Wastewater Management from Aqueous Cleaning Processes

Darren Williams
Cleaning Research Group at SHSU
williams@shsu.edu

Barbara & Ed Kanegsberg
BFK Solutions LLC
barbara@bfksolutions.com
ed@bfksolutions.com

Mark Korzenecki
Sr. Business Dev. Mgr. Wastewater/Ion Ex
mark.Korzenecki@evoqua.com

Chris Riley
Technical Services Dir. Wastewater/Ion Ex
christopher.t.riley@evoqua.com

The PQCW offers practical, hands-on and independent, training in cleaning.
More Info shsu.edu/pqcw pqcw@shsu.edu

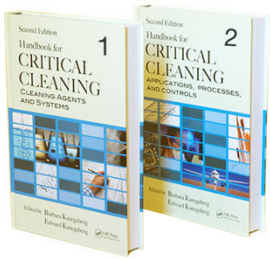
1

1

Hosts: The Product Quality Cleaning Workshop Team

Barbara and Ed Kanegsberg – "The Cleaning Lady and the Rocket Scientist"

- BFK Solutions - Consultants in Critical Cleaning
- Authors and Editors of the two-volume CRC Handbook for Critical Cleaning
- Independent evaluations and recommendations
- Co-chairs of the Product Quality Cleaning Workshops
- barbara@bfksolutions.com and ed@bfksolutions.com



Darren Williams – "The Professor"

- Professor of Physical Chemistry at Sam Houston State University
- Leader of the Cleaning Research Group
- Co-chair of the Product Quality Cleaning Workshops
- Performs cleaning trials and formulates cleaning chemistries
- williams@shsu.edu

2

2

PQCW - Workshops for Terrific Products

- "People with different functions within our company, including Strategic Sourcing, Project Management, and Manufacturing Engineering, attended.
- "We learned a lot; and we have made changes. We are refining our own cleaning requirements and putting together training programs.
- "For example, we used the workshop to develop black light testing and fixtures; and we have already set up a one-hour "Parts Washing 101" training course.
- "The section about EPA amended TSCA had useful, timely information."
  - Christian Johnson, Engineer, Yaskawa, participant, PQCW21

3

3

Wastewater Management from Aqueous Cleaning Processes

Speaker Bios

Mark Korzenecki

Sr. Business Development Manager – Wastewater Ion Exchange (WWIX)

- 18 years with Evoqua as Business Development Manager and High Purity Field Sales Engineer
- Account management roles in hazardous waste/environmental services prior to Evoqua
- Focus on ion exchange, adsorptive media and wastewater treatment systems for managing wastewaters
- Bachelor of Arts degree from the University of Notre Dame

Chris Riley

Technical Services Director – Wastewater Ion Exchange (WWIX)

- Responsible for directing technical support activities for WWIX customers and supporting WWIX media regeneration and quality operations
- Environmental engineering roles in the electroplating and consulting industries prior to Evoqua
- Bachelor's degree in Chemical Engineering from Michigan Technological University
- Master's degree in Civil (Environmental) Engineering from the University of Minnesota
- Registered professional engineer

EVOQUA WATER TECHNOLOGIES

©2022 EVOQUA WATER TECHNOLOGIES LLC

4

EVOQUA WATER TECHNOLOGIES

WASTEWATER MANAGEMENT FROM AQUEOUS CLEANING PROCESSES

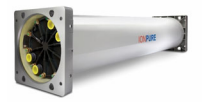
5

Wastewater Management from Aqueous Cleaning Processes

Evoqua Water Technologies – Who Are We?

Water is a critical yet finite resource. We believe there is power and purpose in combining expertise, innovation and a commitment to maintaining this resource, now and in the future.

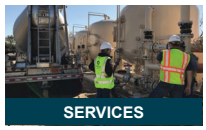
Evoqua Water Technologies is a leading provider of water and wastewater treatment solutions, offering a broad portfolio of products, services and expertise to support industrial, municipal and recreational customers.



PRODUCTS

TECHNOLOGIES

SYSTEMS



SERVICES

EVOQUA WATER TECHNOLOGIES

©2022 EVOQUA WATER TECHNOLOGIES LLC

6

Wastewater Management from Aqueous Cleaning Processes

Evoqua Water Technologies – Key Sectors

OUR TWO SEGMENT APPROACH

We are organized into a **two-segment structure** designed to serve the needs of our customers worldwide.

Our structure has created a customer-facing project and service organization called **Integrated Solutions and Services** ("ISS") and a product technology group, **Applied Product Technologies** ("APT"), focused primarily on sales through indirect product channels.

EVOQUA WATER TECHNOLOGIES

©2022 EVOQUA WATER TECHNOLOGIES LLC

7

Wastewater Management from Aqueous Cleaning Processes

Evoqua Water Technologies – Who We Serve

Evoqua:

- Supports 200,000+ installations worldwide
- Provides water solutions for nearly 90% of the Fortune 500 companies
- Treats 70% of the U.S. municipal wastewater capacity serving nearly 225 million people
- Works with:
  - 20 of the 20 largest Food & Beverage companies in the U.S.
  - 18 of the 20 largest Petroleum refiners in the U.S.
  - 90% of the biggest Chemical companies and 85% of Pharmaceutical companies in the U.S
  - 60% of U.S. Navy vessels use Evoqua's CAPAC technology

EVOQUA WATER TECHNOLOGIES

©2022 EVOQUA WATER TECHNOLOGIES LLC

8

Wastewater Management from Aqueous Cleaning Processes

Agenda

- Aqueous cleaning and wastewater generation
- To treat or not to treat?
- Understanding cleaning wastewater characterization
- Treatment options
- What happens after treatment?

EVOQUA WATER TECHNOLOGIES

©2022 EVOQUA WATER TECHNOLOGIES LLC

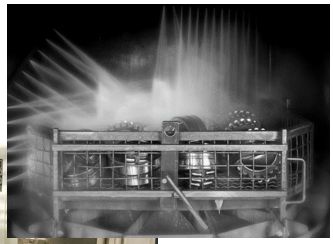
9

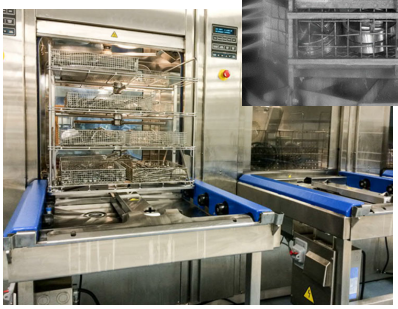
Wastewater Management from Aqueous Cleaning Processes

Aqueous Cleaning and Wastewater Generation

Aqueous cleaning

- Removes soils prior to further processing or as final production step
  - Oils and greases
  - Burnishing, buffing, lapping compounds
  - Flux
  - Scale
  - Oxidation
  - Particulates
- Cleaning process
  - Immersion, spray, ultrasonic
  - Batch and continuous
  - Generates waste cleaning solution and rinsewater





EVOQUA WATER TECHNOLOGIES

©2022 EVOQUA WATER TECHNOLOGIES LLC

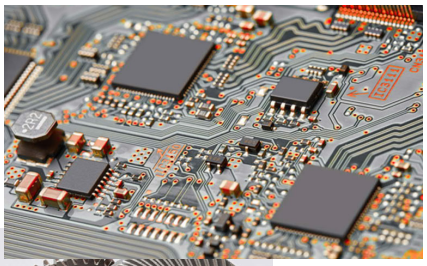
10

Wastewater Management from Aqueous Cleaning Processes

Aqueous Cleaning and Wastewater Generation

Aqueous cleaning

- Water plus
  - Detergents (saponifiers, soaps)
  - Surfactants (wetting agents)
  - Buffers (pH balancing compounds)
  - Builders (carbonate, silicates, phosphates)
  - Emulsifiers (glycerols, phosphatides)
  - Conditioners (complexing agents)
- Cleaner types
  - Acidic (oxidation, scale)
  - Alkaline (oil and grease)
  - Neutral (light soil)



EVOQUA WATER TECHNOLOGIES

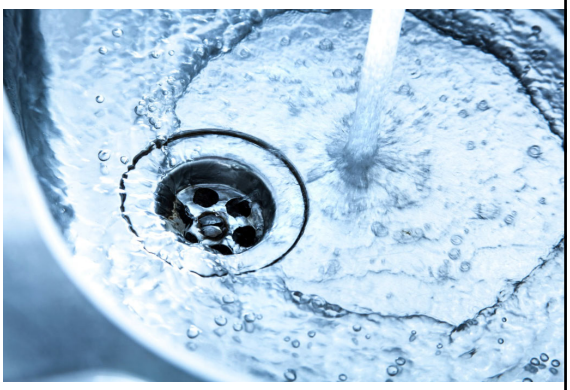
©2022 EVOQUA WATER TECHNOLOGIES LLC

11

Wastewater Management from Aqueous Cleaning Processes

Agenda

- Aqueous cleaning and wastewater generation
- **To treat or not to treat?**
- Understanding cleaning wastewater characterization
- Treatment options
- What happens after treatment?



EVOQUA WATER TECHNOLOGIES

©2022 EVOQUA WATER TECHNOLOGIES LLC

12

Wastewater Management from Aqueous Cleaning Processes

To treat or not to treat?

True or false – aqueous cleaner wastewaters require no treatment

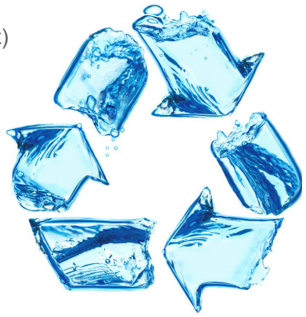
- Sometimes true, sometimes false

Why might you have to treat your cleaning wastewater?

- Remove regulated contaminants (outlined in facility industrial waste discharge permit)
- Local water consumption limits
- Zero liquid discharge (ZLD) facility

Why might you want to treat your cleaning wastewater?

- Minimize water consumption
- Support company sustainability objectives



EVOQUA WATER TECHNOLOGIES

©2022 EVOQUA WATER TECHNOLOGIES LLC

13

Wastewater Management from Aqueous Cleaning Processes

Agenda

- Aqueous cleaning and wastewater generation
- To treat or not to treat?
- **Understanding cleaning wastewater characterization**
- Treatment options
- What happens after treatment?

EVOQUA WATER TECHNOLOGIES

©2022 EVOQUA WATER TECHNOLOGIES LLC

14

Wastewater Management from Aqueous Cleaning Processes

Understanding Cleaning Wastewater Characterization

What is meant by "characterization" of wastewater?

- Determining the chemical properties of a wastewater
- Determining the relevant process parameters

Why is characterization important?

- "It's a need-to-know basis……."
- Need to know what's in the wastewater to know:
  - If the wastewater needs treatment
  - How to treat the wastewater to meet treatment objectives
- Need to know process particulars to know:
  - The required size of any wastewater treatment equipment

EVOQUA WATER TECHNOLOGIES

©2022 EVOQUA WATER TECHNOLOGIES LLC

15

Wastewater Management from Aqueous Cleaning Processes

Understanding Cleaning Wastewater Characterization

Chemical characterization

- pH
- Conductivity/Total Dissolved Solids (TDS)
- Cations
- Anions
- Total organic carbon (TOC)
- Total suspended solids (TSS)

Process characterization

- Daily or weekly wastewater volume generated
- Average and peak flowrates

EVOQUA WATER TECHNOLOGIES

©2022 EVOQUA WATER TECHNOLOGIES LLC

16

Wastewater Management from Aqueous Cleaning Processes

Agenda

- Aqueous cleaning and wastewater generation
- Understanding cleaning wastewater characterization
- To treat or not to treat?
- **Treatment options**
- What happens after treatment?

EVOQUA WATER TECHNOLOGIES

©2022 EVOQUA WATER TECHNOLOGIES LLC

17

Wastewater Management from Aqueous Cleaning Processes

Treatment Options

What treatment options exist for cleaning wastewaters?

- Media, bag or cartridge filtration (particulate removal)
- Carbon filtration (organic/TOC removal)
- Ion exchange (metals and/or TDS-removal)
- Reverse osmosis (TDS removal)
- Ultraviolet (UV) Light (TOC or bacterial treatment)
- Precipitation (metals removal)
- Selective adsorptive media (metals removal)

How do you narrow down the options?

- Goal – discharge compliance or recovery/reuse
- Treatment level required (discharge limit or recovered water quality)
- Let the wastewater characterization be your guide

EVOQUA WATER TECHNOLOGIES

©2022 EVOQUA WATER TECHNOLOGIES LLC

18

Wastewater Management from Aqueous Cleaning Processes

Treatment Options - Filtration

Filtration

- Removes solid, particulate contaminants
- Used as a stand-alone step or as pre/post-treatment for other operations
- Utilizes bags, cartridges, media
- Removes particulates down to <1 micron

Treatment applications

- Discharge compliance
- Recovery/reuse

Advantages/Disadvantages

- Specialty activated carbon and oil-sorbing filters available
- ΔP across filters increases as they load

EVOQUA WATER TECHNOLOGIES

©2022 EVOQUA WATER TECHNOLOGIES LLC

19

Wastewater Management from Aqueous Cleaning Processes

Treatment Options – Carbon Adsorption

Carbon adsorption

- Granular activated carbon (GAC)
- Removes TOC, oxidation compounds (Cl_2, H_2O_2)
- Utilizes pressure vessels

Treatment applications

- Discharge compliance
- Recovery/reuse

Advantages/Disadvantages

- Will provide some clarification
- Can alter the pH of the treated water
- Does not remove all TOC
- Susceptible to fouling with oil, grease, solids

EVOQUA WATER TECHNOLOGIES

©2022 EVOQUA WATER TECHNOLOGIES LLC

20

Wastewater Management from Aqueous Cleaning Processes

Treatment Options – Ion Exchange

Ion exchange resin

- Polymeric beads
- Removes dissolved, ionic contaminants, TDS
- Utilizes pressure vessels

Treatment applications

- Discharge compliance
- Recovery/reuse

Advantages/Disadvantages

- Deionizing resins can produce up to 18.2 MΩ-cm quality water
- Selective resins can remove specific contaminants
- TDS/ionic background limitations
- Susceptible to fouling with oil, grease, solids, TOC

EVOQUA WATER TECHNOLOGIES

©2022 EVOQUA WATER TECHNOLOGIES LLC

21

Wastewater Management from Aqueous Cleaning Processes

Treatment Options – Metal-selective Adsorptive Media

Metal-selective Adsorptive Media

- Granular media
- Removes dissolved heavy metals, passes alkaline earth metals
- Utilizes pressure vessels

Treatment applications

- Discharge compliance

Advantages/Disadvantages

- Selective resins can target specific contaminants
- TDS/ionic background limitations
- Susceptible to fouling with oil, grease, solids

EVOQUA WATER TECHNOLOGIES

©2022 EVOQUA WATER TECHNOLOGIES LLC

22

Wastewater Management from Aqueous Cleaning Processes

Treatment Options – Reverse Osmosis

Reverse osmosis

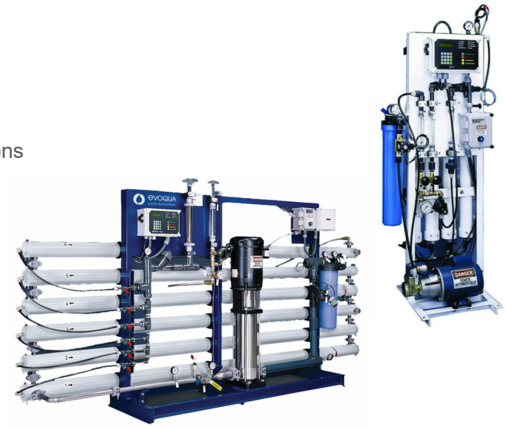
- Polymeric membrane separation process
- Pressure forces water through membranes
- Removes most TDS and compounds; pore size ≈0.0001 microns
- Clean stream (permeate) quality ≈10µS/cm
- Dirty stream (reject) concentrated

Treatment applications

- Water recovery/reuse

Advantages/Disadvantages

- Single-pass recovery ≈50%
- Double-pass recovery ≈75%
- Energy-intensive (high-pressure pump)
- Membranes susceptible to fouling or scaling; regular cleaning required



EVOQUA WATER TECHNOLOGIES

©2022 EVOQUA WATER TECHNOLOGIES LLC

23

Wastewater Management from Aqueous Cleaning Processes

Treatment Options – Ultraviolet Light

Ultraviolet (UV) Light

- Breaks down TOC and microbes
  - 185 nm wavelength for TOC-reduction
  - 254 nm wavelength for microbial-reduction
- Follow with sub-micron filter to remove contaminants
- Used as pre/post-treatment for other operations

Treatment applications

- Recovery/reuse

Advantages/Disadvantages

- Non-chemical treatment
- Most effective on smaller concentrations of TOC or microbes
- No residual effect from treatment
- Turbidity or color can interfere with efficacy

EVOQUA WATER TECHNOLOGIES

©2022 EVOQUA WATER TECHNOLOGIES LLC

24

Wastewater Management from Aqueous Cleaning Processes

Treatment Options - Precipitation

Precipitation

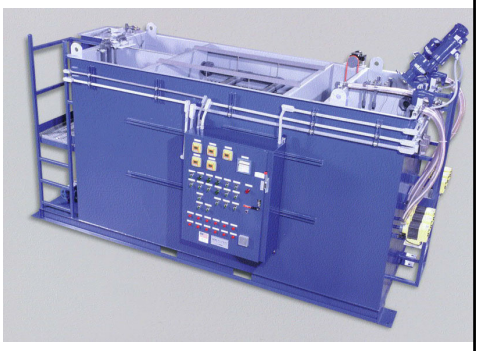
- Converts dissolved metals to particulate metals
- Clean treated water is separated from particulates
- Particulates are captured, dewatered and disposed

Treatment applications

- Discharge compliance

Advantages/Disadvantages

- Best for concentrated metal wastewaters and larger volumes
- Limit to metals-removal ability



EVOQUA WATER TECHNOLOGIES

©2022 EVOQUA WATER TECHNOLOGIES LLC

25

Wastewater Management from Aqueous Cleaning Processes

Treatment Options – Comparison

Comparison of principal technologies used for discharge compliance and recovery reuse

Type	Technology	Wastewater TDS Level	Recovery/ Reuse	Discharge Compliance
Media	Ion Exchange Resin	Low	✓	✓
Membrane	Reverse Osmosis	Low	✓	
Media	Adsorptive Media	Low - medium		✓
Precipitation	Chemical Treatment	High		✓

Other technologies (filtration, carbon adsorption, UV) typically ancillary to the principal technologies

EVOQUA WATER TECHNOLOGIES

©2022 EVOQUA WATER TECHNOLOGIES LLC

26

Wastewater Management from Aqueous Cleaning Processes

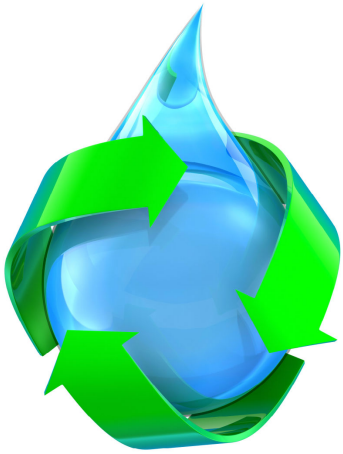
Treatment Options for Sustainability

Sustainability – what does that really mean?

- Recycle and reuse
- Recovery
- Minimal environmental footprint

Many aqueous cleaning wastewaters can be recovered

- Good candidates
  - Dilute rinse waters
  - Low TDS/TOC
- Poor candidates
  - Concentrated cleaning solutions
  - High TDS/TOC



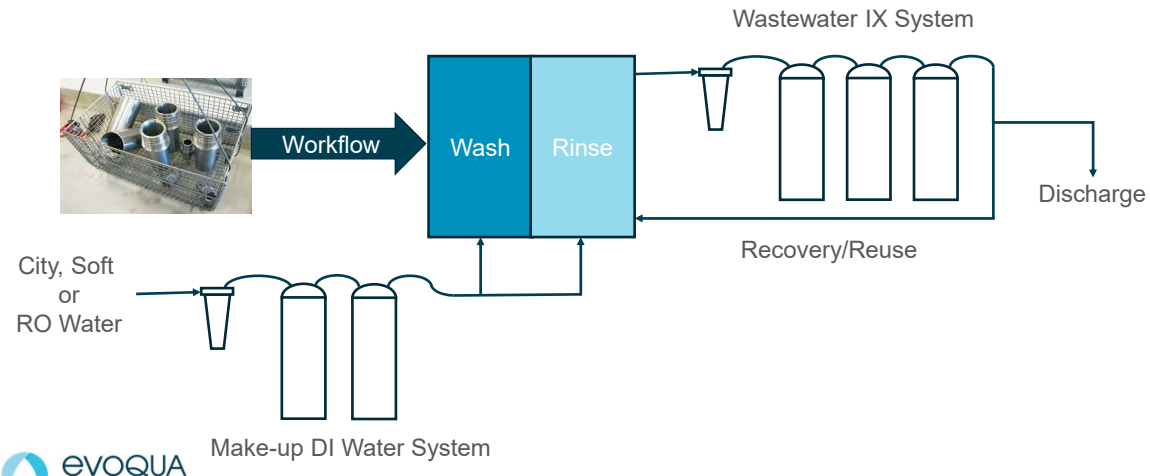
EVOQUA WATER TECHNOLOGIES

©2022 EVOQUA WATER TECHNOLOGIES LLC

27

Wastewater Management from Aqueous Cleaning Processes

Treatment Options – Ion Exchange Example



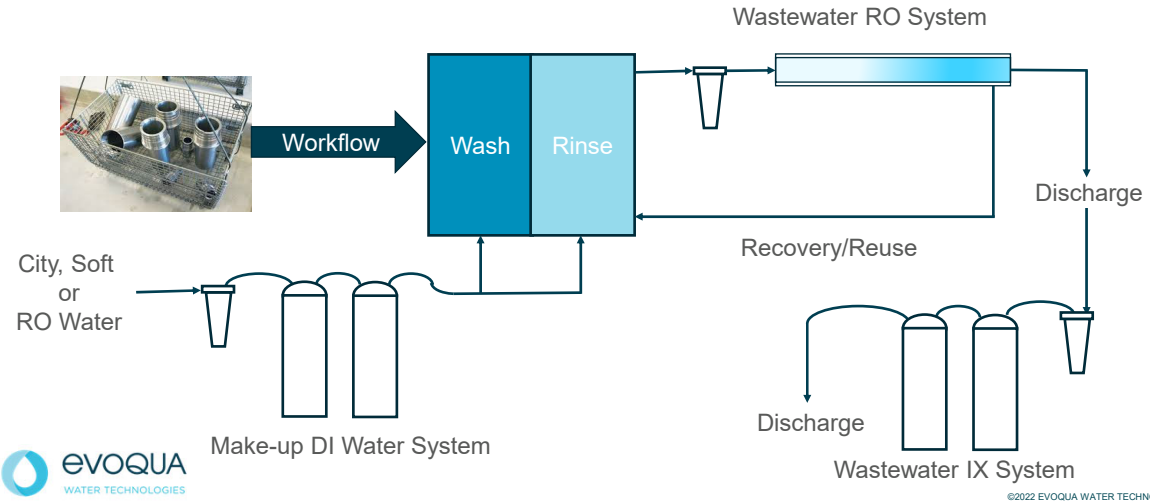
EVOQUA WATER TECHNOLOGIES

©2022 EVOQUA WATER TECHNOLOGIES LLC

28

Wastewater Management from Aqueous Cleaning Processes

Treatment Options – Reverse Osmosis Example



EVOQUA WATER TECHNOLOGIES

©2022 EVOQUA WATER TECHNOLOGIES LLC

29

Wastewater Management from Aqueous Cleaning Processes

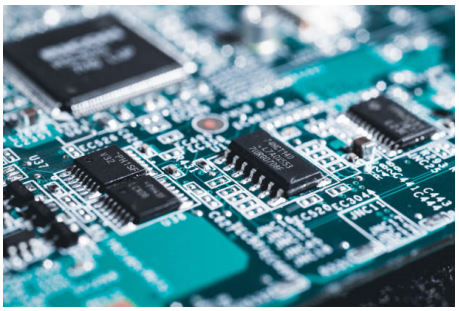
Process Example – Printed Circuit Board (PCB) Cleaning

PCB cleaning steps

- Washing (hot DI water, detergent, surfactant – one or all)
- Rinse (DI water, ≥ 1MΩ-cm, temperature ambient to 140°F)

Wastewater issues and concerns

- Contaminant metals (Pb, Sn)
- TOC
- TDS
- TSS (flux residue, particulates, Pb, Sn)



Treatment approach & options

- Pb typically the only metal of concern from a discharge perspective
- Rinse water typically lower conductivity; TOC and temperature can be a concern
- Ion exchange and RO likely treatment technologies

EVOQUA WATER TECHNOLOGIES

©2022 EVOQUA WATER TECHNOLOGIES LLC

30

Wastewater Management from Aqueous Cleaning Processes

Case Study – Printed Circuit Board (PCB) Cleaning

Problem

- West-coast printed circuit board manufacturer faced drought-related water shortages that adversely affected production
- Customer wanted to reduce their water consumption and at the same time supply the high-quality water typically required of PCB manufacturing operations

Solution

- Evaluated sample of all wastewaters with treatment and recovery potential
- Identified PCB populating rinses that could be successfully recycled using WWIX resin systems
- Installed a 3.6-ft^3 vessel system utilizing activated carbon and mixed bed (cation/anion) exchange resins that treat and recycle up to 10 gpm of the wastewater
- Reduced incoming water usage, eliminated adverse production impact due to water-shortage and improved the quality of the water used to rinse the populated PCBs

EVOQUA WATER TECHNOLOGIES

©2022 EVOQUA WATER TECHNOLOGIES LLC

31

Wastewater Management from Aqueous Cleaning Processes

Agenda

- Aqueous cleaning and wastewater generation
- Understanding cleaning wastewater characterization
- To treat or not to treat?
- Treatment options
- **What happens after treatment?**

EVOQUA WATER TECHNOLOGIES

©2022 EVOQUA WATER TECHNOLOGIES LLC

32

Wastewater Management from Aqueous Cleaning Processes

What happens after treatment?

Wastewater treatment results in treatment residuals

- Waste filters
- Spent activated carbon
- Spent ion exchange resin or adsorptive media
- Residual solids/sludge

Treatment residuals may or may not be regulated

- Depends on contaminant content (via TCLP testing) or other comingled process wastewaters
- Segregated treatment of cleaning wastewaters typically results in non-regulated residuals

Important to understand disposition of treatment residuals

- "Non-regulated" does not mean "no liability"
- Understand where your treatment residuals go and what happens to them

EVOQUA WATER TECHNOLOGIES

©2022 EVOQUA WATER TECHNOLOGIES LLC

33

Wastewater Management from Aqueous Cleaning Processes

Summary

- There are many permutations of aqueous cleaners and soils
- Chemical and process characterization is important for treatment decisions
- Treatment may be necessary or desired
- Several treatment options exist, some suited for discharge treatment and others for recovery/reuse
- Environmental responsibilities do not end with treatment

EVOQUA WATER TECHNOLOGIES

©2022 EVOQUA WATER TECHNOLOGIES LLC

34

Wastewater Management from Aqueous Cleaning Processes

Thank you for attending!

Darren Williams
Cleaning Research Group at SHSU
williams@shsu.edu

Barbara & Ed Kanegsberg
BFK Solutions LLC
barbara@bfksolutions.com
ed@bfksolutions.com

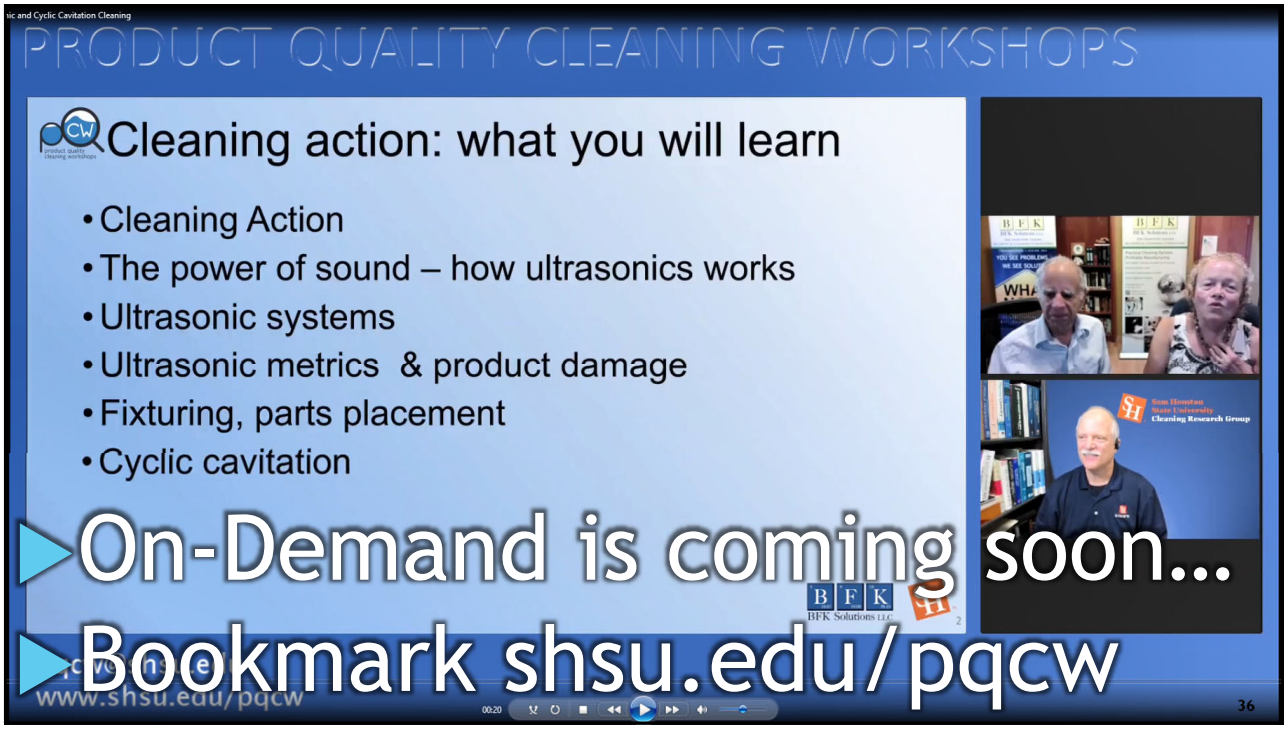
Mark Korzenecki
Sr. Business Dev. Mgr. Wastewater/Ion Ex
mark.Korzenecki@evoqua.com

Chris Riley
Technical Services Dir. Wastewater/Ion Ex
christopher.t.riley@evoqua.com

The PQCW offers practical, hands-on and independent, training in cleaning.
More Info shsu.edu/pqcw pqcw@shsu.edu

35

35



36