



Recovery and Enhancement of Dying Geothermal Production and ReInjection Wells

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Innovazione e Sostenibilità per la Geotermia del Futuro

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Solenis Overview –



MORE EXPERTS

Our solutions are refined in the lab and deployed in your plant by professionals recognized as industry experts.



MORE LOCATIONS

With a broader manufacturing base and more locations worldwide, we're able to deliver the right product to the right place at the right time.



MORE INNOVATION

Armed with an understanding of your current and future needs, we never stop searching, in the lab and in the field, for new and better solutions.

3 • Confidential and proprietary.

6,000 employees
working around the world to deliver unique solutions for your operation.

100+ years
of problem-solving in process enhancement and water treatment.

20 years
average industry experience among our 1,300 field representatives.

1 of only 3
water treatment companies with a truly global footprint.

47 manufacturing plants
strategically located near customers around the world.

120 countries
reached by our solutions. You can find us anywhere.

2,000+ patents
awarded for the technological breakthroughs our team has developed.

11 technical centers
an international network of facilities strategically located to serve you.

More than 25%
of products sold are new innovations developed within the last five years.



What We Offer



Specialty Chemicals



Monitoring and Control



Expert Advice

EcoVadis – Solenis commitment to Sustainability

Solenis achieved Platinum Status in February 2023 for Corporate Social Responsibility, which is our second consecutive year.

This places us in the Top 1% performers of 90,000+ evaluated Companies.

EcoVadis covers >200 purchasing categories in >160 countries grouped under :-

Environmental impacts of operations and products

Labor and human rights

Ethics

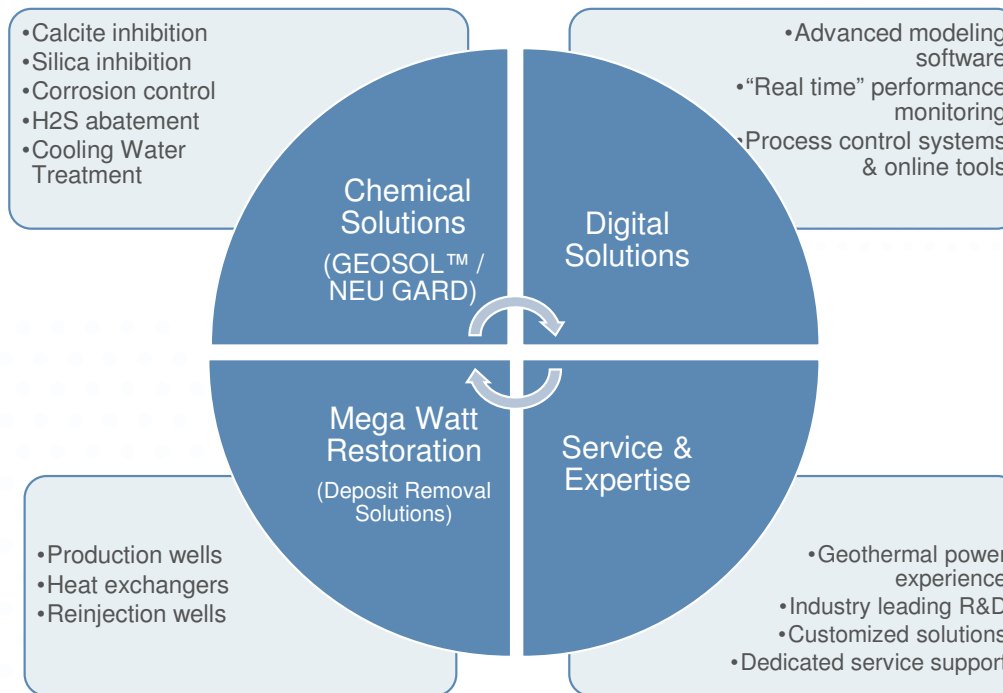
Sustainable procurement

Assessment helps us to identify further improvement opportunities, so that we can demonstrate our commitment to our clients and continuously improve



What We Offer in Geothermal: GEOSOLVE

The Complete Geothermal Power Solution



“MW Efficiency, Asset Protection & TCO Reduction Delivered”

A Game Changer for Geothermal.

Recovery of Dead and Dying Production and Reinjection Wells.

- Summary of the successful technique to recover **dead and dying reinjection and production** wells often to above 100% historical maximum capacities.
- Reinjection recoveries of dead and dying wells from formation scaling: 3 years cumulative data
- ROI Cost and description of process
- Production well recoveries and capacity improvements

Solenis and ThermalClean Ltd (TCL)

- Solenis - global specialty chemical company, 120years in business.
- TCL – specialty geothermal engineering company. 30 years in well maintenance.
- Focused R&D on key problems with Geothermal Energy. Well recovery online, Silica inhibition, corrosion inhibition
- Cleaning reinjection wells **and formations** without taking wells out of service.
- Geothermal Energy issues:
 - Many wells decline due to formation scaling
 - Traditional drilling techniques/work overs do not clean/stimulate the formation.
 - HF proved to be expensive, very risky and unpredictable. .
 - Poor and unpredictable results of pump and soak and CTU/Rig delivered chem cleans
- New method targets silica, metal silicates, metal sulphides, calcite and barite.

Online Stimulation/Cleaning Process. Reinjection

- Conducted during normal operations
- Chemicals added via lance through top of well
- Multi step method
 - Cold water stimulation
 - Non-HF inhibited acid treatment
 - Alkaline and chelant formulation
 - Oscillate chemicals
- Effective for silica, metal silicates, calcite, metal sulfides



How do we do it? Reinjection wells:

- Simply a containerized specialty skid. Mixes chemicals on site pumps into well head. Computerized control.
- No need for mobilization of rigs, CTUs, tanks, cranes etc
- Online mixing means significant chemical savings
- Results are seen with in hours.
- Straight forward and inexpensive
- Very high ROI
- **Safe.. No nasty chems, carcinogens, HF etc**

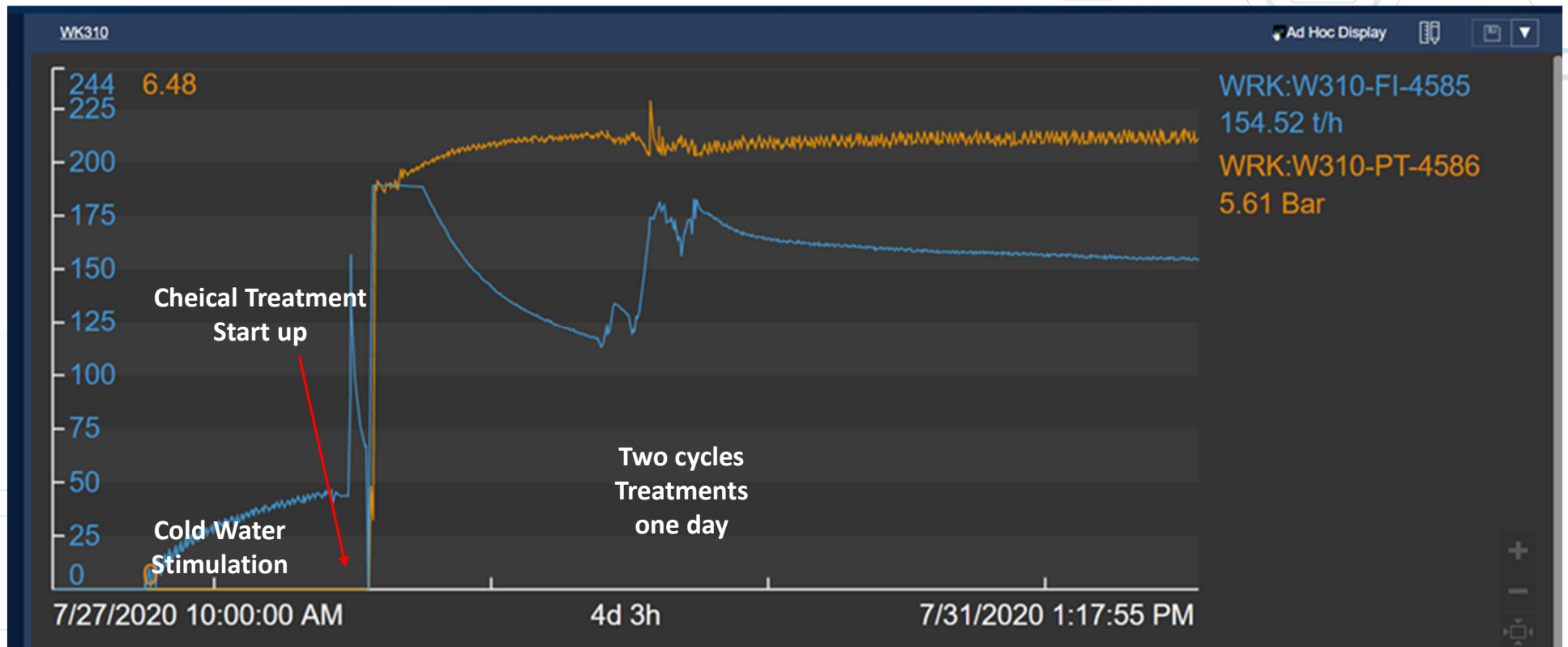


Following Slides Examples of Full Recovery of ReInjection Wells

- Data is direct from DCS screen shots
- Blue lines are flow, brown lines are pressure
- Show full recovery and in many cases above 100% recovery of dead or near dead reinjection wells.
- Slides referenced from GRC 2022, Muller, Wilson, Bluemle: GRC2021
Muller, McLean, Wilson, Bluemle: WGC 2020 Muller Wilson

First Clean of WK310 – July 2020

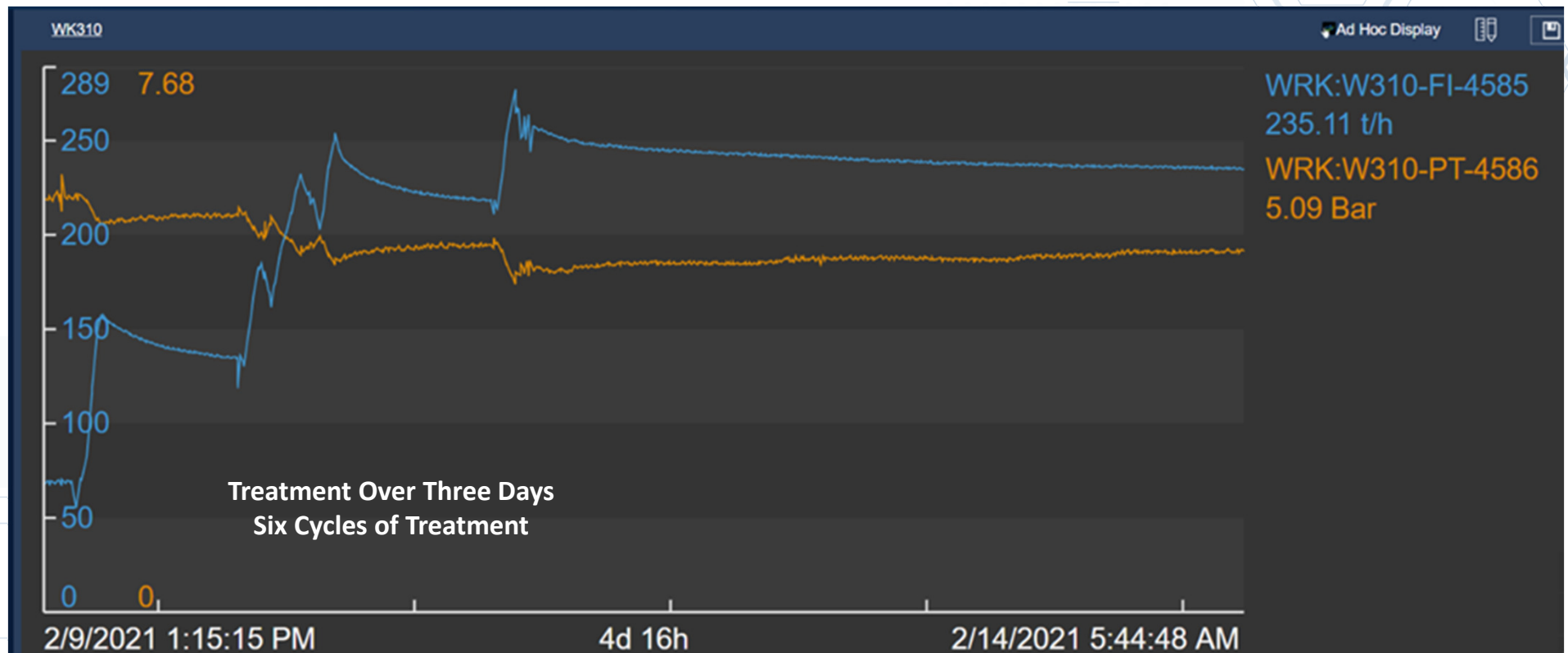
40 t/h → 145 t/h



Reference: 2021 Geothermal Rising Conference October. Date: 3rd – 6th, 2021

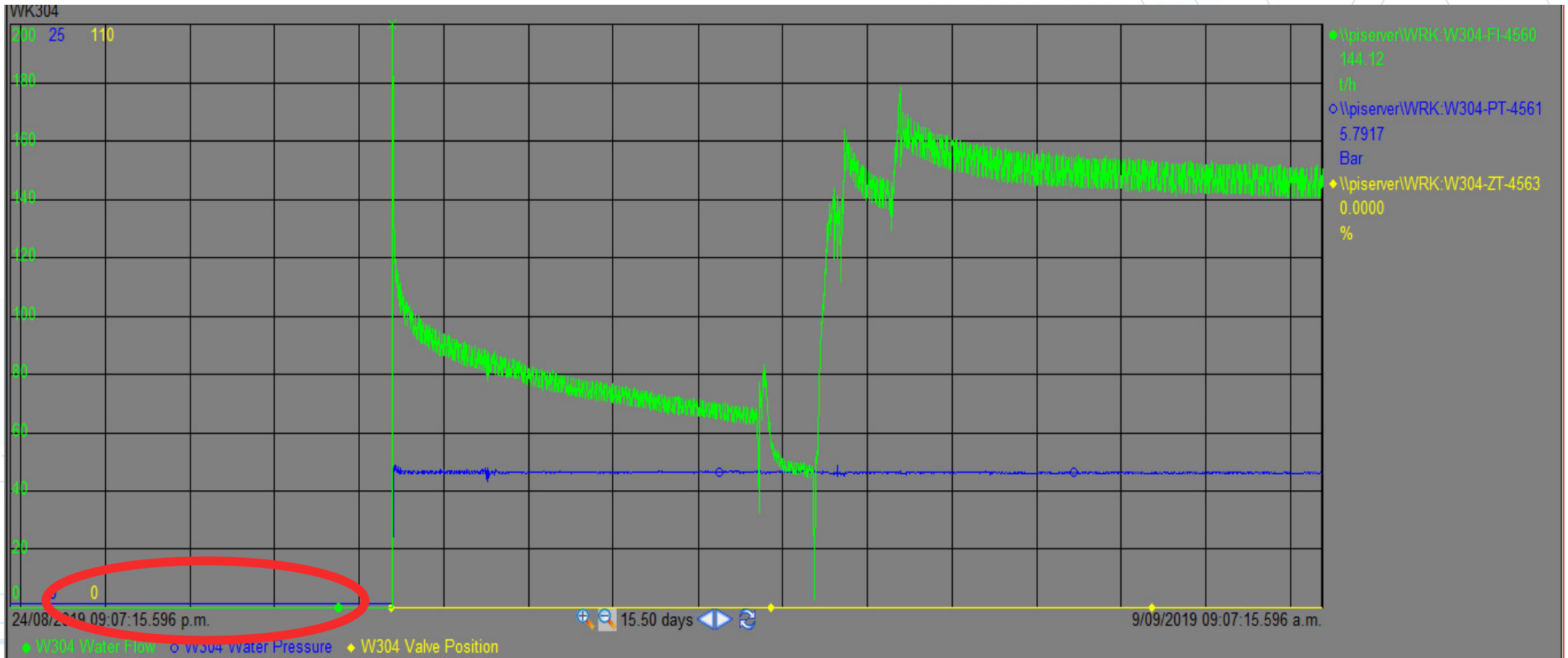
Second Clean of WK310 – February 2021

70 t/h (7 t/h/bar) → 235 t/h (20 t/h/bar).

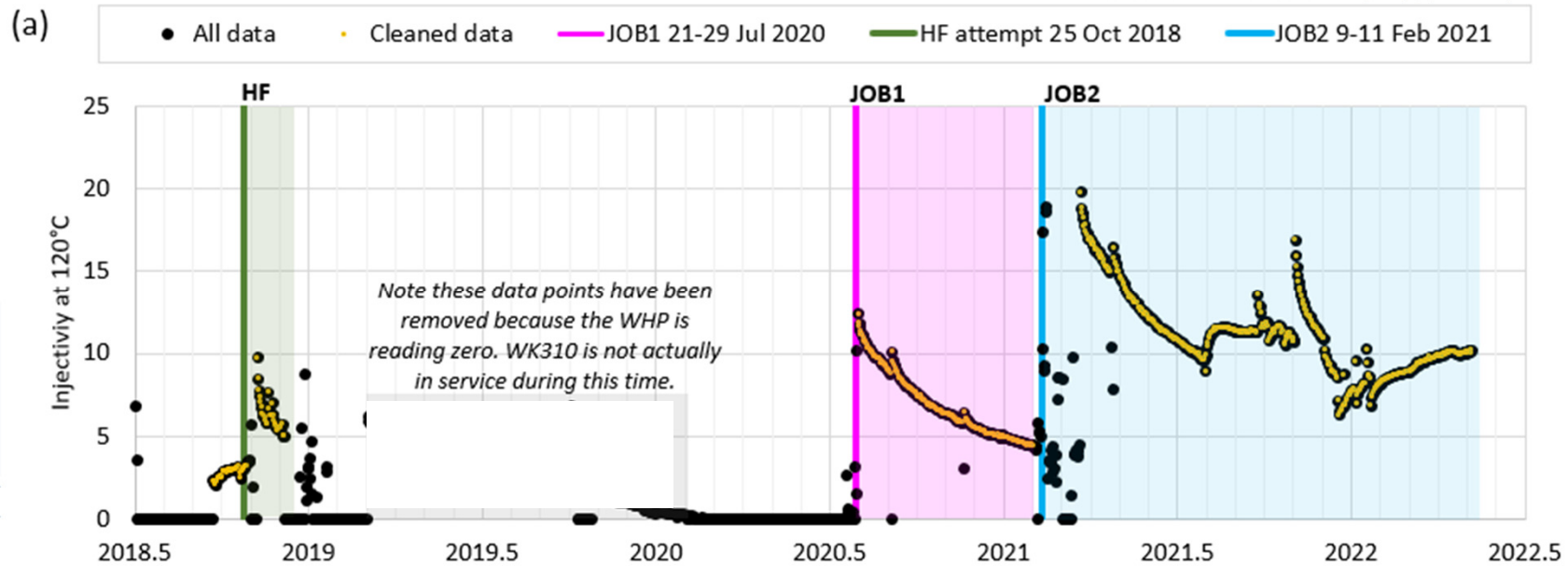


Reference: 2021 Geothermal Rising Conference October. Date: 3rd – 6th, 2021

WK 304. From 0t/hr to 140 t/hr (Note Green is flow, blue is pressure)



Example of recovery and improvement of injectivity



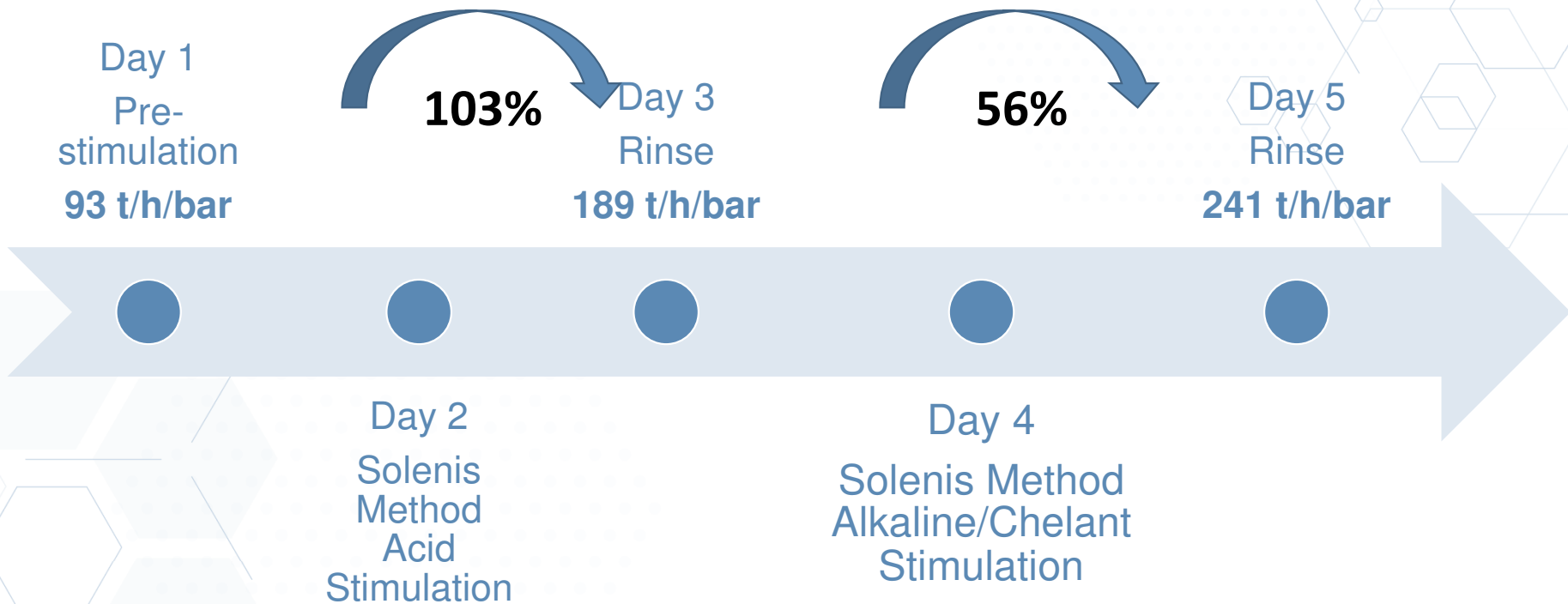
WK310 injectivity at 120 °C 2020 to mid-2022.

Ref: Grc 2022 Muller Wilson Bluemle

Recovery of Dead or Dying Production Wells Due to Formation Scaling

- Higher enthalpy wells sometimes decline due to flashing in the formation.
- No mechanical intervention can solve this.
- The Solenis method has recovered every well it has applied this technique to
- Recovered millions of dollars in production
- Avoided drilling new wells
- Excellent ROI

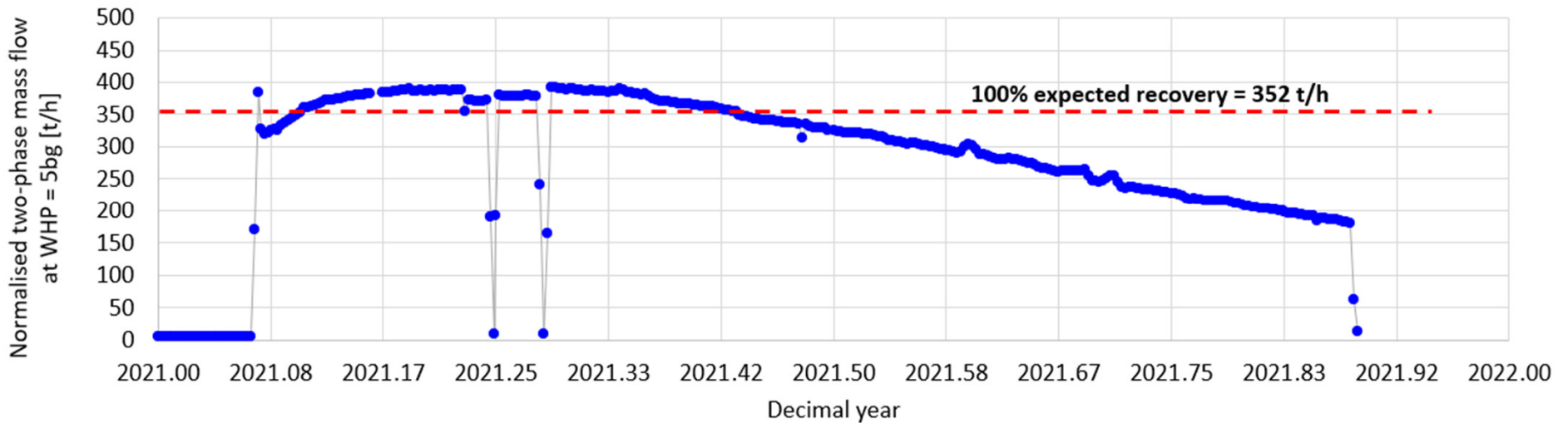
WK260 Chemical Stimulation Process



Injectivity Index assessed at 780 m in target feed zone (FZ5)

Significant ROI

WK260 Production well clean. Dead well to 114% of capacity.



- After cleaning the production well increased from zero (out of service) to a peak of just under 400t/h mass flow
- This additional mass flow averaged 7MW though the time from Jan – Nov 2021. A Marginal cost of fuelling of \$8/MWh.

Case Study A: Production well recoveries, Pay back: weeks

	Workover date	Well	Capacity as % of expected recovery		Comment
			BEFORE JOB	PEAK AFTER JOB	
	December 2020	WK260	0 t/h (0%)	390 t/h @WHP=5bg (111%)	Output sustained Jan-Nov 2021. 51GWHe Data type used = PI WHP/flow data in combination with lip pressure output data.
	August 2021	BR052B	61 t/h @WHP=6bg (79%)	180 t/h @WHP=6bg (234%)	Output continues over 100% expected capacity in April 2022. Greater than 20GWH and still flowing
	Sept-Oct 2021	WK256	170 t/h @WHP=8bg (68%)	230-300 t/h @WHP=8bg (92-120%)	Data quality issues hamper analysis. Peak gain comes from mass balance of entire flash plant. Still flowing above prior data point

Case Study B. Same applied to 2 production wells. Over 100% recovery.

Parameter	Before Shut-in	After Solenis workover	% increase
Steam Flow (t/h)	7.4	26.0	350%
Brine Flow (t/h)	14.8	60.3	400%
Wellhead Pressure (barg)	9.36	11.4	

Review. A breakthrough for Geothermal producers.

- Third party study concluded the Solenis online method at least 13 times more effective than best HF clean.
- Can avoid drilling of new wells! A first for Geothermal.
- Significantly cheaper and safer than HF or offline methods. No concentrated acids enter well casing
- Deeper penetration into formation. PTA analysis confirms off line cleans penetrate about 2 m. This method approx 40m.
- Longer sustained results.
- Easily tailored to well conditions. Note every well is assessed individually.
- Cheaper, safer, easier, better results.
- Can be used to stimulate existing wells in many cases.
- Now being used to stimulate high enthalpy production wells at a cost of around 8-20\$/MW of fueling gain

Thank you.

