



CASE STUDY: USING A ZANAQUA WATER PURIFICATION  
TECHNOLOGY AS A METHOD OF PROCESS WATER REMEDIATION

TECHNICAL AND ECONOMIC EVALUATION OF RESULTS  
FROM A MULTI-MONTH TRIAL AT A  
NEW ENGLAND SOFT DRINK  
BOTTLING COMPANY

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## EXECUTIVE SUMMARY

ZanAqua Technologies has developed a proprietary method of vapor compression distillation (VCD) for water purification that could have significant and beneficial impact to improved waste water remediation and purification. During the technology development process, ZanAqua has focused on applications of producing ultra-pure lab water, industrial rinse, and food and beverage market spaces.

To evaluate and demonstrate water purification efficacy in the beverage water space, ZanAqua provided on-site process water reclamation, at a carbonated soft drink company (CSD Bottling<sup>1</sup>). CSD Bottling produces approximately 6 million gallons of process (cleaning, tank rinse, etc.) water per year and, currently, disposes of this water (high in organic food (sugars)) by means of an independent trucking firm hauling process water offsite for independent remediation. ZanAqua sought to demonstrate distiller efficacy at reducing hauling and remediation costs by reducing BOD<sub>5</sub><sup>2</sup> content in the distillate so that the customer could discharge this distillate into the municipal waste water stream, and thereby reduce the volume to be trucked off-site. The criterion of success was to have the system produce effluent that met or exceeded local municipal limits for disposal in the public sewage system and produced a sufficient economic benefit to warrant consideration.

Through independent lab testing<sup>3</sup>, influent was shown to have BOD<sub>5</sub> levels near 1,980 mg O<sub>2</sub>/L. All ZanAqua tests demonstrated 1-2 log<sup>4</sup> reduction in BOD<sub>5</sub> (from influent to distillate) with resultant distillate BOD<sub>5</sub> levels substantially lower many municipalities' upper acceptable BOD<sub>5</sub> limits<sup>5</sup>.

System operation, with influent water having an influent BOD<sub>5</sub> level of 1,980 and an inflow rate of 19 gallons per hour, demonstrated capability of reducing the distillate BOD<sub>5</sub> level to 120 while producing ~15.5 gph of distillate water flow.

System operation used 1.33 kW of electrical power to produce ~15.5 gph of distillate flow. This equates to 0.095 kW/gal and, at \$0.10/kWh, produces distilled water for \$0.0095/gal.

Combining operating costs (\$0.0095/gal) with capital costs, ZanAqua's VCD water purification system had a Return on Investment (ROI) of 89% by Year 2 of operation, an Internal Rate of Return of 104% (based on a Discounted Cash Flow rate of 8%) and a payback period of less than 1 year.

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<sup>1</sup> CSD Bottling is the pseudonym for the carbonated soft drink company that evaluated ZanAqua's VCD technology.

<sup>2</sup> Biological Oxygen Demand – indicative of bacteria or bacterial foods that deplete oxygen content in water; units are mg O<sub>2</sub>/L. The subscript "5" implies that the BOD level is determined over 5 days.

<sup>3</sup> All water quality testing has been performed by a local, qualified laboratory and are traceable to US EPA standards.

<sup>4</sup> 1 log is equivalent to 10x.

<sup>5</sup> In many communities, this limit is 300-400 mg O<sub>2</sub>/L.

## 1.0 INTRODUCTION AND GOALS

ZanAqua Technologies has developed highly thermally efficient vapor compression distillation technology so as to provide customers with ultra-pure water from tap water, or remediation of water contaminants during process applications. Specifically, ZanAqua Technologies sought to demonstrate that its vapor compression distillation (VCD) technology was capable of reducing BOD content in process water<sup>6</sup> streams. Working with an independent installer, a ZanAqua water purification unit and pre-treatment peripherals were installed at CSD BOTTLING and operated to evaluate the system's ability to distill sugar-based process water.

The initial goal of this onsite evaluation was to distill process water used to rinse sugar-based soft drink tanks (this process water having extremely high BOD levels (~1,980 mg O<sub>2</sub>/L)) so as to reduce the BOD<sub>5</sub> content to an acceptable level for direct discharge into the local municipal waste water system (typical acceptance (BOD<sub>5</sub>) level: less than 300 mg O<sub>2</sub>/L). Distillation efficiency (i.e., reduction of BOD concentration in the distillate stream) was to be determined by submitting water samples to an independent lab for content analysis and confirmation of reduced BOD<sub>5</sub> content in the distillate stream. (Samples of original influent, distillate and concentrate are shown below.)



The second goal was to demonstrate long-term distillation capability in this specific environment with this specific influent water. This was to be accomplished by returning the distillate and concentrate streams, from the distillation system, to a common tank for recycling through the ZanAqua distiller, continuous operation of the distillation system and monitoring influent, distillate and concentrate flow rates<sup>7</sup>.

The final goal, established after several months of distilling process water, was to demonstrate self-cleaning of the distillation system by means of periodic recirculation of distillate water into the influent stream. Self-cleaning efficiency was determined by monitoring influent, distillate and concentrate flow rates and by submitting water samples to an independent lab for content analysis and confirmation of reduced BOD<sub>5</sub> content in the distillate stream.

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<sup>6</sup> Process water includes water used to wash tanks and lines.

<sup>7</sup> Reduced flow rate(s) indicate fouling of the distillation system with sugars.

## 2.0 RESULTS AND CONCLUSION

### 2.1 Water Purification

As stated earlier, ZanAqua's objective, for distilling process water, was to reduce BOD<sub>5</sub> content so as to permit discharging treated process water into the municipal waste water stream. To do so, without penalty, BOD<sub>5</sub> content must be below the current maximum BOD<sub>5</sub> level of 300 mg O<sub>2</sub>/L. Influent, distillate and concentrate water quality and measurement parameters are given in the Appendix.

ZanAqua's VCD system, coupled with influent pre-filtering and water softening (pretreatment common to virtually all means of water purification) operated during operating hours at CSD Bottling, continuously for 4 months.

The ZanAqua system operated with an influent flow rate of approximately 19 gallons per hour and an influent BOD<sub>5</sub> level of 1,980 mg O<sub>2</sub>/L. Under continual daily operation, the ZanAqua system produced distillate at a rate of approximately 15.5 gallons per hour with a distillate BOD<sub>5</sub> level of 120 mg O<sub>2</sub>/L and concentrate at a rate of approximately 3.5 gallons per hour with a concentrate BOD<sub>5</sub> level of 3,630 mg O<sub>2</sub>/L.

If distillate flow rate dropped to less than ~13 gph, the influent stream was switched to the municipal water source to re-hydrate sugars, flush the system and return system performance to nominal values (influent: ~20 gph; distillate: ~17 gph and concentrate: ~3 gph). After this brief flushing the system was returned to process water remediation.

Continuous operation demonstrated successfully capability of ZanAqua's VCD technology to reduce BOD<sub>5</sub> levels in the distillate stream to well below upper limits of municipal waste water streams.

### 2.2 Operating Economics

During system operation, parameters, such as system power and flow rates, were recorded to facilitate financial analysis of the cost and opportunity of ownership. Thanks to process water remediation possible with the ZanAqua water purification technology, CSD would be able to cut the hauling and remediation costs of their process water by 80%. At an influent flow rate of approximately 19 gph, the system consumed 1.33 kW of power. At a energy cost of \$0.10 per kWh, system power consumption equates to \$0.0095 per gallon of distillate produced.

With predictions for system operating costs (e.g., maintenance, consumables, power, water) and extrapolation from a single ZanAqua Element to a complement of ZanAqua Expansion Modules capable of treating CSD Bottlings's full process water flow rate, our calculations indicate a payback period of less than 11 months, an Internal Rate of Return of 104% and, by Year 2 of operations, a Return on Investment of 89%.

## APPENDIX

### WATER QUALITY LAB RESULTS<sup>8</sup>

<b><u>Subject of Test</u></b>	<b><u>Test Results - Influent</u></b>	<b><u>Test Results - Distillate</u></b>	<b><u>EPA Limits for Public Drinking Water</u></b>	<b><u>Description</u></b>
<b><u>General Bacteria</u></b>				
Total Coliform	Present	Absent	0	There should be no Coliform bacteria in the sample
Fecal/E.Coli	Present	Absent	0	There should be no Fecal/E.Coli Bacteria in the sample
<b><u>Biochemical Content</u></b>				
BOD <sub>5</sub>	1980.2 mg O <sub>2</sub> /L	120.0 mgO <sub>2</sub> /L		Bacteria or bacterial foods that deplete oxygen content
<b><u>General Chemistry</u></b>				
Sodium	401.90mg/L	0.85 mg/L	250.0 mg/L	20.0 mg/L is MASS. DEP Guideline
Potassium	34.57 mg/L	0.07 mg/L	No Limit	A Component of Salt
Copper	0.19 mg/L	0.36 mg/L	1.30 mg/L	Indicates Plumbing Corrosion
Iron	3.21 mg/L	Not Detected	0.30 mg/L	Brown Stains, Bitter Taste
Manganese	.017 mg/L	0.005 mg/L	0.05 mg/L	May Cause Laundry Staining
Magnesium	1.29 mg/L	Not Detected	No Limit	A Component of Hardness
Calcium	16.88 mg/L	Not Detected	No Limit	A Component of Hardness
Arsenic	0.013 mg/L	Not Detected	0.010 mg/L	Natural Occuring Element
Lead	Not Detected	Not Detected	0.015 mg/L	A Toxic Metal
pH	6.03 SU	6.03 SU	6.5 - 8.5 SU	Acid/Basic Determination
Turbidity	32.0 N.T.U.	1.20 N.T.U.	No Limit	Presence of Particles
Color	3.0 C.U.	Not Detected	15.0 C.U.	Clarity (0), Discoloration (15)
Odor	3.0 T.O.N.	3.0 T.O.N.	3.0 T.O.N.	Odor due to Contamination
Conductivity	2421.0 umhos	13.0 umhos	No Limit	Electrical Resistance (umhos/cm)
T.D.S.	1,452.6 mg/L	7.8 mg/L	500.mg/L	Total Dissolved Minerals Present
Sediment	Present	Absent	Present	Undissolved Solids
Alkalinity	575.0 mg/L	40.0 mg/L	No Limit	Ability to Neutralize acid
chlorine	Not Detected	Not Detected	4.0 mg/L	A Disinfectant
Chloride	43.3 mg/L	0.2 mg/L	250.0 mg/L	A Component of Salt
Hardness	47.5 mg/L	0.00 mg/L	No Limit	0-75 is considered soft
Nitrate	0.6 mg/L	Not Detected	10.0 mg/L	Indicator of Biological Waste
Nitrite	Not Detected	Not Detected	1.0 mg/L	Indicator of Waste
Ammonia	7.550 mg/L	2.445 mg/L	No Limit	Indicator of Waste
Sulfate	16.7 mg/L	Not Detected	250.0 mg/L	A Mineral, Can Cause Odor

<sup>8</sup> All water quality testing was performed by a local, independent, qualified laboratory according to established EPA testing standards.