High-Efficiency Water Treatment for Oil & Gas Markets

Keynote Address

North American Petroleum Accounting Conference
Dallas, Texas, May 14-15, 2015

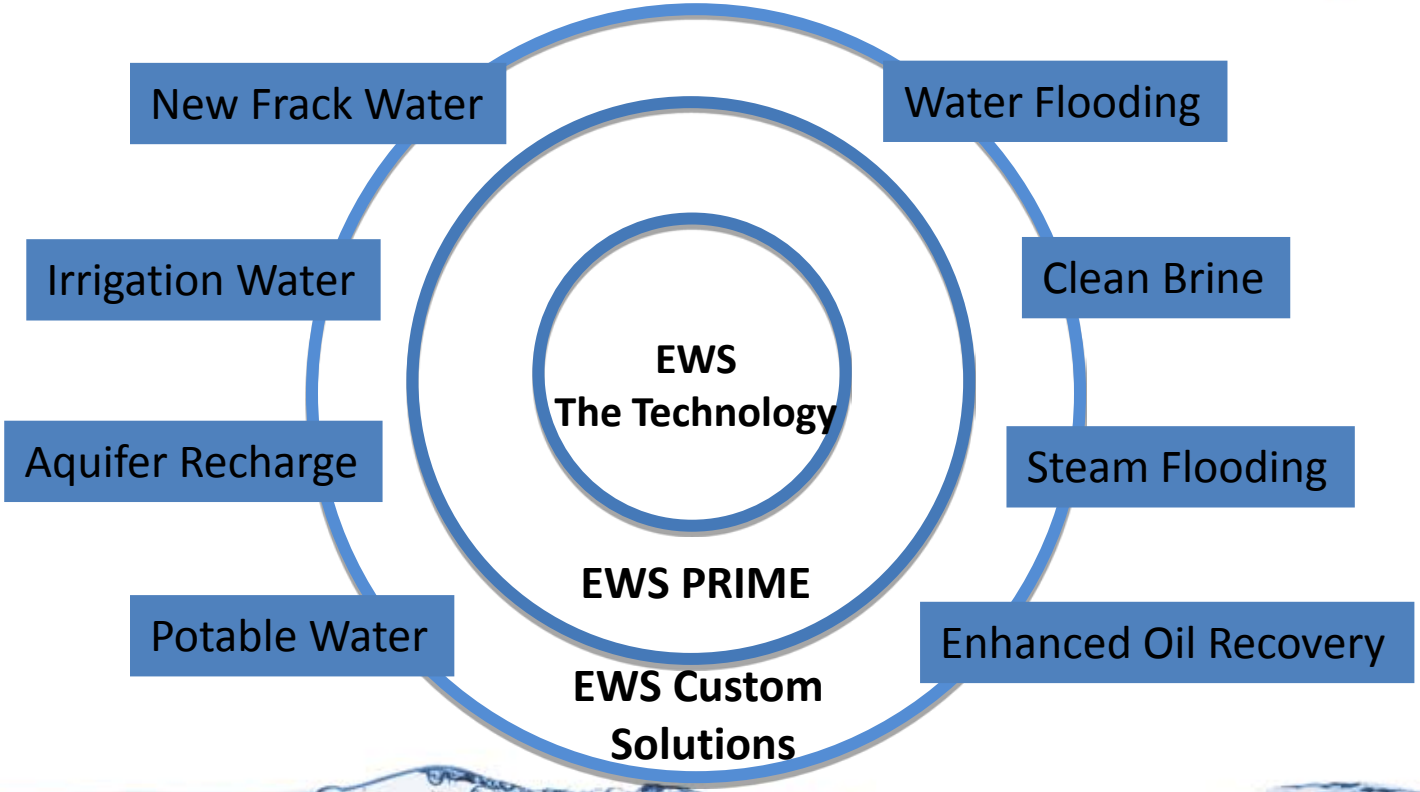
History & Applications

- Founded in 2007 to develop algae growth and harvesting technology
- Developed Electro Water Separation - a patented proprietary OriginClear technology for the removal of non-soluble contaminants from large quantities of water
- Applications in algae harvesting, wastewater treatment and oil & gas flowback & produced water treatment
- Long term strategy is licensing while commercializing the technology

A Technology & A Process

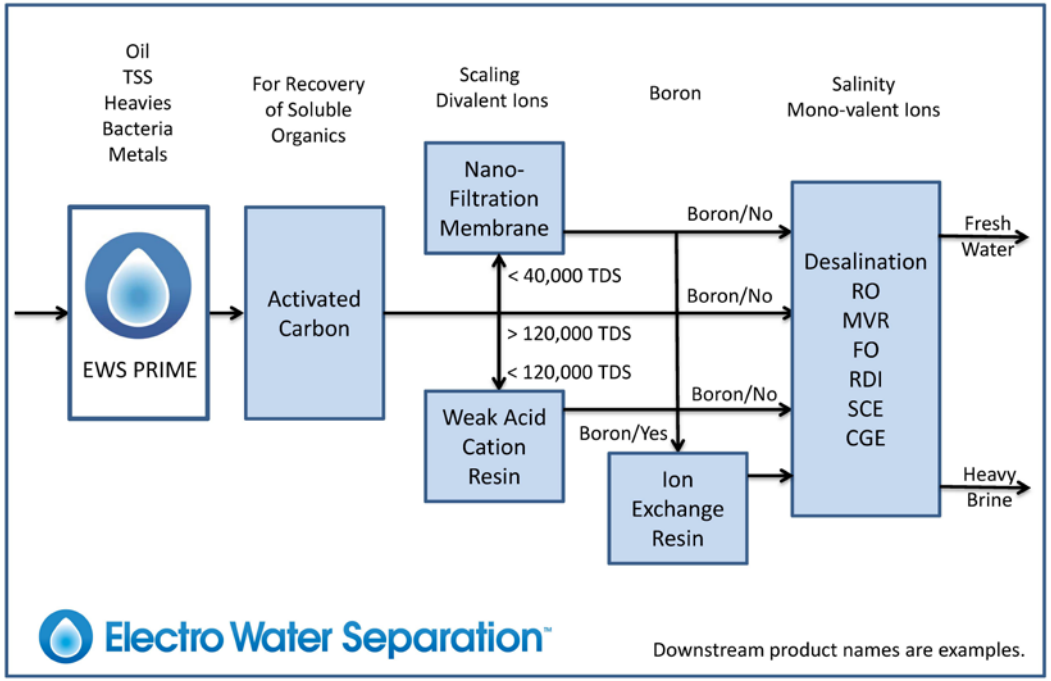
- **Electro Water Separation™ (EWS)**
  - A first stage technology for all O&G water
  - Removes essentially all TPH, TSS, and bacteria
  - EWS is a patented licensable technology
- **EWS PRIME**
  - A commercial process incorporating EWS
  - Suitable for most water treatment applications
  - Precursor to downstream desalination processes.
  - To be manufactured by licensees with other processes to achieve beneficial use

One Technology, Many Solutions



Potential Process Road Map

Heavy Brine for drilling fluid, completions and work overs.



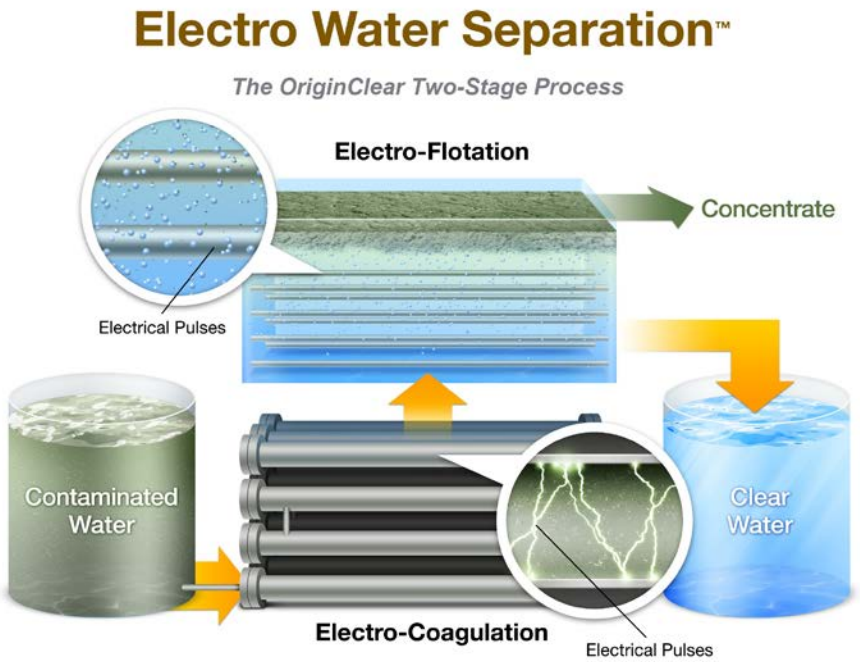
Electro Water Separation

- Process Flow Diagram
  - Post upfront oil-water separator
  - Integrated single equipment
- The Essentials
  - Continuous & very low energy
  - No chemical addition
  - Mobile or centralized facility
- Function
  - Targets dispersed 1 to 25 micron size oil droplets and suspended solids
  - Coalesces to 25 micron plus
  - Disinfects bacteria
  - Oxidizes and co-precipitates specific dissolved ions

EWS PRIME P1000
With Electro-Coagulation Reactors
on Right

Basic EWS Technologies

- Proprietary electro-coagulation
  - Breaks the oil-water emulsion
  - Neutralizes charge on droplets & particles
  - Coalesces 1 to 25 micron droplets & particles
  - Coalesces to 25 plus for gravity separation
- Proprietary electro-oxidation
  - Creates oxidizing agents
  - Disinfects bacteria
  - Oxidizes heavy metals
  - Breaks up dissolved organics
- Proprietary electro-flotation
  - Creates cloud of micron-sized gas bubbles
  - Lifts oil & solids into a surface mat



Differentiation - EC

- Proprietary Electro-Coagulation
  - Unique electrode configuration for minimum power and maintenance
  - Unique choice of donating and non-donating anode & cathode materials
  - High mass transfer & pressurized reactor to keep gas in solution
  - Pressure released in flotation chamber for immediate dispersion of gas
  - In-line flocculation of oil & suspended solids

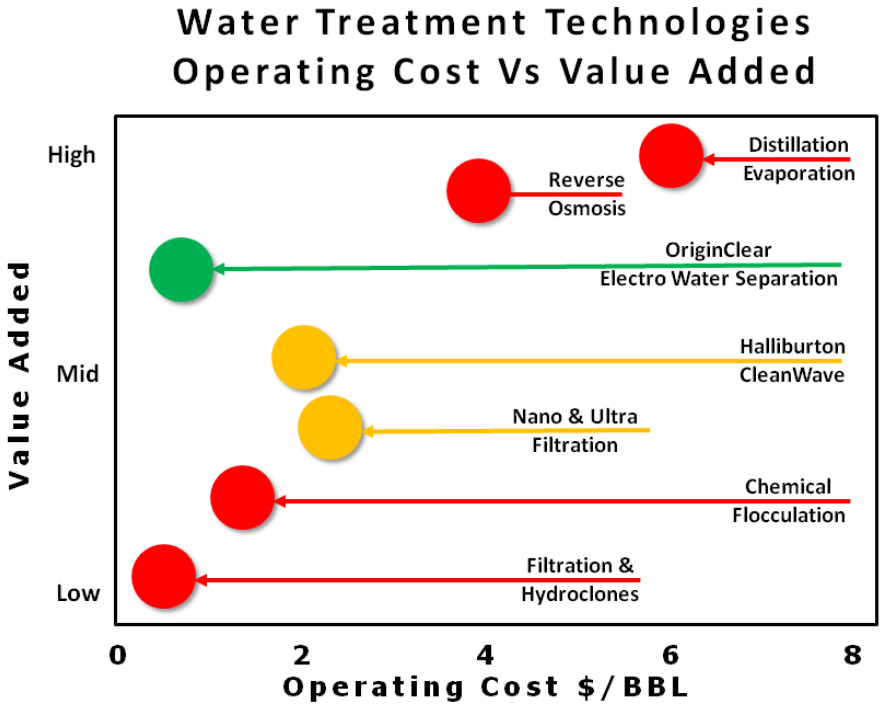
Differentiation - EF

- Proprietary Electro-Flotation
  - 100% of water exposed to micron gas bubbles
  - Unique non-sacrificial anode/ cathode configuration for low power
  - Four-chambered flotation chamber

Differentiation – EO, SCADA

- Proprietary Electro-Oxidation
  - Generation of oxidizing agents for bacteria disinfection
  - Low energy, chemical free process
- Proprietary SCADA process control
  - Touch screen control
  - PLC algorithms for real time control and off site monitoring and control

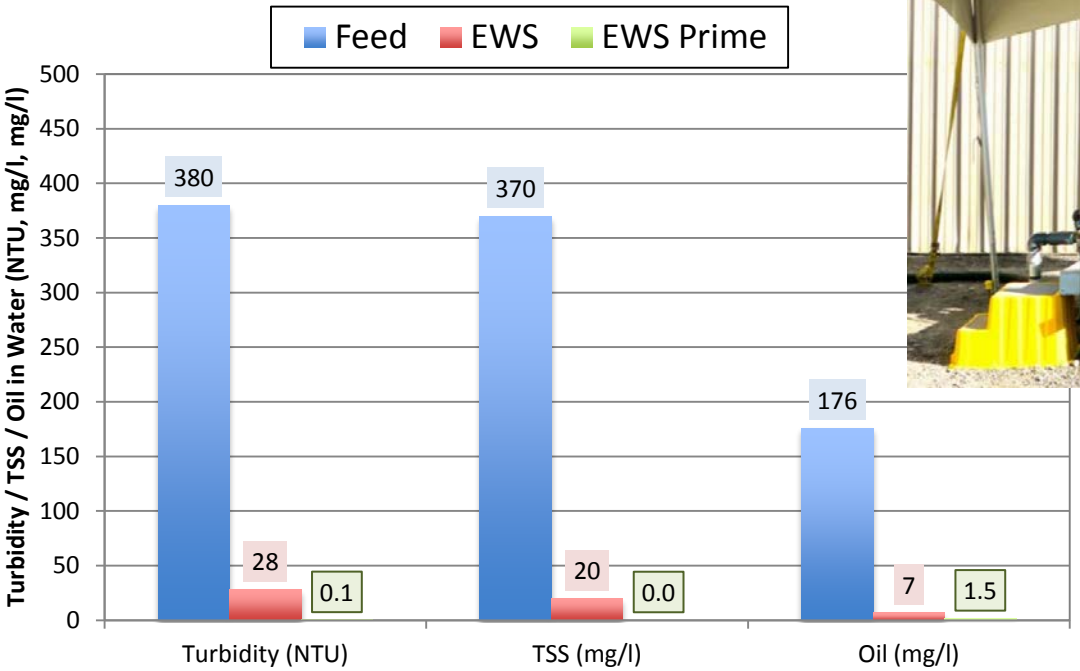
Best Value-Added Process



Field Case Studies

- Three Unique Produced & Flowback Water Trials
  - Gas wells from western slope of Colorado – Niobrara
  - West Texas Intermediate oil wells of west Texas – Permian
  - Heavy oil CSG wells of Bakersfield – Monterey basin
- EWS PRIME used for all three trials
  - System throughput 1000 barrels per day
  - Spiral Water self cleaning filter for BS&W
  - EWS for 90% removal of all non-soluble contaminants & bacteria
  - Ultra-filtration polishing to achieve non-detectable levels

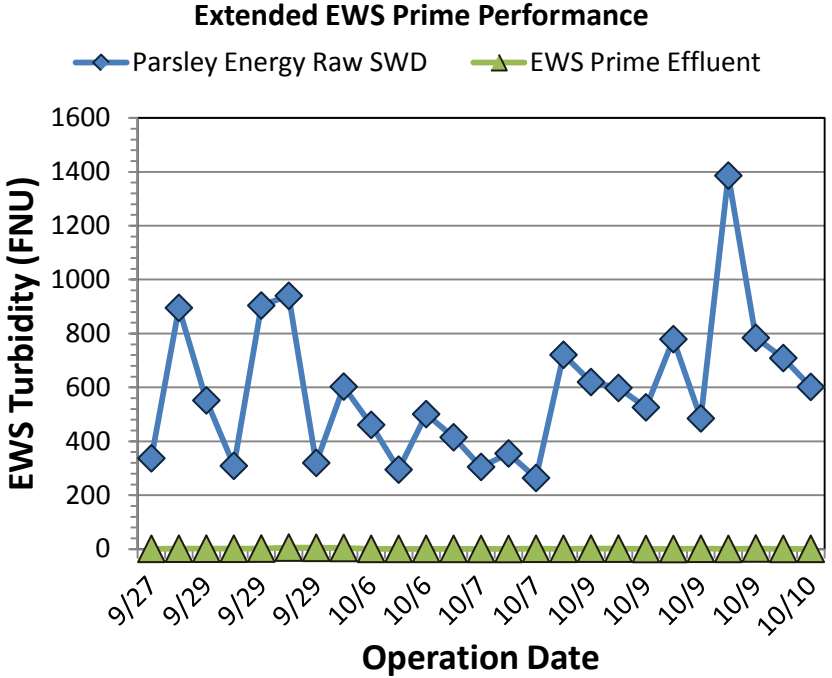
Niobrara Performance



Feed water for testing: Produced & frac flowback from Colorado Western Slope disposal well facility

Better than 99% removal of Turbidity, TSS and Oil observed

Permian Robustness

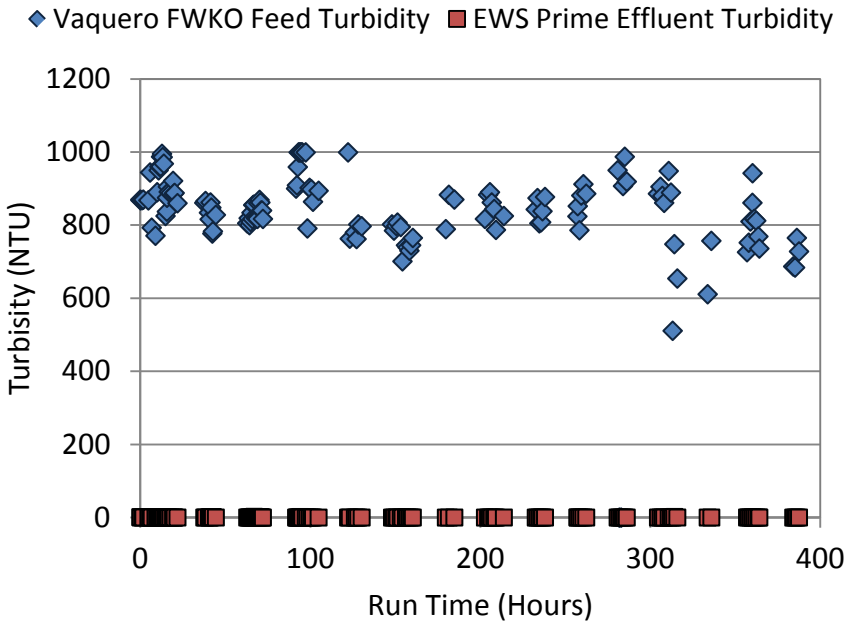


Wide variations in feed from many different truckloads and tank mixing over two weeks of operation in the Permian

Recovered Oil

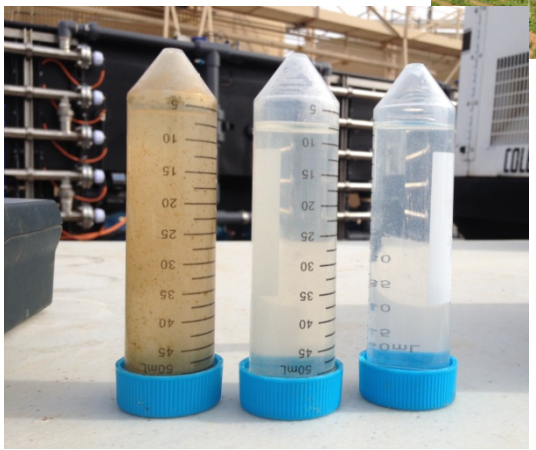
Water Samples

Monterey Clarity



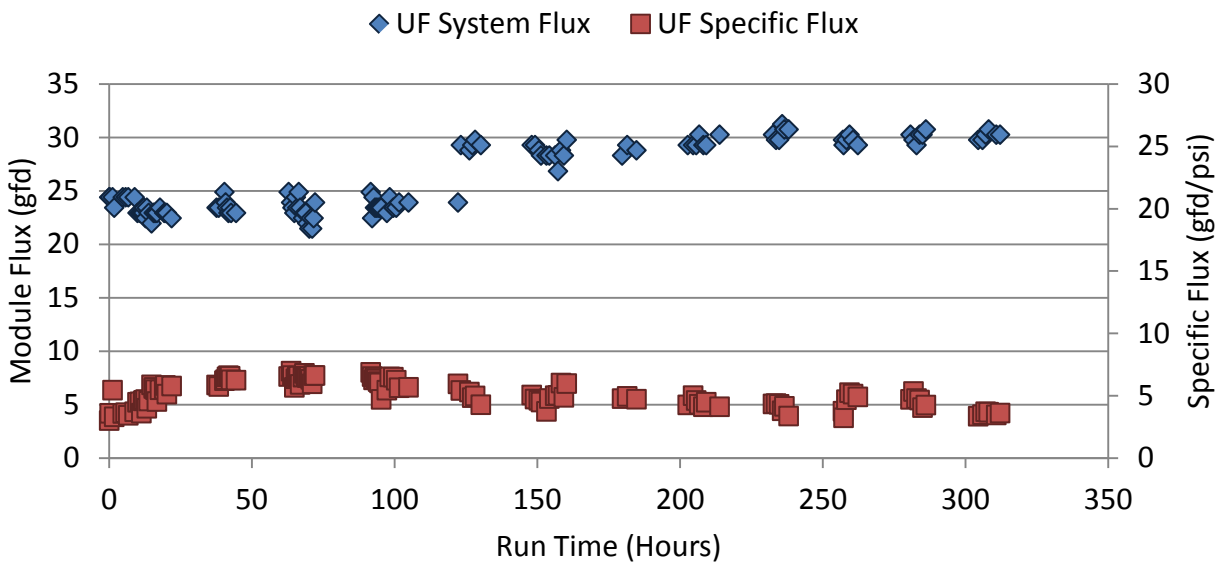
Field operations to treat CSS produced water to steam boiler make-up and irrigation quality

Beneficial Re-use



Water Samples

High Energy Efficiency



Vaquero Site in Monterey Formation

No observable membrane fouling even at high production capacity due to complete produced water pre-treatment

Independent Lab Data

Parameter (ppm)	Vaquero Feed	EWS PRIME Effluent	EWS Custom Effluent
BOD	20	7.2	5.9
COD	530	110	41
TSS	100	64	3*
TRPH (HEM)*	142	9	<5.0*
Diesel Range Organics	108	6.4	0.7
Gasoline Range Organics	0.46	0.19	.063
Motor Oil Range Organics	196	8.8	1.03

All data generated by Zalco Laboratories

Sampled 18 Feb 2015 at Hershey Tank Battery, Vaquero Energy (Bakersfield CA)

* Detection Limit

TRPH: Total Recoverable Petroleum Hydrocarbons

HEM: Hexane Extractable Material

Cost Performance

- EWS PRIME Specific Energy Consumption (SEC)
  - 0.28 kWh per barrel or 6.7 kWh/kgal - including EWS & UF
  - $0.042 per barrel at $0.15 per kWh
- EWS PRIME Operating Expense w/o Labor
  - $0.042 per barrel energy cost
  - $ 0.053 per barrel consumable (weekly partial anode replacement)
  - $0.047 per barrel typical process equipment maintenance
- Total Operating Expense $0.14/bbl
- EWS PRIME Capital Cost: $0.20/bbl
  - Amortized over 5 years at 3% interest
- EWS PRIME Total Cost w/o Labor: $0.34/bbl

Bottom Line Performance

- EWS PRIME performed in wide range of environments
  - Gas wells to WTI to Heavy Oil
  - Truck load to truck load (black to yellow)
  - Salinities from 900 to 160,000 ppm
- Contaminants removed by EWS PRIME
  - TPH is below detection limits of 5 ppm
  - TSS to below detection limits of 3 ppm
  - Gasoline, Diesel, Motor Oil Range to less than 1 ppm
  - Bacteria removal expected to be higher than 99.5%
- Eliminates plugging of downstream desalination

- Desalination requires total removal of oil and TSS.
- EWS PRIME is the most cost effective solution.

Contact Information

Sales or Licensing Questions?

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