A Novel Approach to Oil and Gas Water Treatment

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Owners | Priority One

PRIORITY ONE

A Novel Approach to Oil and Gas Water Treatment

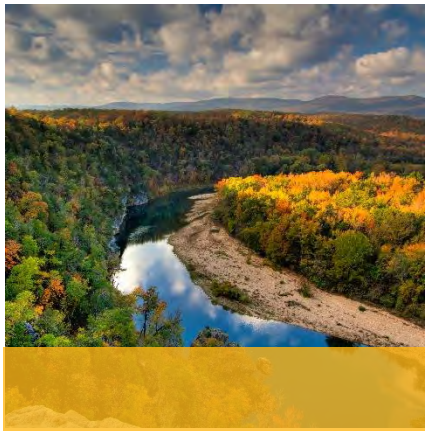
Agenda

Water is Crucial to O&G Process

Electrochlorination Process

Disinfection of Water for Hydraulic Fracturing

Treatment and Recycling of Produced Water



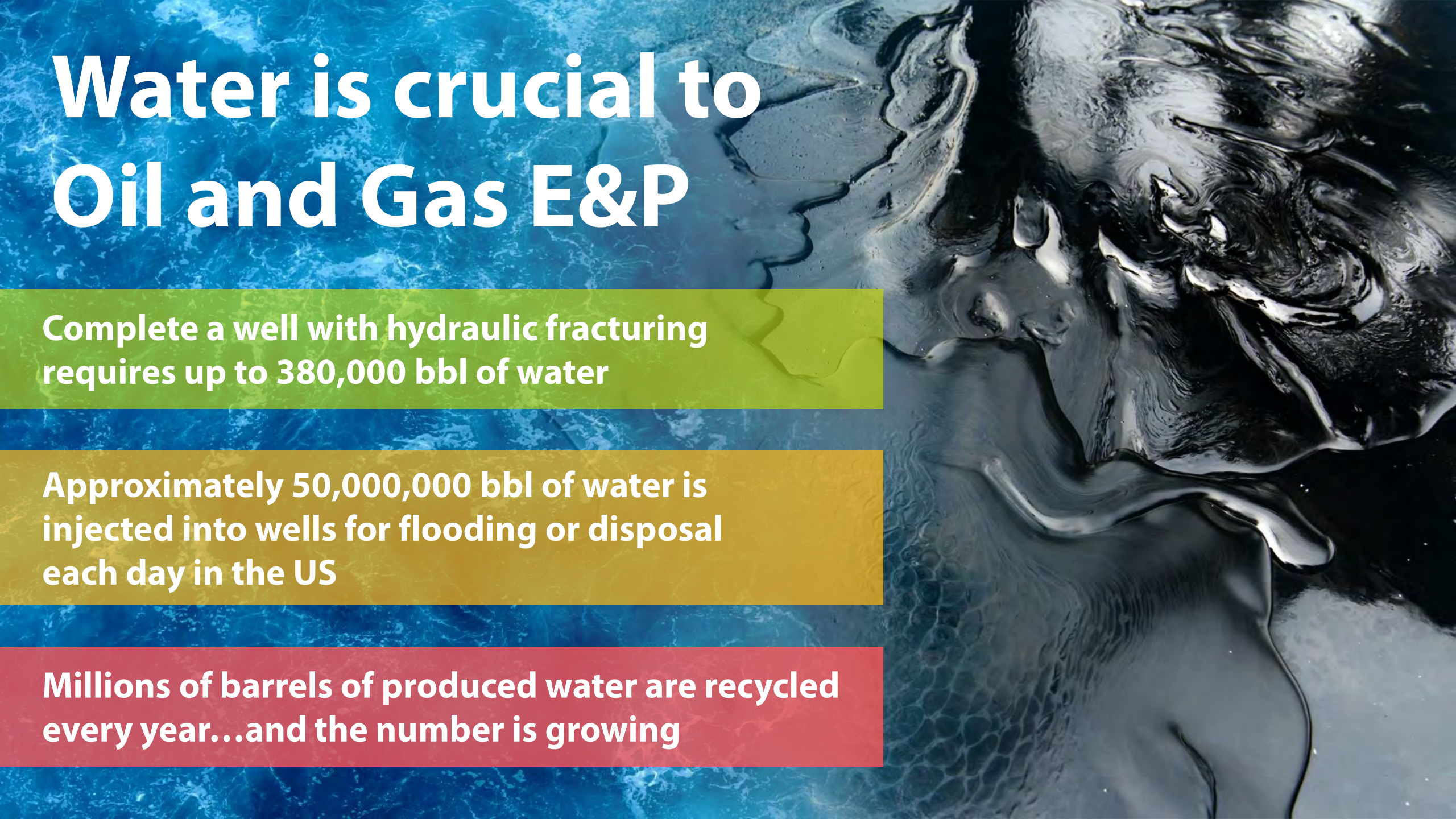
Case Study

Water is crucial to Oil and Gas E&P

Complete a well with hydraulic fracturing requires up to 380,000 bbl of water

Approximately 50,000,000 bbl of water is injected into wells for flooding or disposal each day in the US

Millions of barrels of produced water are recycled every year…and the number is growing



Water Lifecycle: Upstream/Midstream

Water withdrawn from the environment used to drill or stimulate a well

Flowback and produced water are returned along with hydrocarbons from the well once it is in production

Produced water is collected after being separated from hydrocarbons

Treatment of produced water for injection into SWD wells

Water can be recycled for use in further E&P operations

Treatment of produced water for release back into the environment

Electrochlorination can help the process

Eliminate Oilfield Bacteria

Oxidize Hydrogen Sulfide

$H_2S \rightarrow SO_4^{2-}$

Oxidize Iron and Help Remove Suspended Solids

How electrochlorination works

Salt, water, and electricity produce sodium hypochlorite

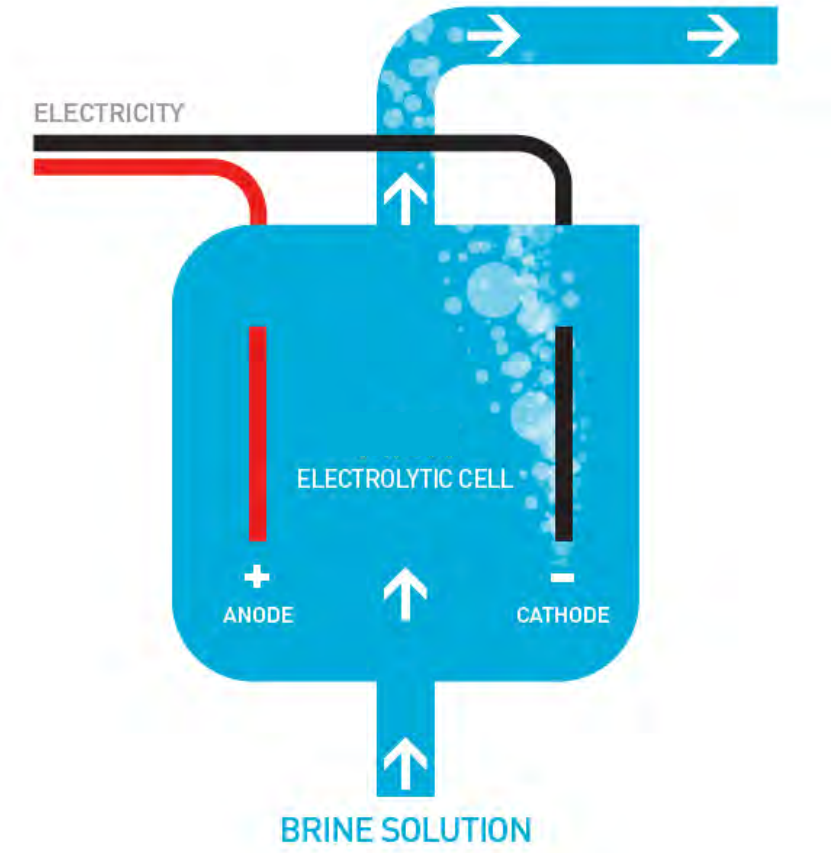
Primary electrochemical reactions:

Anode- Oxidation of Chloride: $2\ Cl^- \rightarrow Cl_2 + 2e^-$

Cathode: Reduction of water: $2\ H_2O + 2e^- \rightarrow 2\ HO^- + H_2$

Overall chemical reaction:

$NaCl + H_2O + 2e^- \rightarrow NaOCl + H_2$



Using Electrochlorination for Oil and Gas Applications

Disinfection of water for hydraulic fracturing

Produced water recycling

Treatment of water for injection wells

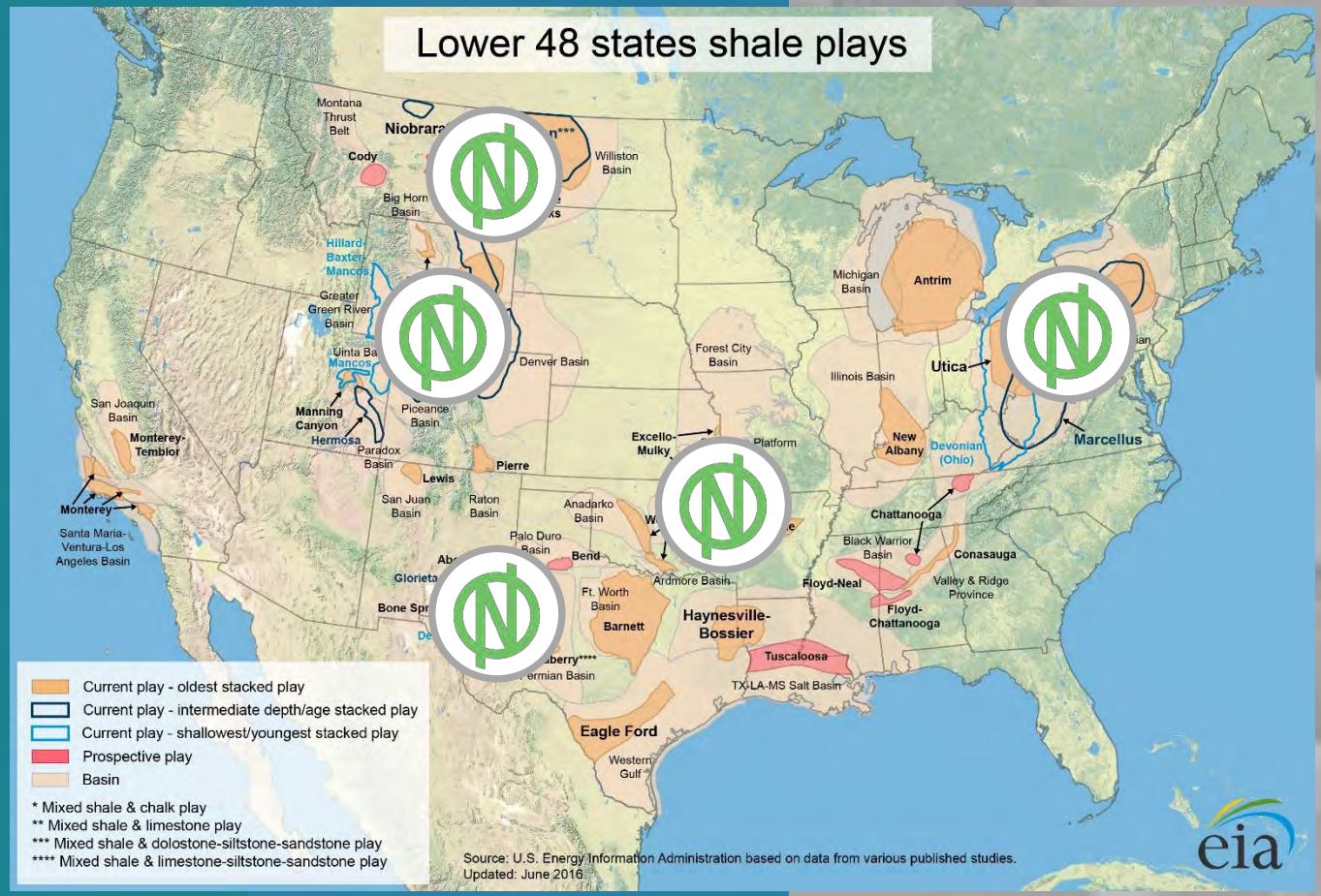
Mobilized Electrochlorination Systems

Extensive field experience has gone into the design of mobile, containerized electrochlorination systems for use in upstream and midstream O&G water treatment applications

- Self-contained
- Transfer site to site
- Temp controlled
- Safest oilfield chemistry
- American made

Deployed Mobile ClorTec Systems

- Used throughout the country
- About 30 units in the field. More on the way!
- Thousands of stages of frac water have been disinfected
- Millions of barrels of produced water recycled



Deployed in Permian, Haynesville, SCOOP/STACK, Fayetteville, Marcellus, and Bakken

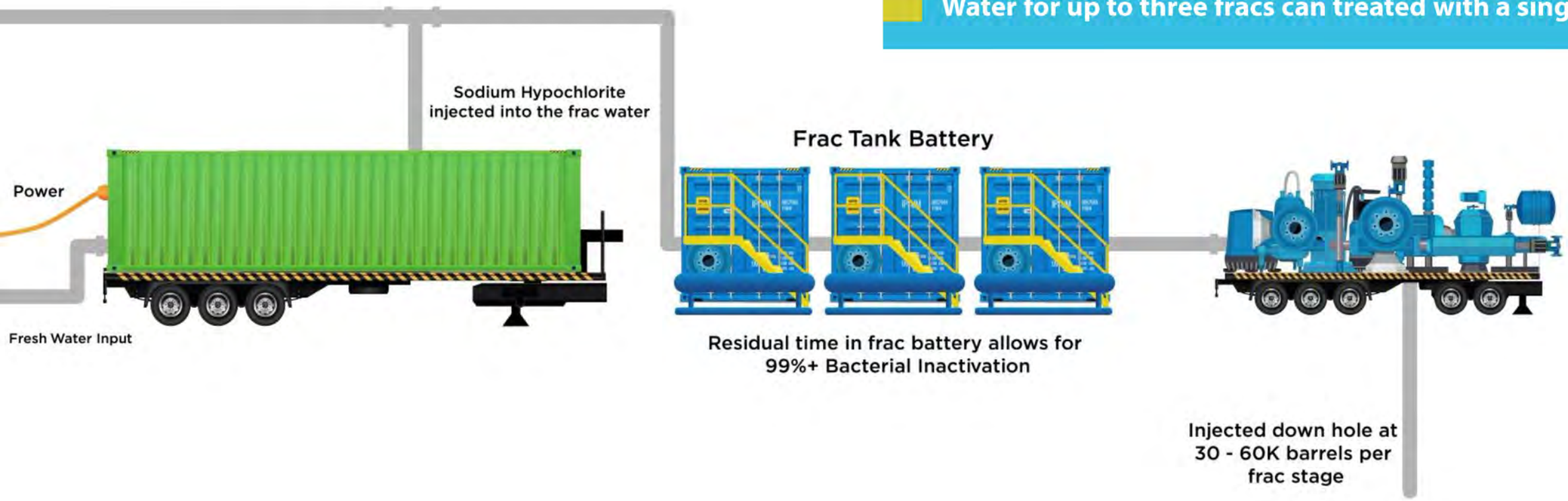
Disinfection of Water for Hydraulic Fracturing

Disinfection of water for hydraulic fracturing prevents bacteria from contaminating a fractured formation

Standard On-the-fly Disinfection Process

ClorTec CT1500 System

- CT1500 system is our flagship unit for this application
- Capable of producing 1,500 lbs of chlorine per day
- Water for up to three fracs can treated with a single unit

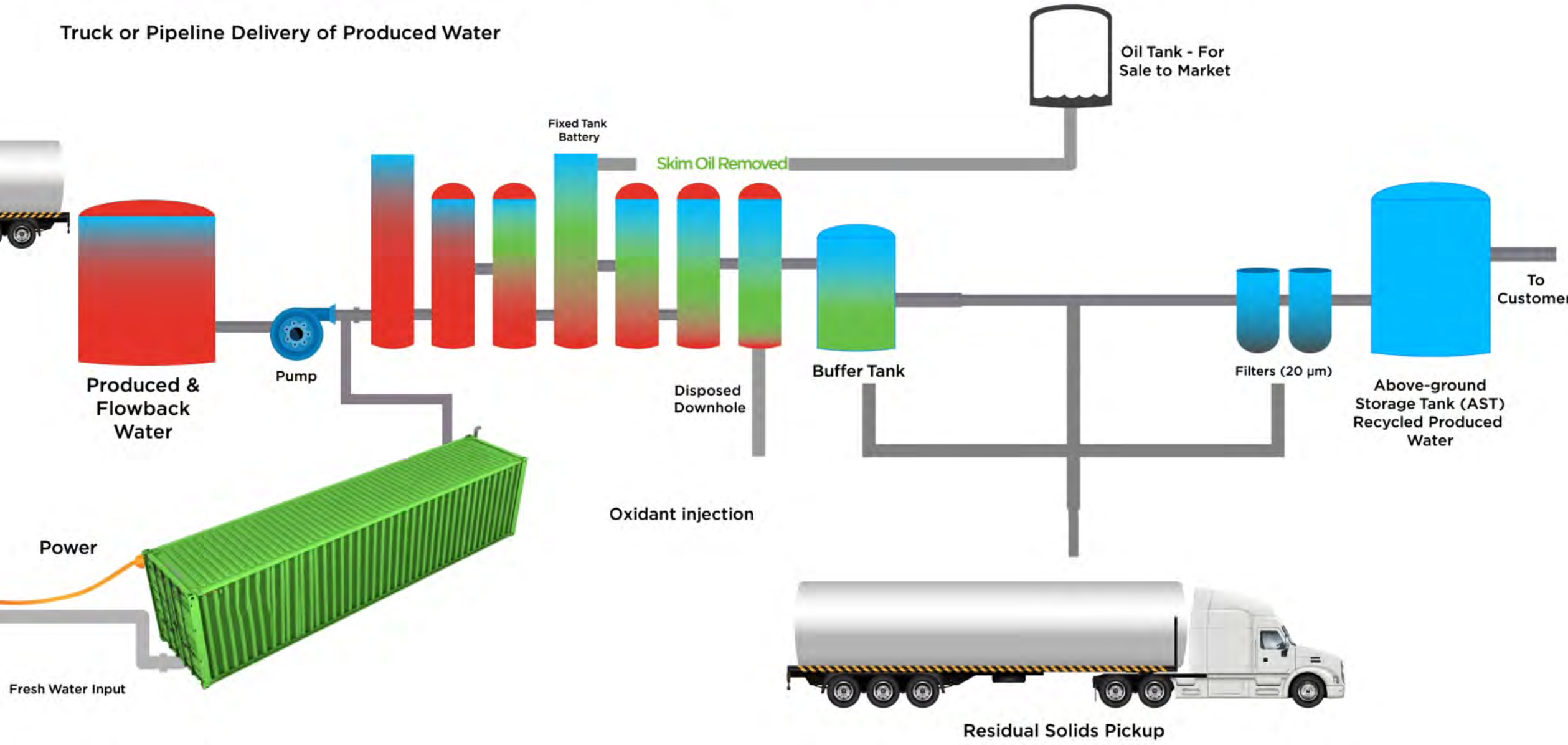


Treatment and Recycling of Produced Water

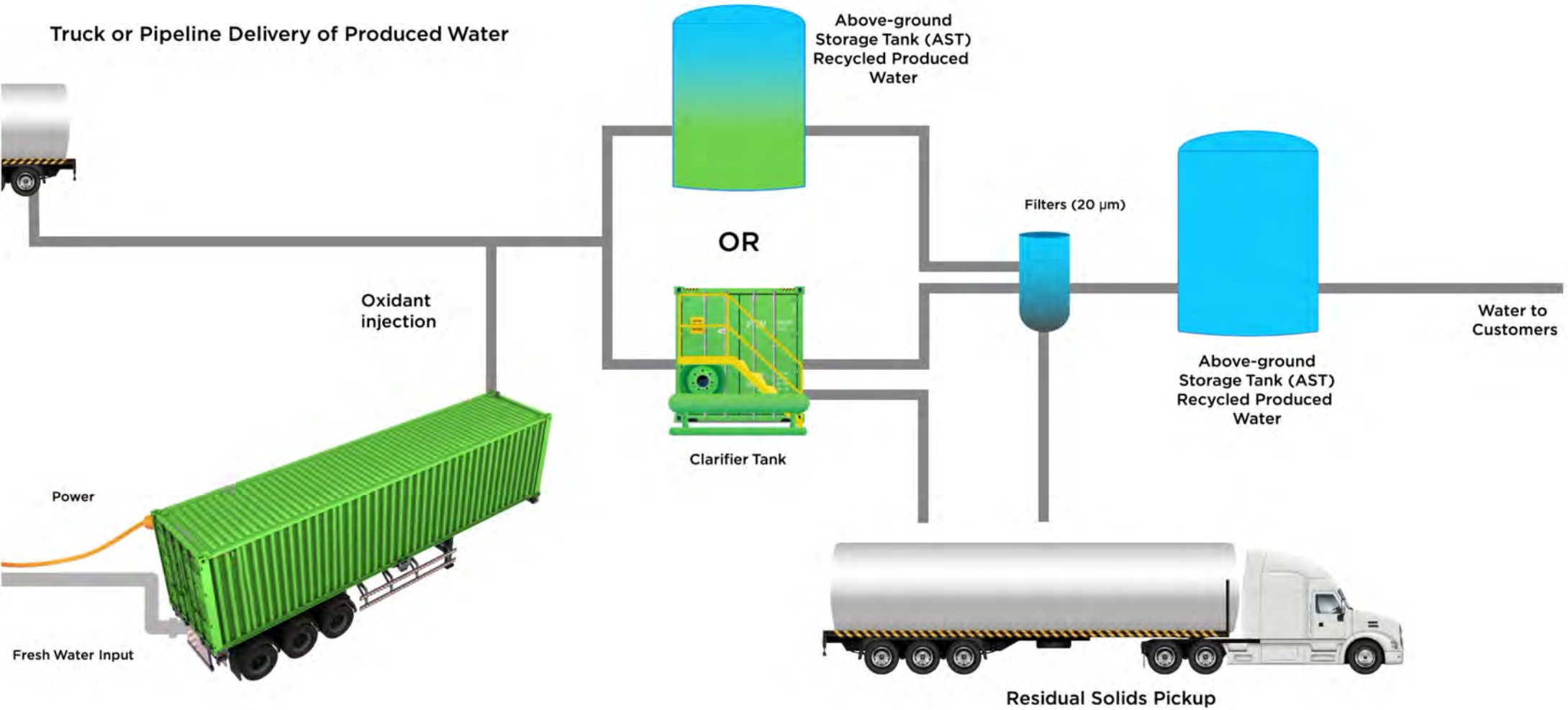
Hypochlorite oxidizes undesirable components of produced water.

When combined with contact time and filtration, it can facilitate the removal of suspended solids to yield a frac-ready water.

Produced Water Recycling with Fixed Infrastructure



Produced Water Recycling with Mobile Infrastructure



ClorTec Benefits in Produced Water Recycling

Reduced OPEX

OPEX for most produced water treatment if usually typically several times lower than other oxidizers

OPEX savings delivers ROIs of less than 12 months in many cases

Improved Safety

Hypochlorite produced by ClorTec is at low active chemical concentration (<1%) and mild pH (usually ~10), making ClorTec the safest option for oilfield oxidizing chemistry

Supply Chain Stability

Production of hypochlorite is on demand by the operator and requires only salt, water, and power- eliminating the need to rely on the delivery of specialty chemistry

Produced water recycling:
Case study

Bacteria, iron, and hydrogen sulfide are all controlled

Fayetteville, Arkansas Produced Water

	Pre-Treatment	Post-Treatment
SRB (CFU/mL)	>10,000,000	0.9
APB (CFU/mL)	10,000	0.3
H_2S (mg/L)	35	0
ORP (mV)	-455	638

Permian Produced Water

	Pre-Treatment	Post-Treatment
TSS (mg/L)	192	88
Iron (mg/L)	4.85	0.41
ORP (mV)	3.2	181

OPEX: Hypochlorite and chlorine dioxide

	Chlorine dioxide	Sodium hypochlorite
Quantity Treated	35,000 bbl/day treated	35,000 bbl/day treated
Contamination	5 mg/L H_2S, 35 mg/L Fe	5 mg/L H_2S, 35 mg/L Fe
Chemistry Production Cost	\$3.21/lb ($1.36/gal HCl, $3.46/gal $NaClO_2$)	\$0.69/lb
OPEX	\$0.0718/bbl	\$0.0115/bbl

Annual savings using hypochlorite: $771,000

ROI for ClorTec system: ~8 months

Delivery to Market

Priority One delivers a full chemical service package to suit each customer's need.

Full service oilfield water treatment delivered by Priority One.

Your Questions

Answered

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