

ADVANCED MEMBRANE PROCESS FOR WATER AND WASTEWATER RECOVERY

Advanced Water Solutions Inc.

“Water Treatment without the Waste”



Riad Al-Samadi, Ph.D., P. Eng.

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AWS MISSION STATEMENT

“To significantly reduce cost, improve water quality and reduce waste by providing innovative processes and leading edge solutions to potable, industrial and waste water problems, Worldwide.”

“No one knows the worth of water till the well runs dry.”

- Benjamin Franklin

“Our greatest wealth is water – not oil”

- Confucius

ARROW® & ZERO® Process Development History

- Unique Integration of proven process steps.
- Successful pilots at GM Engine Plant & Kimberley Clark Tissue plant in Mexico.
- Successful pilot at a landfill-leachate in Ontario.
- Successful pilot at Bristol-Myers-Squibb pharmaceutical facilities in New Jersey (2007).



ARROW[®] & ZERO[®] Process Commercialization

- First **ZERO[®]** commercial unit installed at Bruce Nuclear Station (99% recovery).
- Full scale **ARROW[®]** system supplied to Colgate-Palmolive in New Jersey (2008).
- Tanner Industries **ARROW[®]** system in Pennsylvania (2010).
- Overall process permeate recoveries: 94-96%.
- **ZDW-RO[™]** Drinking Water Prototype (2011): > 8 Years operation at 90-95% Recovery - No cleaning, same (original) RO membranes. Virtually zero maintenance cost.



World of Care



ZERO[®] High Recovery Process Pilot Plant



Bristol-Myers Squibb
Together we can prevail.®



ARROW™ Plant Water Recovery System at Colgate-Palmolive in New Jersey



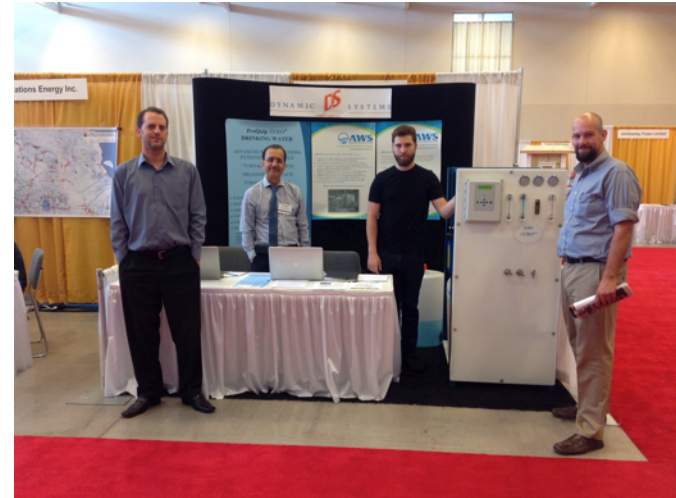
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1 GPM ZERO[®] Drinking Water Demo

(U.S. Patent 9,199,866 B2, 2019)



ZDW-RO™ Drinking Water Prototype

(U.S. Patent 9,199,866 B2, Dec. 1, 2015)



ZERO[®] Drinking Water Pilot – Green Street (Sask.)

(U.S. Patent 9,199,866 B2, Dec. 1, 2015)



ZERO[®] Drinking Water Pilot – Green Street

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ZERO[®] Drinking Water Pilot – Green Street (U.S. Patent 9,199,866 B2, Dec. 1, 2015)



ZERO[®] Drinking Water Pilot – Green Street (U.S. Patent 9,199,866 B2, Dec. 1, 2015)



ZERO[®] Drinking Water Pilot Performance

- Pilot comprised Ozone/UF pretreatment skid and high recovery RO (**ZERO[®]**) purification skid (Q3-Q4, 2017).
- Successful unattended operation of pilot plant for 3 months with stable UF and RO membrane flux.
- UF Membranes were operated at > 99% recovery while RO membranes were operated at 90% recovery. Conventional RO would achieve 30-50% permeate recovery for this application.
- Two comprehensive sampling campaigns demonstrated compliance with all of the Canadian & Saskatchewan Drinking water quality limits, including TDS, iron, manganese and THMs.
- The trihalomethanes (THM) were reduced from current 100 – 170 ppb to < 0.5 ppb, virtually complete absence of THMs.

WHY AWS?

- Vast experience in solving complex water problems.
- Bring together water chemistry, microbiology and advanced membrane and ion exchange technologies.
- State-of-the-art water purification, desalination, water reuse, waste minimization and challenging drinking water technologies (13 U.S. & International Patents).
- Offer only optimum designs & cost-effective solutions.
- Custom-designed and reliable solutions.
- Innovative integration with existing plant systems and equipment (bolt-on designs).
- Diverse technology applications: desalination, nuclear Rad Waste, Uranium-ISL, plant water production, industrial and municipal wastewater recovery, drinking water production.

U. S. PATENTS (2000 to 2015)



INTERNATIONAL PATENTS (2009 to 2016)



References & Testimonials

References – Technical Papers

- “New Reverse Osmosis Systems Boasts almost ZERO Percent Discharge Waste”, US Water News Journal, March 2006.
- “Membrane Process Offers Improved Water Recovery”, Ultrapure Water Journal, April 2008
- IAEA UN Technical Expert from Canada on Spent Nuclear Fuel Chemistry (Slovenia, 2009).
- “A High Recovery Membrane Process for Purification of Low-Level Radioactive Liquid Waste”, 34th Conference of the Canadian Nuclear Society, Toronto, June 2013.
- “Advanced Membrane Process for Water and Wastewater Recovery”, IWC Conference, Orlando (FL), November 2013.

References & Testimonials – Colgate

An **ARROW®** System was installed at the Colgate-Palmolive facilities in Morristown, NJ in April 2008:

Water Recycling

“Recycling water is one of the most effective ways we can make a positive impact on our environment. A team at Colgate's Morristown, New Jersey facility found a way to reduce both waste and costs by developing a plan to recover rejected water by redirecting and putting the water through a water purifying system in the plant. The resulting high-purity water can then be used in production processes, as well as for other purposes in the plant. The project has resulted in recovery of more than 26 gallons of water per minute, reducing water waste by almost **95%** and delivering savings of **\$250,000 per year**. The team received a 2009 Chairman's: *You Can Make a Difference Award for this sustainability new innovation*”.



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References & Testimonials – Tanner Industries

A **ZERO**[®] System was installed at the Tanner Industries Ammonia Plant in Newcastle (PA) in Oct. 2010. The plant supervisor offered the following statement recently:

“The AWS **ZERO**[®] high recovery technology RO unit in New Castle has performed and still performing very well for us since day one. The unit maintained an efficiency between 94% - 95% producing on average 4-5 mg/L water quality. The process requires little maintenance and infrequent membrane cleaning. We are extremely happy with its performance.”

Al Mazahreh
Plant Supervisor
Tanner Industries Inc.

