



SAVE ENERGY AND IMPROVE PROCESSES WITH OUR **CHEMICALS & SERVICE**

*Tackling Geothermal Well Challenges: Laboratory Formulation of a Multifunctional Inhibitor*

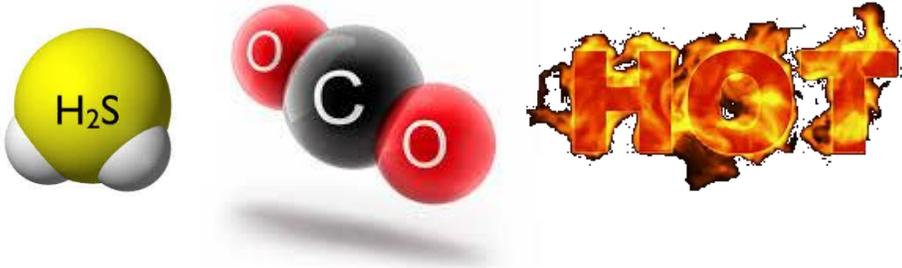
**GEOTHERMAL**  
2024



E.Petteruti - Upstream & Geothermal Business Development Manager

# PRODUCTION CHEMISTRY & DEEP GEOTHERMAL

Aggressive environment



Exotic species

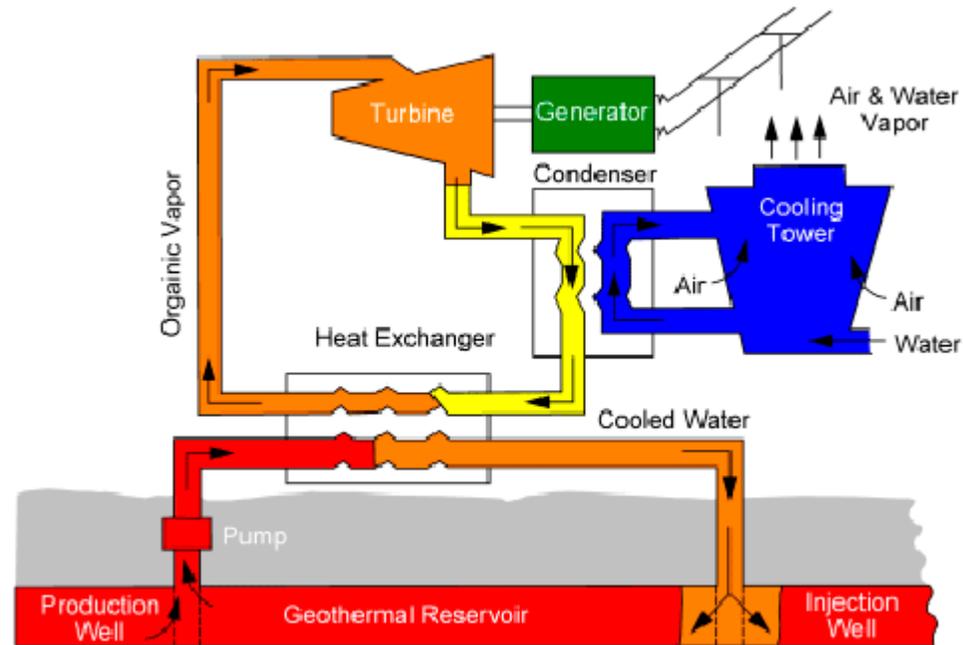


Periodic table elements: Antimony (Sb, 51, 121.760, Metalloid), Arsenic (As, 33, 74.92160), Lead (Pb, 82, 207.2), and a yellow radiation hazard symbol (RADIATION HAZARD RADIOACTIVE SUBSTANCE).

Environmentally Friendly, Stable Chemicals



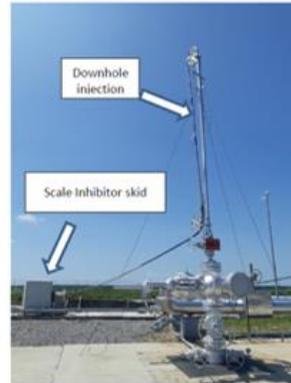
# DEEP GEOTHERMAL PLANT



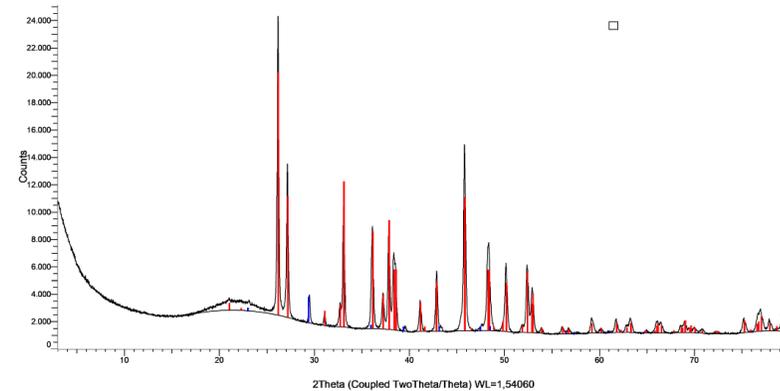
Corrosion Inhibitor upstream water reinjection, after the last heat exchanger (10 ppm)

Scale inhibitor injected downhole@2200 m (5 ppm)

# FIELD SURVEY



SI downhole injection



- Aragonite
- Calcite

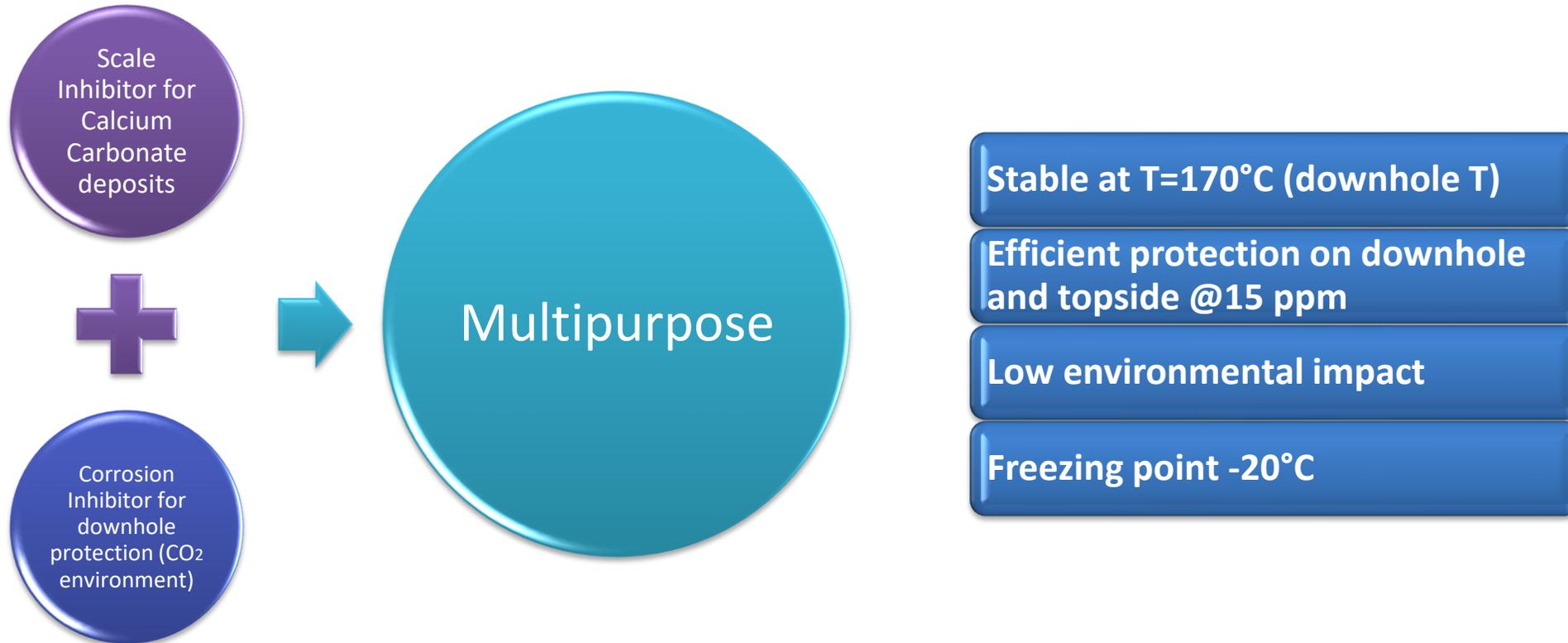


scale in an old pipeline

diffractometric analysis of the sample collected during the survey reveals a mix of Aragonite and Calcite

gas composition CO<sub>2</sub> 99.5%mol

# SCOPE OF THE PROJECT



# DYNAMIC SCALE LOOP



## Dynamic Scale Loop test Parameters

<b>Temperature</b>	170°C
<b>Pressure</b>	50 bar (725 psig)
<b>Pre-scale stage</b>	
<b>Brine flow rates</b>	Anionic 8 ml/min
	Cationic 8 ml/min
<b>Time</b>	600 seconds
<b>Scale stage</b>	
<b>Brine flow rates</b>	Anionic 2 ml/min
	Cationic 2 ml/min

Temperature: 0 to 350°C

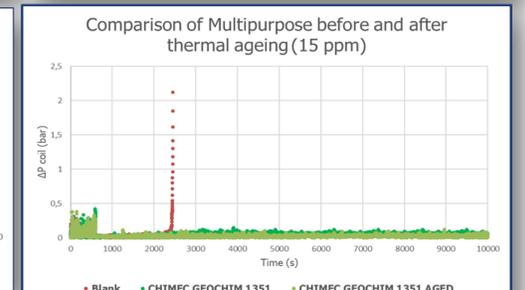
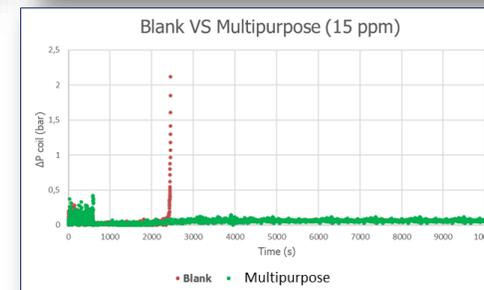
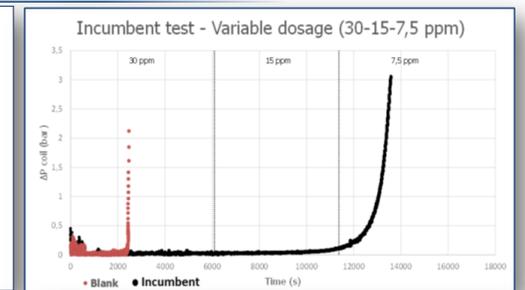
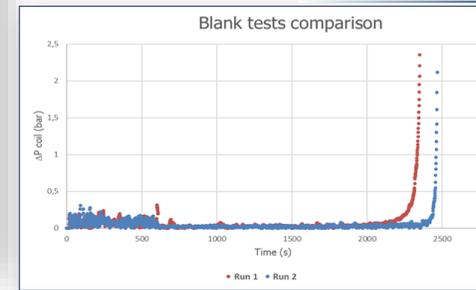
Pressure: ≥ 200bar

Liquid shear rate: up to 2000s-1

Gas carrier: CO<sub>2</sub>, H<sub>2</sub>S, CH<sub>4</sub>

Material construction: Inconel Alloy

MIC



# PERFORMANCE

Weight loss coupon test by Rotating Cage (RC)  
 high shear-high pressure conditions  
 ASTM G170

The cage is especially useful in the evaluation of:

- flow effects on corrosion
- application of HT, HP, High shear stress on corrosion phenomena
- inhibitor effectiveness and film persistency under variable shearing conditions
- rapid screening of inhibitors or longer test runs for particular needs



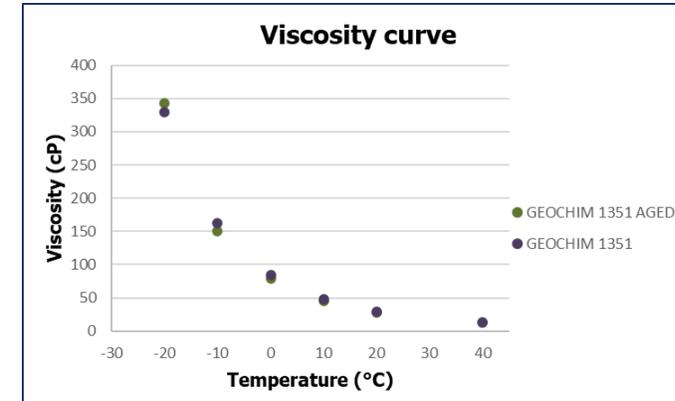
**HP/HT Rotating Cage**

Parameters	Conditions
Temperature	140°C
CO <sub>2</sub> pressure	7 bars
Water Cut	100%
Water Phase typology	Re-built field brine
Test duration	24 hours
Rotation speed	1000 rpm (3 m/s)
Metallurgy	Carbon Steel AISI C1018

Product	Corrosion (MPY)	Efficiency (%)
Untreated	198,12	-
MULTIFUNCTIONAL	23,8	88
MULTIFUNCTIONAL AGED	33,7	83

# MULTIFUNCTIONAL

Parameter	Method	UNAGED	AGED
		Aspect (20°C)	CR0
Density (20°C)	CR6	1.05	1.05
pH (as such)	CR7	7.5	7.1
Viscosity (20°C)	CR37	< 50 cP	< 50 cP
Flash Point	ASTM D93	> +62°C	> +62°C
Freezing Point	-	< -20°C	< -20°C



Outstanding multifunctional behavior

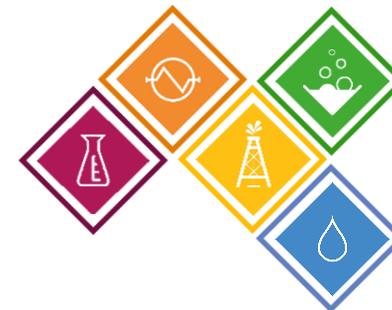
Scale Inhibition power assessed via HP/HT DSL

Corrosion Inhibitor performance assessed via LPR and RC at HP/HT conditions

No impact on the performance after thermal ageing of the chemical at 150°C for 24 hrs

The tested dosage allows protection of both downhole & surface equipment without increasing chemical consumption

WGK-1 classified, CEFAS registration ongoing



# THANK YOU!



***SPE Italian Section Board Director***



**ETIP Geothermal**

***2024-2026 Steering Committee***



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