THE PRODUCED WATER SOCIETY
PERMIAN OPERATIONS

Exploring fluid compatibility for reusing 100 % produced water: Case Studies from Permian Basin

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PfP Industries

Why "The Wall" To Reuse/Recycle?

- https://www.theatlantic.com/photo/2013/05/on-the-border/100510/

- Hfrqrplfv0''
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Produced Water Challenges

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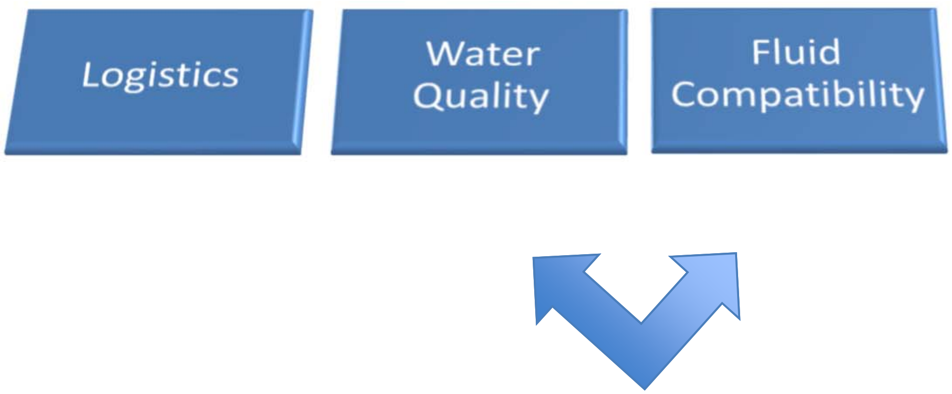

Source: Google Images

Major Impurities in Produced Water

Cations:	***Anions***	***Others:***
Iron	Carbonate	Micro-organisms: SRB/APB/Iron/Archaea
Calcium	Bicarbonate	Gas: H_2S, CO_2, O_2
Magnesium	Sulfate	Total Oil & Grease (TOG)
Strontium	Phosphate	Total Suspended Solids (TSS)
Barium		Total Dissolved Solids (TDS)
Boron		NORM
		Organics, TOC, COD, BOD

Major Risks: Asset, Formation, Safety, Production:

Scale, Corrosion, Fouling, H_2S, Souring..

Interferes/Inhibits: Hydration, Pre/Over X-link, Breakers, Buffers, Reduces Permeability

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Permian Produced Water Composition

Locations	*Permian "A"*	*Permian "B"*	*Permian "C"*	*Permian "D"*	*Permian Fresh Water*	*Permian Brackish Water*
Water Analytes	*Concentrations*					
pH	6.5-7.3	7	7.07	6.4	7.8	6.8
ORP (mV)	(-)250 -(-) 80	(-)246	(-)360	(+)40	(+)140	(+)98
TDS(mg/L)	66K-130K	93K	66K	189K	.3K-2K	2.8K-8.5K
Sodium (mg/L)	21K-39K	28K	21K	51.5K	0.05K-.5K	0.5K-2.5K
Total Hardness as CaCO3(mg/L)	860-8,266	6,000	4,800	47,308	52-750	994-2,100
Iron (mg/L)	02-25.0	112	47	28	0	0
Calcium (mg/L)	206-2,752	1,671	1,315	14,576	13-225	233-550
Magnesium (mg/L)	27-630	224	217	2,220	4.9-45	99-200
Bicarbonate (mg/L)	427-3,700	3,700	2,440	72	110-250	188-450
Chloride (mg/L)	42.8K-81.5K	59K	42K	117K	0.06K-1.2K	0.58K-4K
Sulfate (mg/L)	60-520	227	210	0	33-100	30-1,170
Boron (mg/L)	0-60	60	52	72	2.3	1.2
TOG (mg/L)	10-1,360	38	15	15	0	0
H2S (mg/L)	0-6	<0.1	10	0	0	0
SRB (cell/mL)	10-10,000	1,000	10,000		10	10
APB (cell/mL)	10-100,000	10,000	10,000		10	10
TSS (mg/L)	110-800	452	625	710	1	7.6

PRRO WATER

Types & Concentration of Analytes Vs. Job types

Slick Water	***X-Link***
Iron	Iron
TSS	TSS
SRB/APB	SRB/APB
H_2S	H_2S
TOG	TOG
	Boron
	Hardness
	Alkalinity

Threshold Level: Varies

Why: Formation, Asset,
Job types, Fluid System,
Operator's team,
Service Company,
Comfort level etc.

Treatment Trends and Technologies

- ***Mechanical Treatment***

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- Fkhplfdo#Wuhdwphqw

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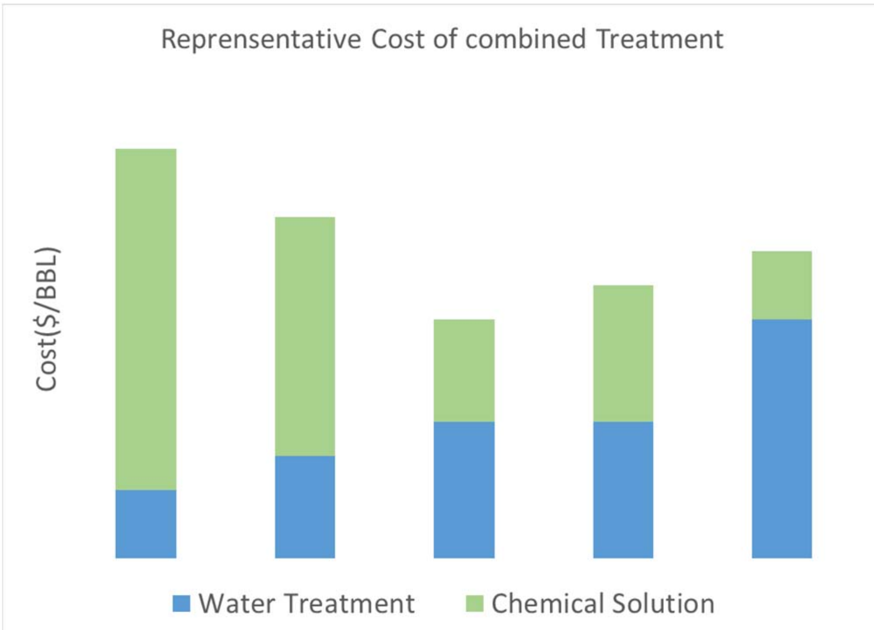
- Hwf1

Multiple Technologies To Optimize Treatment Cost



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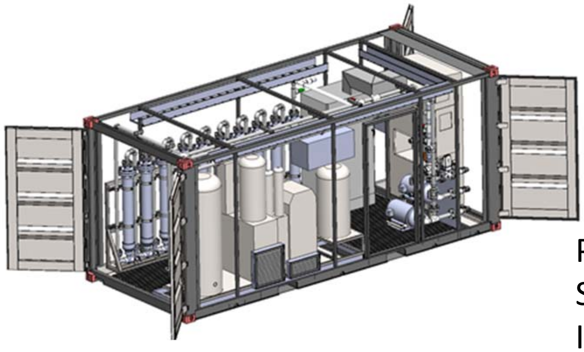
hwf1

Hydro-Pod™ Technology

http://recycle-frac-water.com/



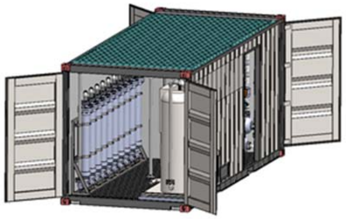
Oxidation-Ozone:

1. Iron
2. SRB/APB
3. Organics
4. O&G
5. H_2S

Electro-coagulation:

6. Ca, Mg, Ba, Sr, etc. (Multivalent Cations-Hardness)
7. SO_4, CO_3, HCO_3, etc. (Anions)
8. Boron
9. Total Dissolved Solids (TDS)
10. Total Suspended Solids (TSS)
11. Others.

PLC, automation,
Spill containment,
Inbuilt sensors
Up to 120 GPM



20 ft. container, 3 phase 220 V, 60 KW

X-link:Treated Produced Water (100%) w/PRRO-Fluid

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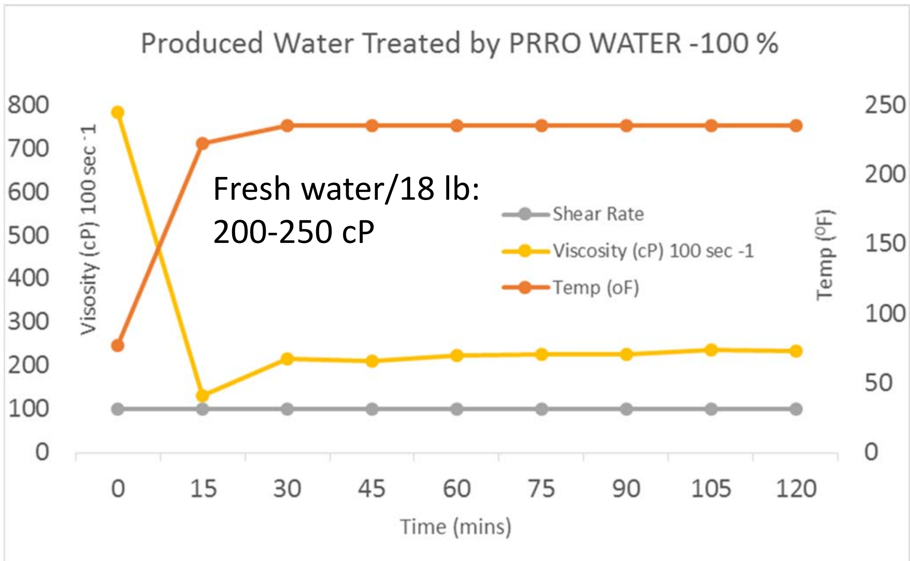

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PRRO WATER

Untreated Produced Water (100%) w/PRRO-Fluid

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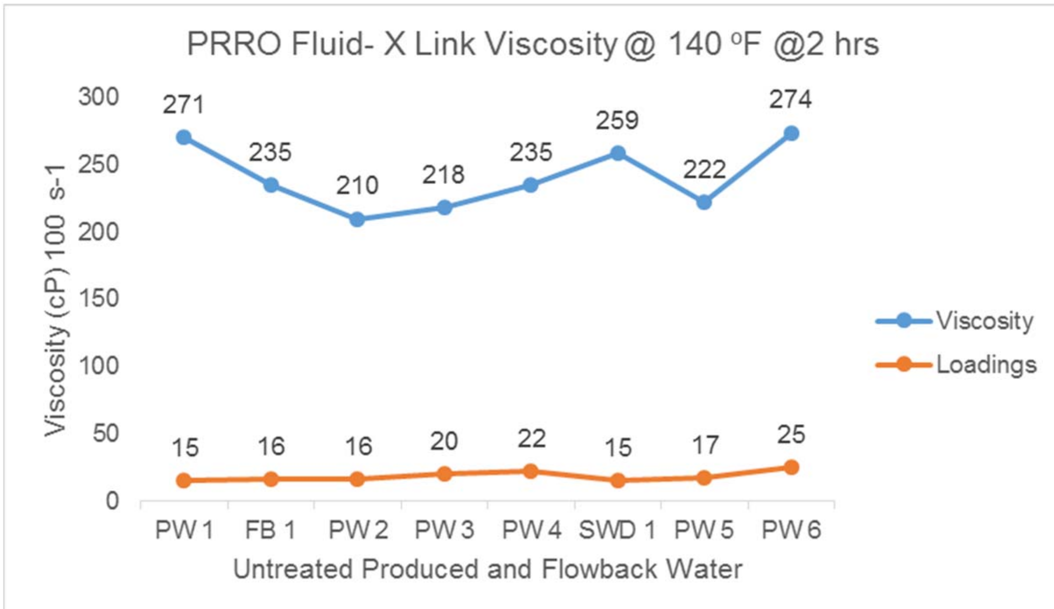

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Slick Water : Produced Water (100%) with PfP AFRE-4

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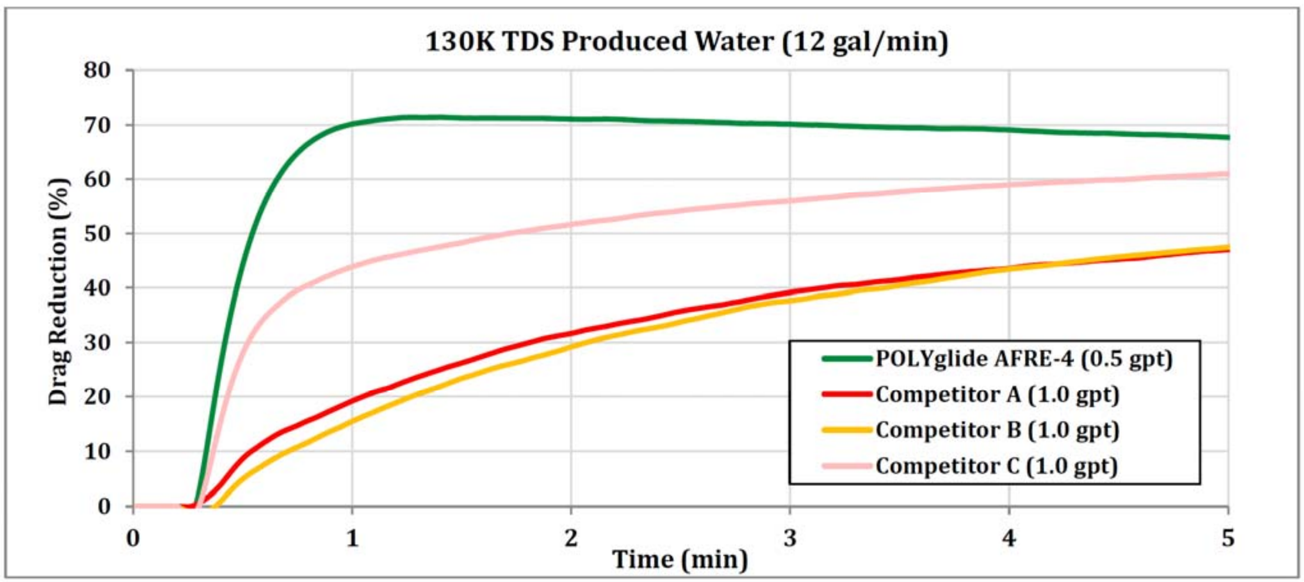

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Cost-Benefit Analysis: X-Link System

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- Surgxfhg#Zdwhu#Pdqdjhphqw#Frvw0Orjlvwlfv
- Fdslwdo#Frvw0VZG/#Hydsrudwlrq#Srqgv/#VDW/# Lqiudvwuxfwxuh#hwf1
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- ''#E ?##''#D

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- Wuhdwphqw0'2eeo#ru#p6
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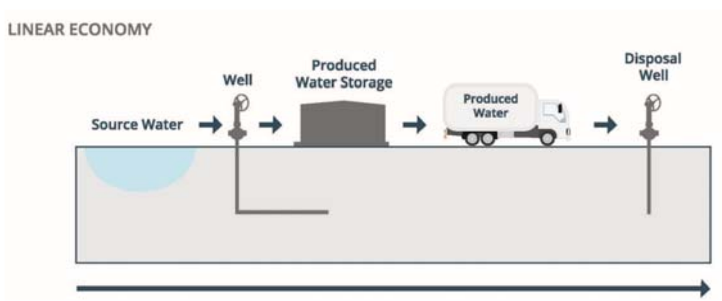
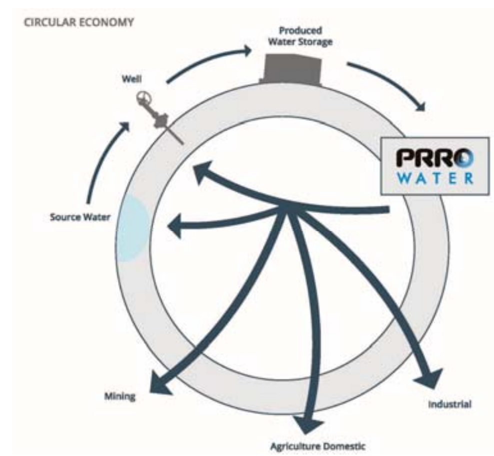
Fluid Package	*Fresh Water System Cost ($/1000 gal)*		*Produced Water System Cost ($/1000 gal)*	
	Instant	**Delayed**	**Instant**	**Delayed**
Guar Slurry X-Linker Buffer Activator Water	60.5	66.04	56.24	61.78

PRRO WATER

Produced Water Challenges

Logistics | Water Quality | Fluid Compatibility | Regulations





Thank You

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