMING WASTE HEAT INTO NEW PROCESS HEAT

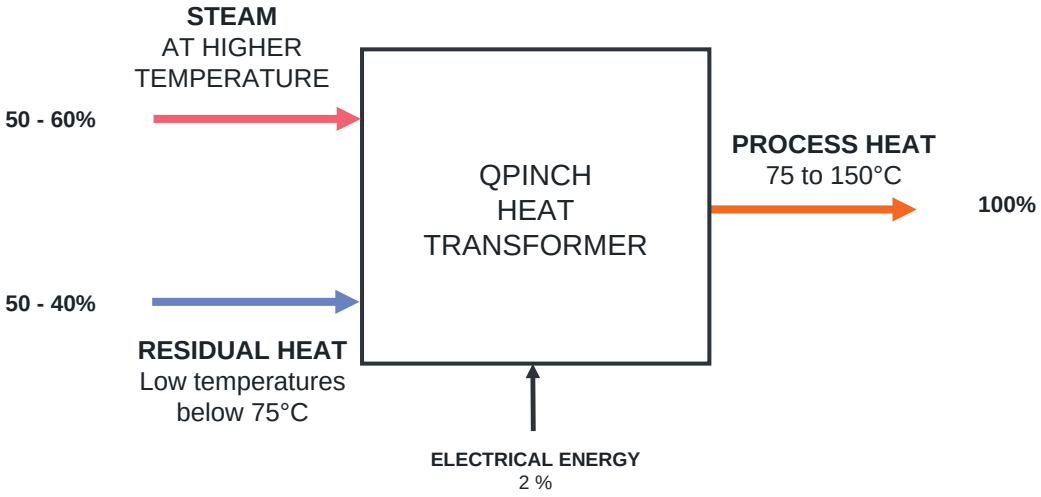


PRODUCT

HIGH TEMPERATURE APPLICATIONS

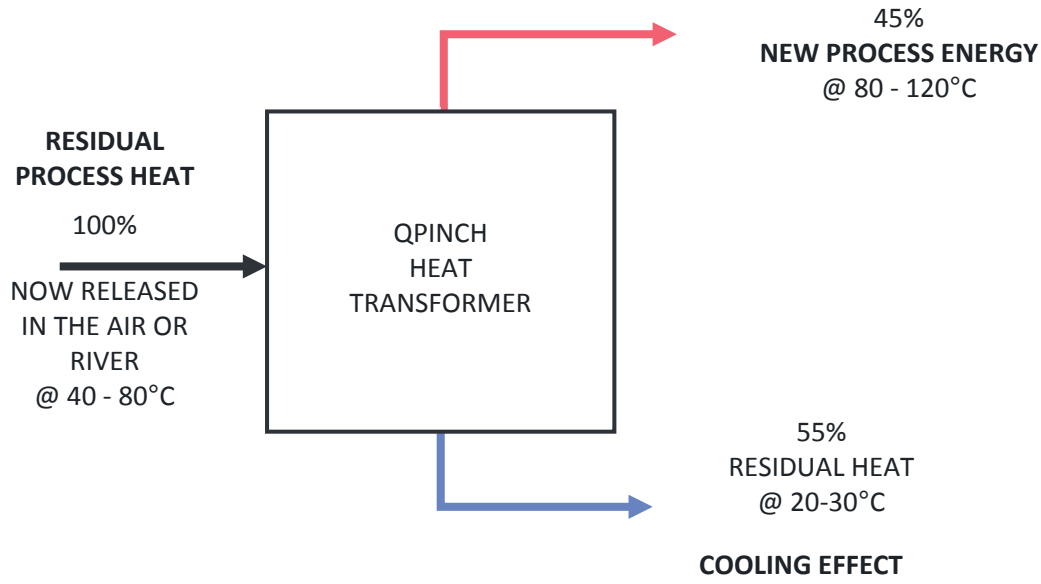


LOW TEMPERATURE APPLICATIONS

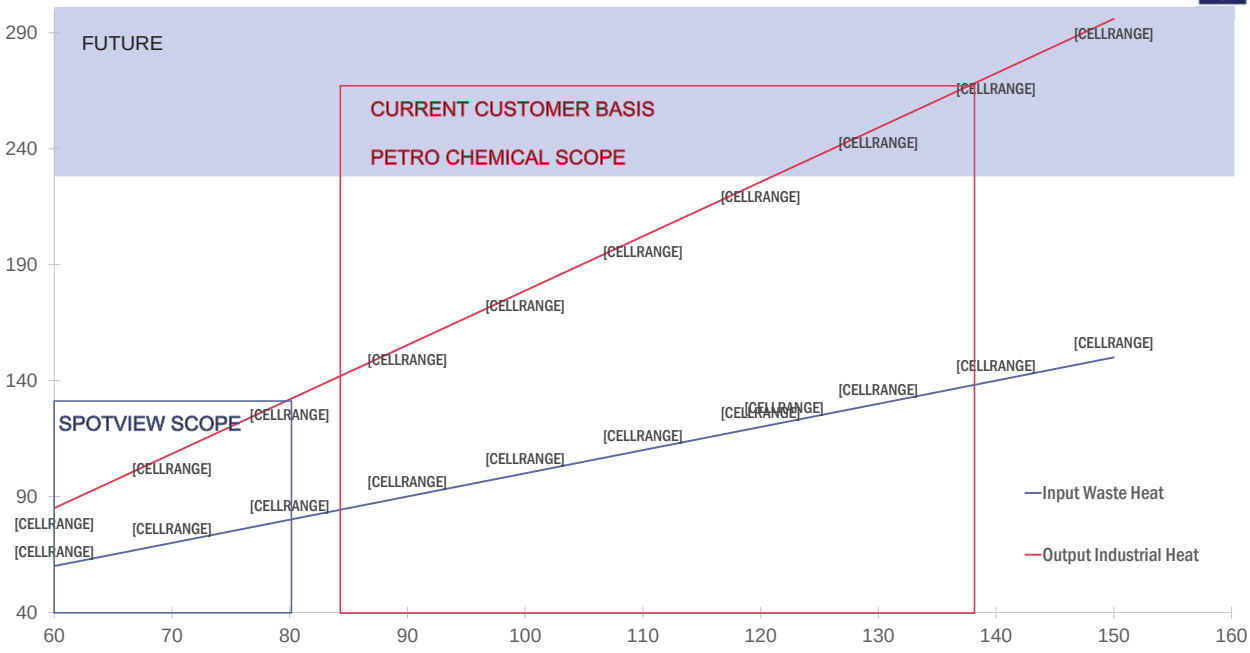


SPOTVIEW SCOPE

SPOTVIEWAPPLICATIONS



SCOPE SPLIT SPOTVIEW <-> CURRENT CUSTOMER BASIS



THANKS FOR YOUR ATTENTION

This project has received funding from the European Union's Horizon 2020 research and innovation programm under grant agreement No 723577

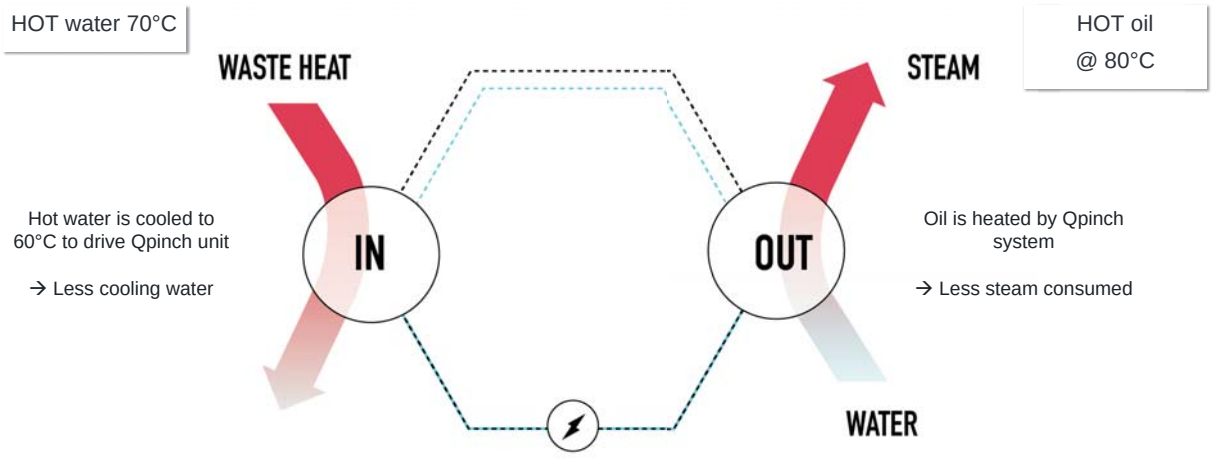
BACKUP SLIDES

CHALLENGES TO VIABLY TRANSFORM RESIDUAL HEAT INTO PROCESSS HEAT

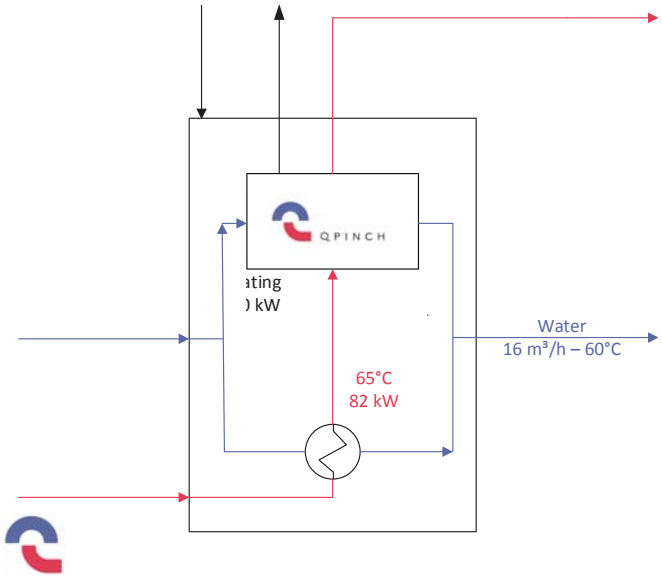
QPINCH HEAT TRANSFORMER

YOU NEED LARGE TEMPERATURE INCREASES AND HIGH OUTPUT TEMPERATURES	▶	INPUT TEMPERATURE FROM 25°C AND HIGHER DELIVERS TEMPERATURE INCREASES OF MIN. 75˚C (UP TO 100˚C) DELIVERS PROCESS HEAT IN FULL RANGE (80°C TO 220+ °C)
LOW ELECTRICAL ENERGY COST (LARGE OPEX KILLS BUSINESS CASES)	▶	MARGINAL OPERATIONAL COST (ALMOST NO ELECTRICAL ENERGY NEEDED)
LOW CAPEX FOR MEGAWATT SCALE	▶	EASILY SCALABLE INTO HIGH MEGAWATT RANGES (<> OTHER TECHNOLOGIES)
EASY TO BUILD EASY TO IMPLEMENT (EASY TIE-IN IN EXISTING ASSETS OR NEW DESIGNS)	▶	STANDARD CHEMICAL INDUSTRY EQUIPMENT DEGRESSIVE CAPEX WITH INCREASING DUTY (MEGAWATTS)

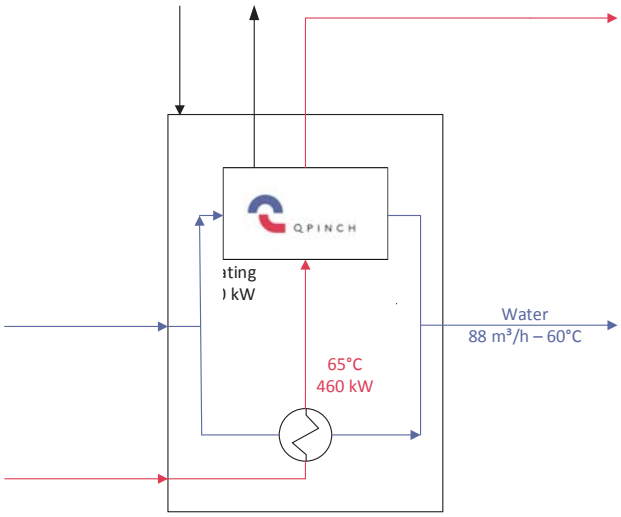
CASE 1 STEEL



Case 2: Steel



Pilot Unit



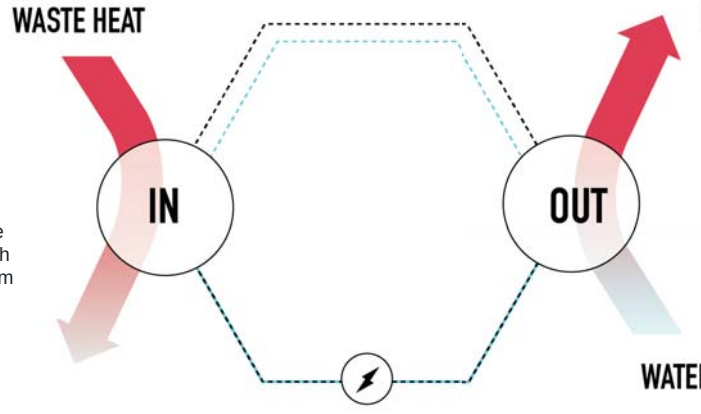
Industrial Unit

CASE 2 P&P

Process water to waste water treatment plant @40°C

Water is cooled to drive Qpinch unit together with the consumption of steam

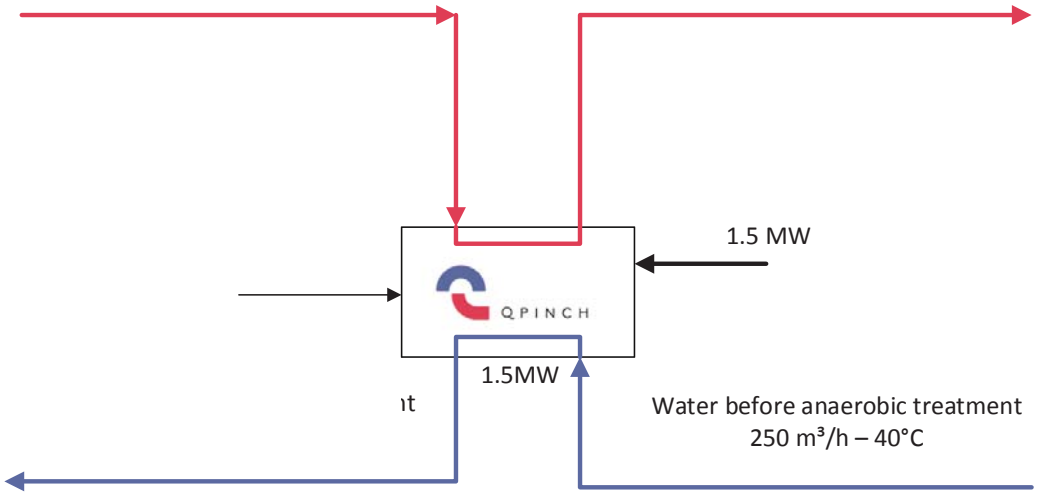
→ Less cooling water



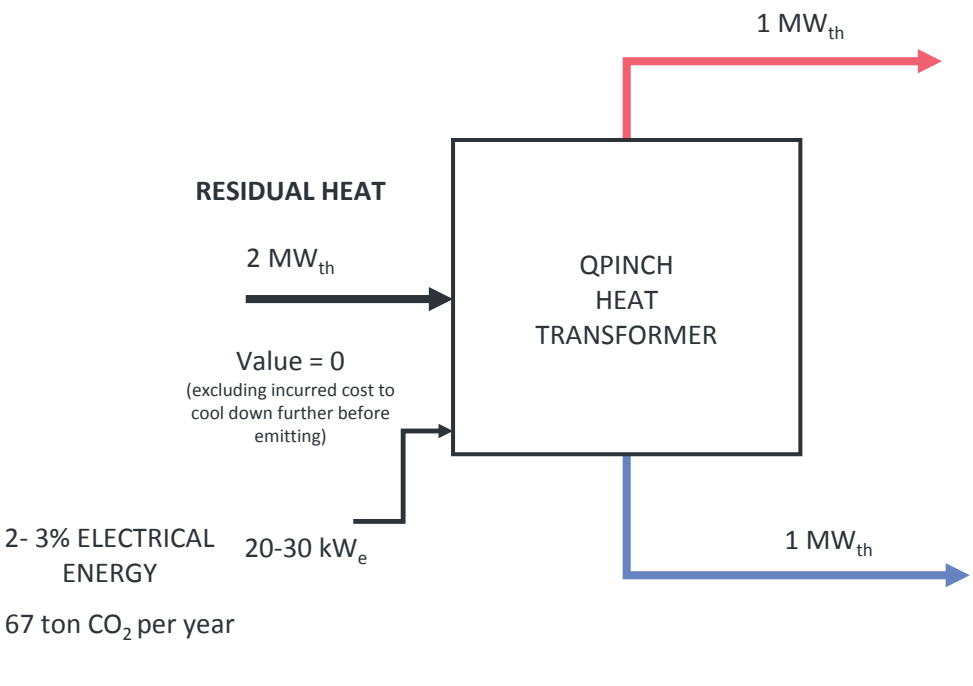
Heated stock preparation water

→ Less steam consumed

P&P Case: Water to anaerobic treatment



FINANCIAL & OPERATIONAL BENEFITS



SAVINGS/YEAR/MW
36.000 GJ gas

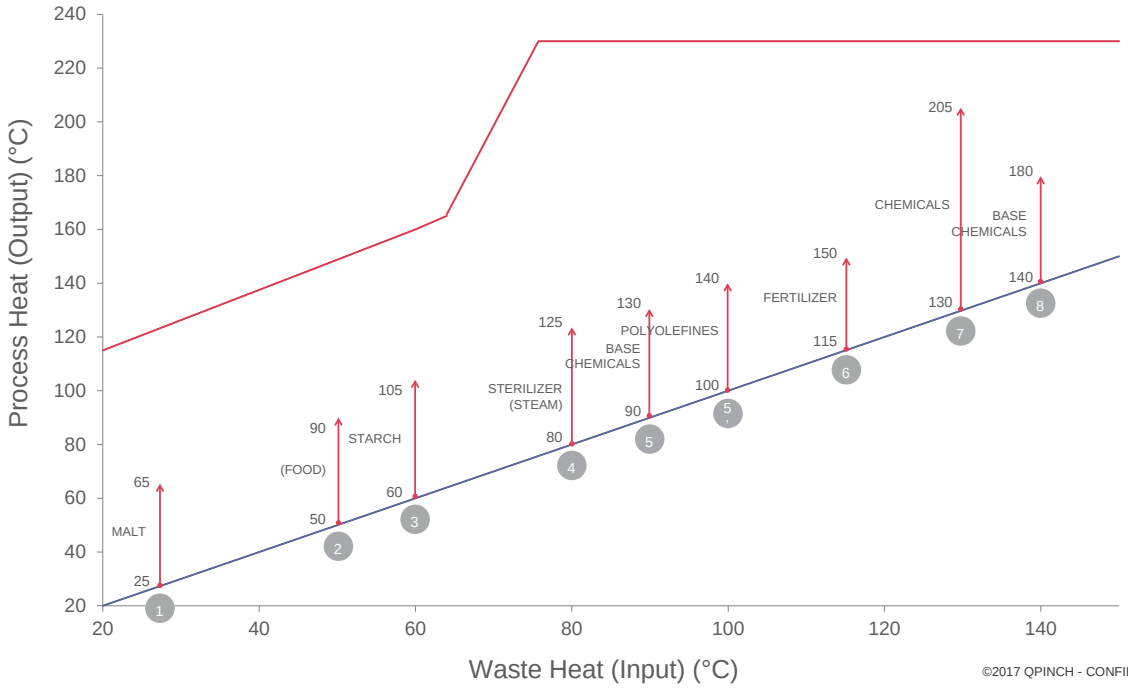
2.200 ton CO_2 per year
(equiv. of 1.350 cars)

350.000€/y

PAYBACK
3-5y

EXTRA BENEFITS
Extra cooling
(savings in cooling energy)
Extra plant capacity

USE CASES



akvoFloat:

Innovative Flotation - Ceramic Filtration Process for Low energy Oily Wastewater Treatment

Proven Technology. Proven Expertise.

ThyssenKrupp · TOTAL · acciona · bp · SIEMENS

Company

COMPANY FACTS

akvola Technologies is a water technology company specialized in the removal of non-soluble contaminants from hard-to-treat waters in the most challenging operating conditions by means of akvoFloat™ – a novel flotation-filtration process technology. We design and sell plants based on the akvoFloat™ technology.

- **Founded**: 2013 (spin-off of the Technical University of Berlin)
- **Headcount**: 24
- **Honors & Awards**: **Frost & Sullivan Technology Innovation Award** 2017
  Water Innovation Europe 2016
  IDA Award 2015
  GreenTec Awards 2014
  ACES Awards 2014

The Problem: Hard-to-treat industrial waters

Conventional technologies fail to treat hard-to-treat waters reliably and cost-effectively

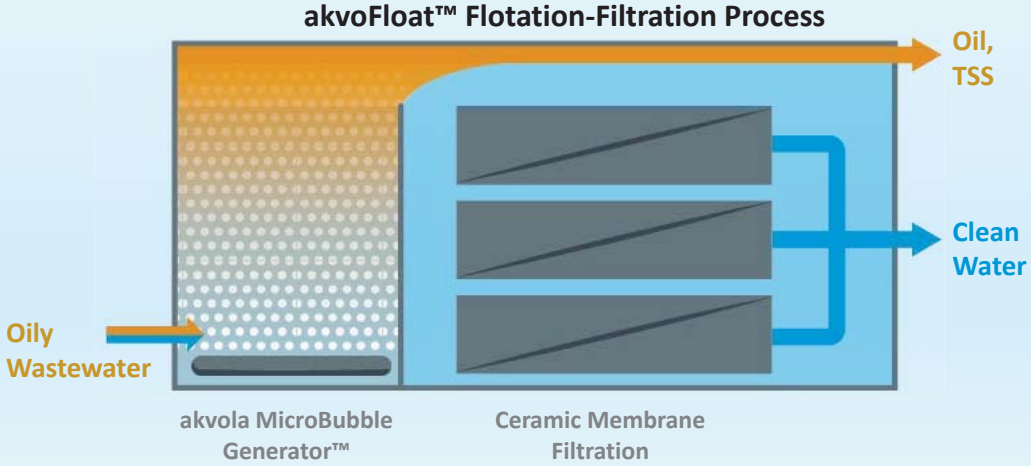
HARD-TO-TREAT WATERS:

- High oil concentration (400-30.000 mg/l)
- High suspended solids load (> 5.000 mg/l) or turbidity (> 10.000 NTU)
- Unpredictable variations in flow and load
- High temperatures (> 40°C)
- High salinity (TDS > 50.000 ppm)
- High Harsh chemical environments (pH 2-13)

Industries:
- Metalworking
- Refining & Petrochemicals
- Upstream Produced Water
- Steel
- Food & Beverage
- Chemical
- Steel

The Solution – akvoFloat™

akvoFloat™ is a separation technology based on a proprietary flotation-filtration process. This process leverages the **akvola MicroBubble Generator™**, **novel ceramic membranes** and our **proprietary membrane cleaning strategies**, resulting in the most energy-efficient design on the market for **oil** (free, dispersed & emulsified) and **suspended solids removal** in hard-to-treat waters.



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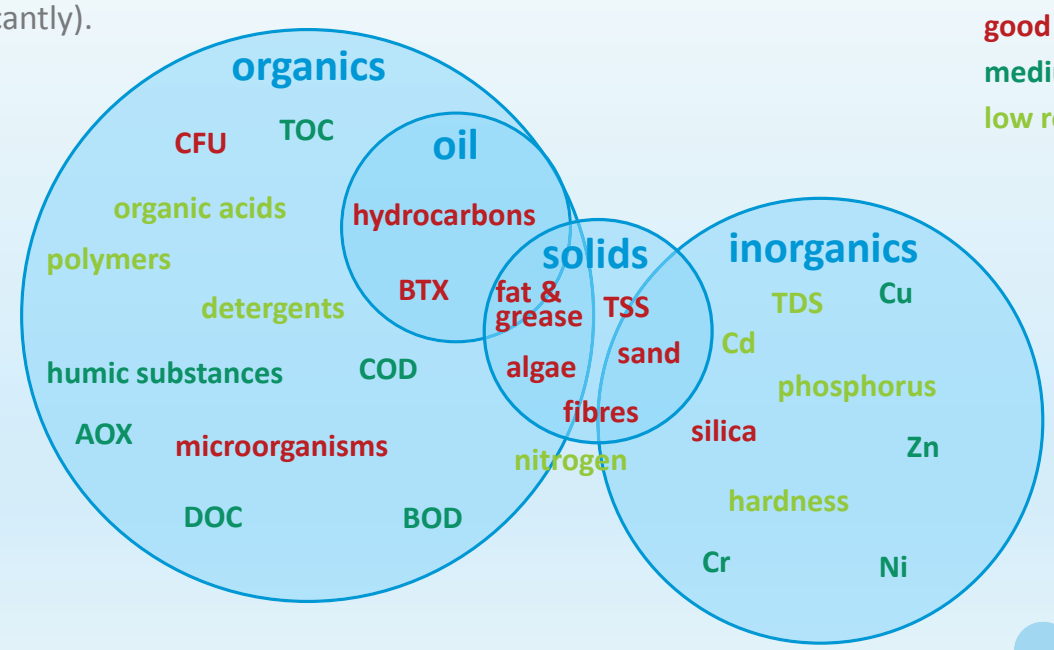
The Process Technology – akvoFloat™

Targeted Contaminants

akvoFloat™ reduces many contaminants (chemicals can improve removal rates significantly).



Innovation in Detail

Innovation #1: akvola MicroBubble Generator™

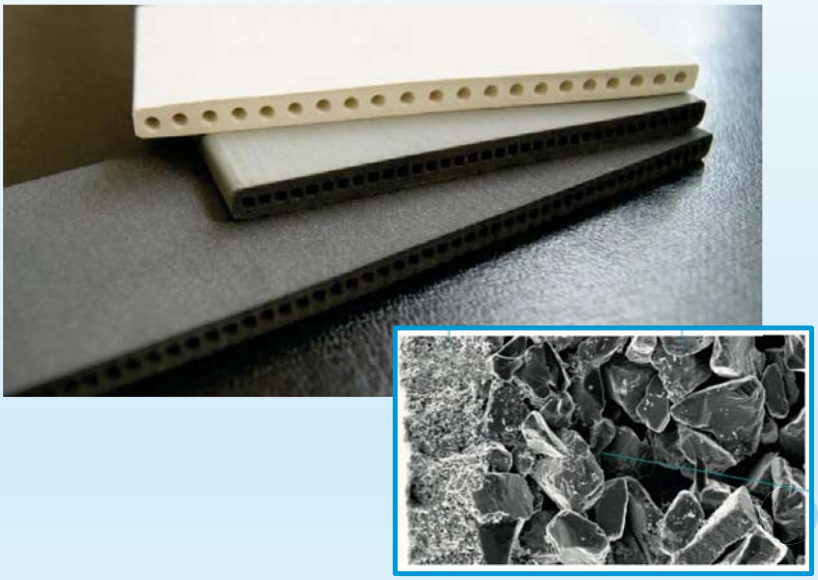
Microbubbles are generated with 90% less energy than conventional technologies

- Material: Al_2O_3
- Pore size: 2 µm
- Average bubble size: 70-100 µm
- Operating pressure: 1-1,5 bar (max. 3 bar)
- Air/Gas consumption: 15 Nl/m^3
- Energy Consumption: 0,1 kWh/m^3
- Use of any gas is possible (air, ozone, nitrogen, …)

Innovation #2: Filtration Membranes

akvola Technologies selects the right membrane for each application

- Material: SiC or Al_2O_3
- Submerged vacuum/gravity driven
- Pore size: 0,04-0,2 µm
- Outside-in filtration
- Typical flux: 150-250 lmh*
- Operating pressure: -0,2 to -0,4 bar
- Operating temperature: 10-70 °C

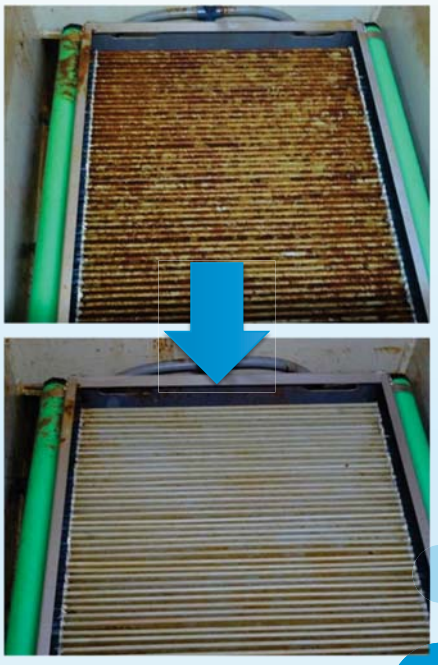


*In heavily loaded industrial wastewater

Innovation #3: Membrane Cleaning Strategies

Conventional and proprietargy strategies

- Chemical Enhanced Backwash (CEB): dosing of chemicals into the backwash water
- Cleaning in Place (CIP): soaking the membrane in a chemical solution
- **Proprietary Cleaning Strategy: akvoClean**
  - Fast oxidation by activating free Cl-ions
    - NaOCl and acid: good effectiveness, 5 min duration, preventive effect, low chemical consumption
  - Air Flush: “backwash” with air
  - Hot solutions increase effectiveness

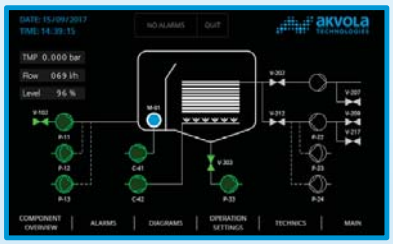


Before and after akvoClean (refining WW)

Innovation #4: Process Automation

akvoFloat™ can adjust to different conditions.

- akvoFloat™ units are fully automated and can be equipped with remote control.
- The optimal operation conditions are adjusted according to the feed quality:
  - membrane flux
  - backwash intervals
  - flotation bubble size
  - float layer removal
  - chemical cleanings



Markets & Applications

- Minimize wastewater volumes and costs
- Extend fluid lifetime
- Treatment of metalworking fluids, die casting emulstions, washing and rinsing waters, deoiling baths, ...
- **More…**

- Wastewater reuse
- Revamp secondary treatment
- Treatment of segregated effluents: desalter effluent, tank bottom draws, ...
- Hydrocarbon recovery
- **More…**

- Produced water reuse (PWRI, EOR, SAGD)
- Meet offshore discharge limits
- **More…**

- Wastewater reuse (e.g. sand filter backwash)
- Treatment of cooling water from a direct contact circuit
- Process water from pickling and organic coating
- **More…**

Benefits of our akvoFloat™ systems

- ✓ **Fast Payback Times** – between 12 and 24 months through the 95% lower energy consumption and lower CapEx in comparison to evaporators and conventional flotation-filtration treatment trains
- ✓ **Less Waste** (< 5%) – through a high water recovery rate
- ✓ **No Irreversible Fouling** – Membrane permeability can always be recovered through our innovative cleaning strategies, even in hard-to-treat waters
- ✓ **High Removal Efficiency** – from very high to very low concentrations in one single step reliably

Contact Details

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Treatment of Dairy and Paper & Pulp Effluents using Elevated Pressure Sonication

Avilés, Spain, October 4th, 2018
Narinder Bains, SERE-Tech Innovation Ltd (Est. 2008)
www.seretechinnovation.com

Spot View

Horizon 2020 European Union Funding for Research & Innovation

SPIRE PROJECT

Introduction

Spot View
Horizon 2020 European Union Funding for Research & Innovation
SPIRE PROJECT

Dairy Industry Water Usage (ref: BREF doc)

- Water consumption is mainly associated with cleaning operations
  - Surface and ground/potable water for cooling
  - Flushing
  - CIP
- Reasonably efficient water consumption ~1-5m^3/m^3 of milk
- Wastewater is the main environmental issue in the dairy processing industry

Introduction

Dairy Industry

- Wastewater volume in a well managed installation is reported to be 1-2 m^3/m^3 of milk
- However, this is not typical in current dairy installations where approximate values are closer to:-
  - Milk, Cream, Yoghurt – $3m^3/m^3$ of milk
  - Butter, Cheese – $4m^3/m^3$ of milk
  - Dry milk, whey – $5m^3/m^3$ of milk
- Average COD for dairy wastewater ~ 3000mg/l
- Volumes range 500m3 – 1000m3 per day
- Cost of WWTP €1M – €1.5M per annum

Context

Dairy Industry

- A significant portion of dairy wastewater COD results from skimming cream from milk using separator centrifuges and bacto-centrifuges
- 'Desludge' makes up 0.1 - 0.15% volume of the milk feed
- High in bacterial load 107 - 108 cfu/ml and highly unstable
- Thermal treatment can cause bacterially induced solidification of protein/solids
- Bactofuge 14 - 16% protein, 20% solids
- Separator 3.5 - 4% protein, 10% solids

Context

Dairy Industry

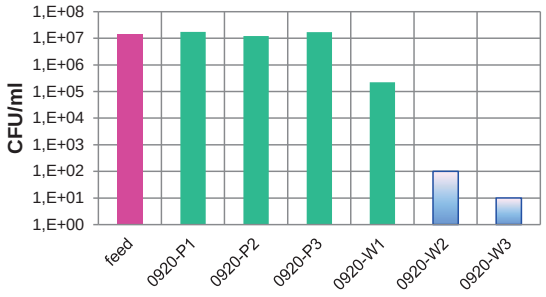
- Separator/Bactofuge can account for ~2000mg/l COD in effluent of a single large dairy facility
- Effective recovery and stabilisation could achieve significant WWTP circa €0.5M cost savings and create value recovery
- 60 – 90 tonnes per annum of dry protein recovery potential
- Therefore, potential for value recovery
- Use as animal feed ingredient or other high value protein supplementation

Elevated Pressure Sonication - Dairy

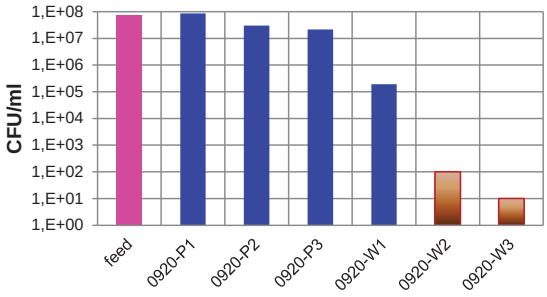
- Patented technology
- High Pressure CO_2, low temperature 40-50°C
- Low frequency sonication
- Low energy input 5-30kJ/L
- Achieved up to 6.8 $\log_{10}$ reduction in anaerobic and aerobic bacteria
- Enables stability and recovery of value chemicals

Elevated Pressure Sonication - Dairy

Aerobic CFU of feed and treated after EPS



Lactic CFU of feed and treated after EPS

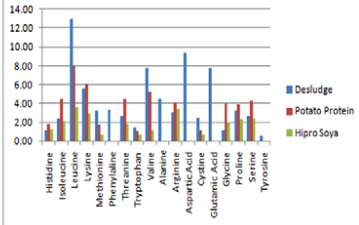


Amino Acid Profile

Material: Freeze-Dried Powdered

De-Sludge	Desludge Result (%)	Potato Protein Value (%)	Hipro Soya Values (%)
Dry Matter	96.80	92	88.5
Protein	75.21	79	47
Histidine	1.20	1.78	1.24
Isoleucine	2.40	4.42	2.11
Leucine	12.90	7.9	3.57
Lysine	5.60	6.04	2.91
Methionine	3.20	1.74	0.65
Phenylaline	3.30		
Threanine	2.70	4.42	1.85
Tryptophan	1.40	1.11	0.65
Valine	7.80	5.21	1.15
Alanine	4.50		
Arginine	3.00	4.11	3.4
Aspartic Acid	9.40		
Cystine	2.50	1.15	0.7
Glutamic Acid	7.80		
Glycine	1.20	3.95	1.97
Proline	3.20	3.87	2.3
Serine	2.70	4.27	2.35
Tyrosine	0.60		

Amino Acid Profile Comparison



Elevated Pressure Sonication – Paper Industry

- Very high water consumption circa. 1000 m^3/hr
- High COD loadings 4 – 6 g/l
- 50% Starch dissolved into water + Cellulose, Hemicellulose, Colloids, VFA's contribute to COD/TOC loads in effluent
- Biomass contributes to TS content which is difficult to settle and treat using conventional techniques
- EU paper industry seeking to reduce water intake and achieve zero discharge goals
- Alternative reuse, recycling and recovery techniques being investigated
- Elevated Pressure Sonication has been tested for value recovery and biocontrol concepts in the SPOTVIEW project

Elevated Pressure Sonication - Paper

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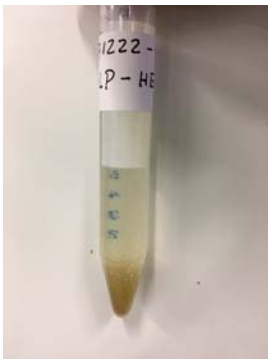

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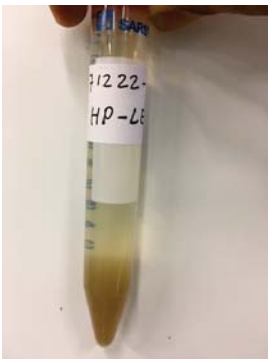

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- In all cases where EPS was applied suspended solids appear to have expanded with treatment with a visible improvement in water clarity
- Treated samples appear to self-flocculate with no chemical addition

Elevated Pressure Sonication – Paper Industry

Paper and Pulp Effluent

Test	Characteristic	pH	COD mg/l	% Change in COD
0	No P, No US	7.1	1700	0
1	No pressure, low US energy	6.9	1700	0
2	No pressure, high US energy	7.4	1800	+ 5.9
3	Low pressure, low US energy	6.1	2200	+ 29
4	Low pressure, high US energy	6.7	3800	+ 124
5	High pressure, low US energy	6.0	2400	+ 41
6	High pressure, high US energy	6.9	2900	+ 70.6

- Increased COD when EPS treated, shows increased extraction of organic compounds for recovery

Conclusion so far

- Dairy – Desludge can be stabilized effectively and higher value protein concentrate recovered
- Dairy – Potential to reduce COD on WWTP significantly and achieve effluent treatment cost savings circa €0.5M for a large dairy
- Paper & Pulp – EPS trials showed good effluent clarification associated with extraction of organic compounds from biomass/solids
- Paper & Pulp – Good bacteria kill effect on effluent samples to control bioactivity pre- and post UF

Acknowledgement

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 723577

Valmet Ultrafiltration for Tissue mills

Avilés, October 4th, 2018

Timo Sutela, Pasi Nurminen

Spot View

Horizon 2020
European Union Funding
for Research & Innovation

SPIRE PROJECT

Fresh Water Reduction

Steps to controlled reduction

Spot View

Horizon 2020
European Union Funding
for Research & Innovation

SPIRE PROJECT

Fresh water consumption m³/ton of paper

m³/t

20 — All fresh water to paper machine

Counter-current principle for all process water

All make up water from clean to dirty

15 — Stable process conditions; no temperature or pH variations

Waste water out from pulp mill

Separate water loops for different departments

10 — Recycling and cleaning of save all clear filtrates

8 — Efficient pulp washing before paper machine

5 — Minimizing the long loop water volume

Minimizing the salts at chemicals and process

0 — Water buffer volume bigger than stock volume

Effluent treatment and microflotation

Fibre recovery Save All / disc filter

Removal of stickies and ash/microflotation

White water treatment / microflotation

Valmet Ultrafiltration for White Water

Valmet Ultrafiltration for Extractives removal

Biokidneys for pulp mill

Salt removal with Nanofiltration

ctp centre technique du papier

Valmet Ultrafiltration T

Modular process for Tissue mill white water treatment

- *Valmet Ultrafiltration T* process is designed to produce colloidal and bacteria free ultrapure water from *Tissue mill white waters to*
  - Reduce fresh water consumption
  - Improve tissue machine runnability and efficiency
- Compact and modularized process
  - Includes all needed components for fully automated operation
- Membrane Technology solution with Valmet Ultrafilter CR1010-30

Received funding from the European Union's Horizon 2020 Research and Innovation Programme under Grant Agreement no. 723577

Valmet Ultrafilter CR

Technical features

Valmet Ultrafilter CR1010/30

- Membrane area 42 m²
- Membrane diameter 1 000 mm
- Filter cassettes 30 pcs
- Membranes 60 pcs
- Motor 37 kW
- Size, ca 1,8 x 2,1 x 1,4 m
- Membrane pore size 0.02 – 0.05 µm

Valmet Ultrafiltration T
Cross Rotational - Technology

- Plate & frame module
- Polymeric flat sheet membranes
- Cross flow created by rotors

- High cross flow velocity (> 10 m/s)
  - High turbulence
  - High and stable capacity
  - Low clogging of membrane

- Low pressure difference (< 1 bar)
  - No clogging of membrane
  - High membrane life time

Valmet Ultrafilter

Valmet Ultrafiltration T
The product

The Permeate produced with Valmet Ultrafiltration technology is:

- Free from solid substances
- Free from colloidal material
- Free from turbidity
- Free from secondary and micro sticky
- 50-70 % less anionic trash
- Free from bacteria

Using permeate instead of fresh water decreases the overall water consumption in the tissue-making process and creates savings in the energy used for heating the fresh water.

A modern tissue machine consumes 5–15 m^3 of water per ton of paper.
With Valmet Ultrafiltration T solution the consumption is decreased by 1–2 m^3.

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