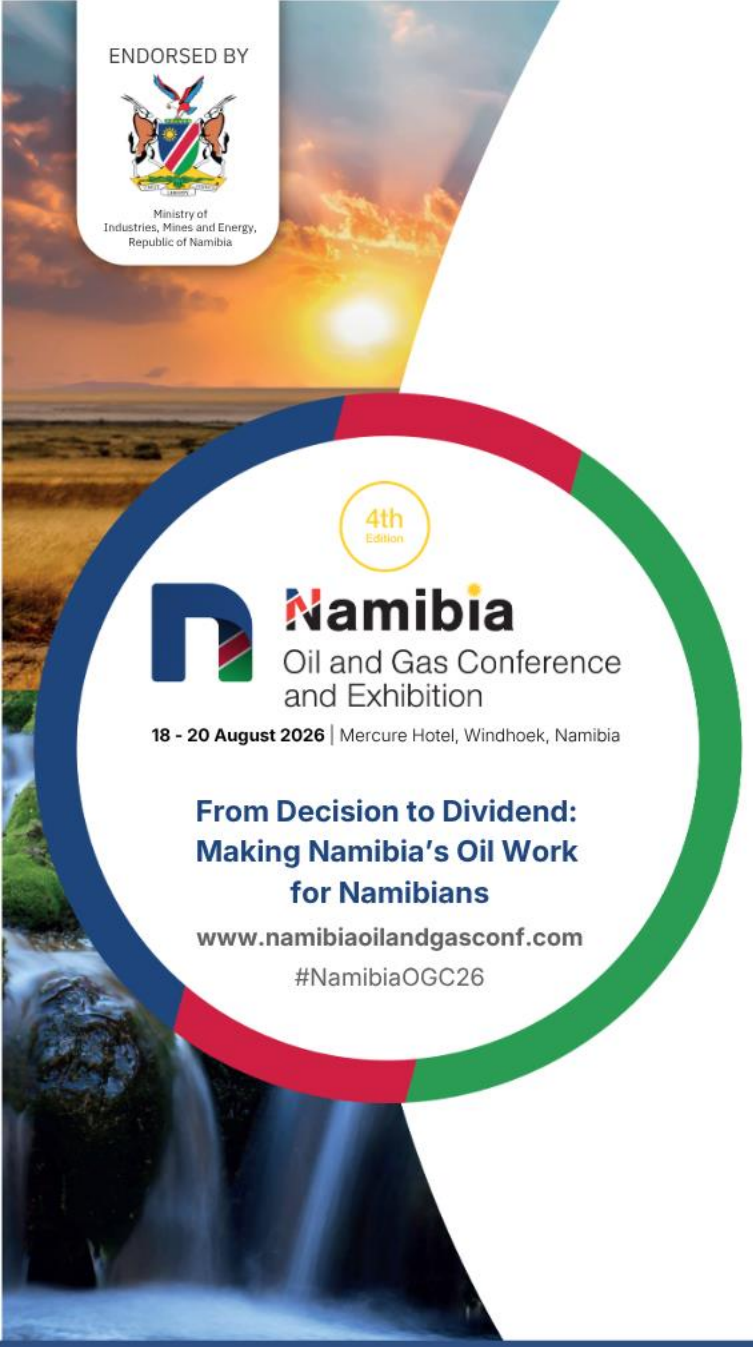


VINK CHEMICALS

Next Generation Biocide Chemistries for Long Term Preventive Microbial and Hydrogen Sulfide Control for Namibia's Assets

H_2S Formation in Reservoirs

Biogenic Sulfate Reduction is responsible for reservoir souring.

1. Thermal decomposition of sulfur containing organic compounds

- High temperature
- Deep in reservoir
- Slow, stable production over time

→ H_2S

2. Thermochemical sulfate reduction

- High temperature
- Slow, stable production over time

→ H_2S

3. Biogenic Sulfate Reduction (The only true driver during operational lifetime of a field)

- Occurs at reservoir conditions
- Highly dynamic

→ H_2S

BIOGENIC SULFATE REDUCTION (BSR)

SRB (Sulfate Reducing Bacteria) + Electron donors (e.g. VFAs) + SO_4^{2-} (Sulfate) → H_2S (Hydrogen sulfide) + Organic byproducts

GROWTH & ACTIVITY DRIVEN BY:

Water · Nutrients (VFAs, N, P) · SO_4^{2-} Sulfate

+ other factors

VERY DYNAMIC

If care is not taken, a reservoir can become sour in **less than a year.**

HOW WE LIMIT CONTAMINATION AND CONTROL SRB POPULATIONS

Biocides in drilling fluids

Limit microbial contamination during drilling operations.

Biocides in production water being reinjected

Prevent reinjection of microbes and limit SRB growth.

Control today, protect the reservoir for tomorrow.

Use of biocides for prevention and treatment

INDUSTRY STANDARD BIOCIDES – ADVANTAGES & DISADVANTAGES

CHLORINE OR CHLORINE DIOXIDE

ADVANTAGES

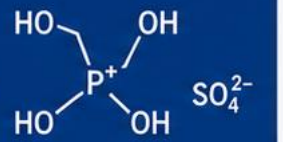
- Is cheap and is often produced onsite.
- Is fast acting.
- Excellent against planktonic bacteria.

DISADVANTAGES

- It is not long lasting.
- Relatively poor at removing established bioifilms.
- High chlorine concentrations accelerate corrosion.
- Formation of by-products damaging to the environment.

THPS

(Tetrakis(hydroxymethyl) phosphonium sulfate)



ADVANTAGES

- Rapid action and excellent against SRB's.
- Also scavenges H_2S. Provides dual biocide and H_2S control.

DISADVANTAGES

- It degrades quite quickly and is not long lasting.
- Limited effectiveness against biofilms.
- Reacts with H_2S therefore some biocide may be consumed as a scavenger rather than act as a biocide.

GLUT

(GLUTARALDEHYDE)

ADVANTAGES

- Broad spectrum and excellent against SRB's.
- Excellent biofilm penetration.

DISADVANTAGES

- Slow acting.
- Highly toxic and dangerous.

QUAT

(QUATERNARY AMMONIUM COMPOUNDS)

ADVANTAGES

- Fast acting.
- Good biofilm penetration.

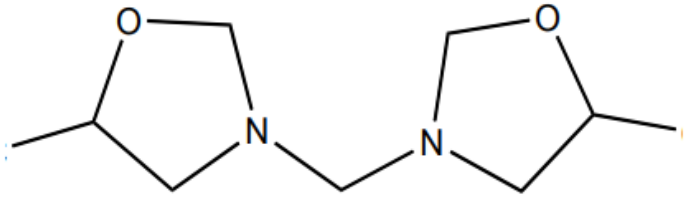
DISADVANTAGES

- It is not long lasting.
- Only effective against some bacteria (notably gram positive bacteria).
- Can cause foaming and thus operating issues.
- Will adsorb onto surfaces.
- Is mostly stable and barely biodegradable.

The next generation of biocides

MBO

MBO (3,3'-methylenebis[5-methyloxazolidine])



Vink Chemicals grotan® OX – Value Outline

- ✓ Potent Broad Spectrum Biocide – **Prevention**
- ✓ Multiple actives with differing persistency and kill mechanisms
- ✓ Long lasting preservative
- ✓ Is not susceptible to immunities
- ✓ Fully Soluble in oil and water, to address microbial and H_2S partitioning demands
- ✓ Is a pure active containing no solvent or water meaning a greater cost-efficiency
- ✓ Already extensively uses in paints, coatings and frac fluids as a long lasting preservative biocide
- ✓ H_2S scavenger capacity – **Remediation**

-> Ideally placed for reservoir souring control

Optimisation Review of a Novel Chemistry for Enhanced Microbiological Souring Remediation and Mitigation under Simulated and Realistic Field Trial Conditions

AUTHORS

Matt Snape, Jennifer Knopf

Vink Chemicals GmbH & Co. KG

Matt Streets, Kerry Lillis, Muna Mohamud and Bob Eden

Rawwater Engineering Company Limited UK

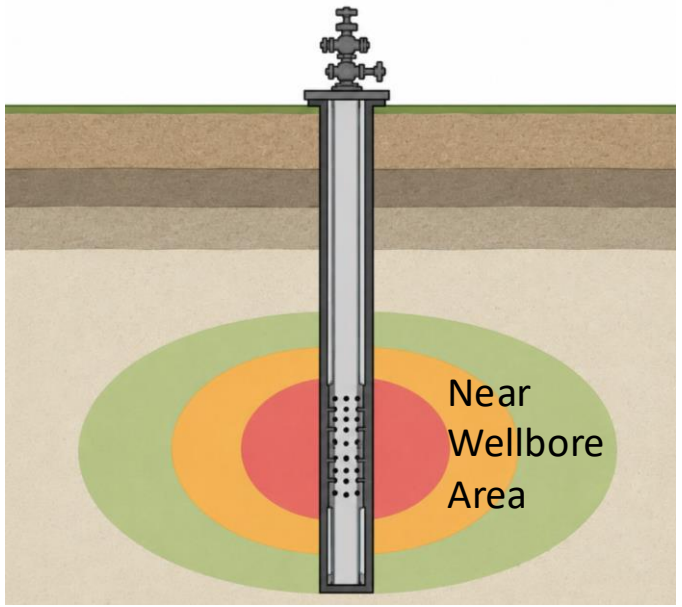
TEKNA 41st Oil Field Chemistry Symposium, Geilo, Norway · Mar 16, 2026

Tekna

Experimental Design- Testing Biocide Efficacy

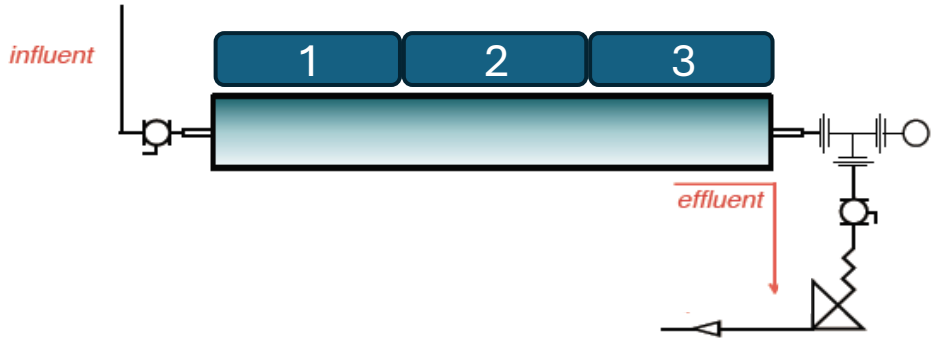
• **10** duplicate high-pressure flowing bioreactor tubes were operated over 17 weeks.

• Designed to replicate downhole near-wellbore conditions, including pressure, temperature, flow effects, microbial metabolism and microbial community dynamics.



Bioreactor Set-Up

Bioreactor Type: Cylindrical 10x 100cm 316L SS
Packing Type: hydrocarbon-containing sand containing a mature and diverse biofilm from an oil and gas field.
Injection Cycle: Weekly batch flow injection at a rate of 5.00 mL/min. 1/3 sweep.
Injection Fluid: Anoxic, synthetic produced water containing 120 mg/L of mixed volatile fatty acids as a carbon source
Pressure: 1,000 psig
Temperature: 30°C



Bioreactor Operation

- Weeks 1 – 4 1/3 Swept Volume Injection (No biocide application)
- Week 5 Full Swept Volume Injection (**Biocide application**)
- Weeks 6 – 17 1/3 Swept Volume Injection (No biocide application)

Experimental Design- Testing Biocide Efficacy

- Biocides dosed at 750 ppm across full swept volume.

- Multiple analytical techniques were used to monitor the aqueous and core samples.

BIOCIDES TESTED

Glutaraldehyde (50% Active)

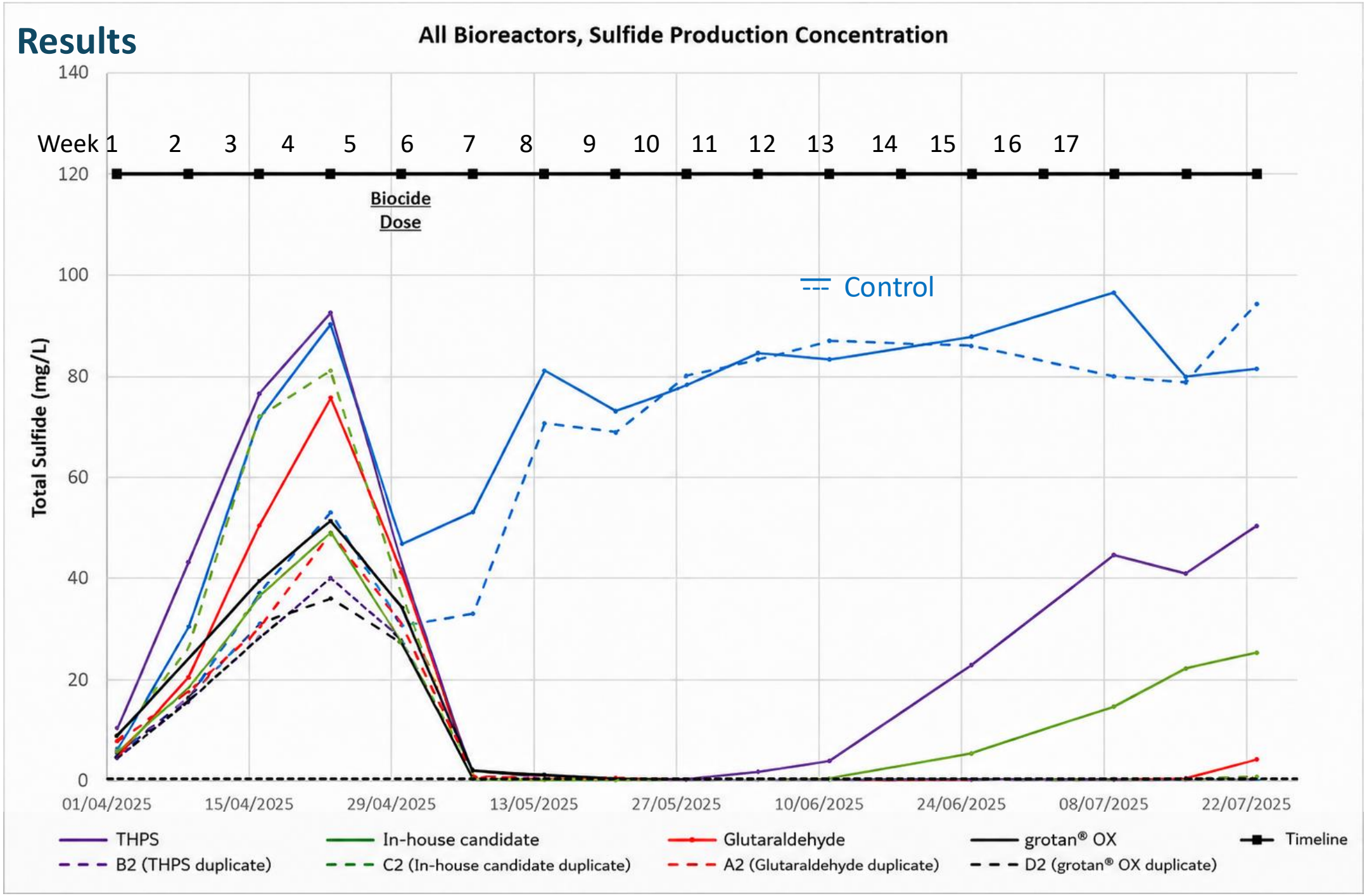
THPS (50% active)

In-house Candidate (> 95% active)

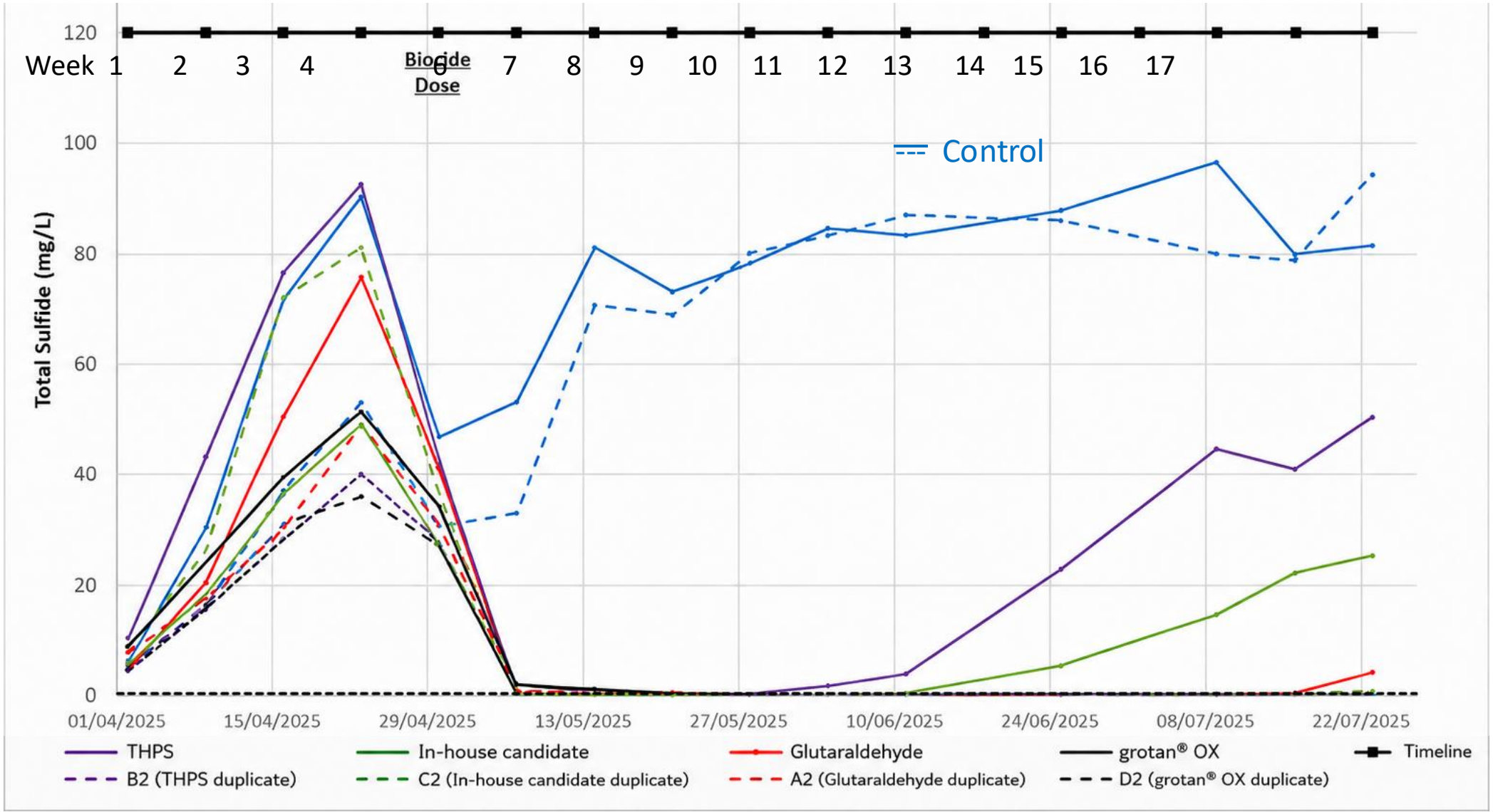
grotan® OX (99% Product active / 47% Released Active)

Analysis	Project Week																
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
Sulphide	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■
VFA	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■
pH	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■
AMPi/AEC				■	■	■		■		■			■				■
MPN				■	■	■		■		■			■				■
qPCR																	■
NGS																	■

Results


All Bioreactors, Sulfide Production Concentration
Week 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17
Biocide Dose
Control
Total Sulfide (mg/L)
140
120
100
80
60
40
20
0
01/04/2025
15/04/2025
29/04/2025
13/05/2025
27/05/2025
10/06/2025
24/06/2025
08/07/2025
22/07/2025
THPS
In-house candidate
Glutaraldehyde
grotan® OX
Timeline
B2 (THPS duplicate)
C2 (In-house candidate duplicate)
A2 (Glutaraldehyde duplicate)
D2 (grotan® OX duplicate)

THPS Suppressed SRB metabolism for 4 weeks after biocide injection, indicating only short-term control.
In-house candidate Suppressed SRB metabolism for 6 weeks, demonstrating improved but still limited control.
Glutaraldehyde Suppressed SRB metabolism until 11 weeks after injection, showing long-term control but partial late decline.
grotan® OX Achieved complete, sustained Suppression of SRB metabolism throughout the trial duration, demonstrating robust and persistent long term microbial control.



Results

AEC	Interpretation
> 0.8	Microbes are actively growing
0.5 - 0.8	Microbes are viable but not actively growing
< 0.5	Microbes are dying or have gone dormant

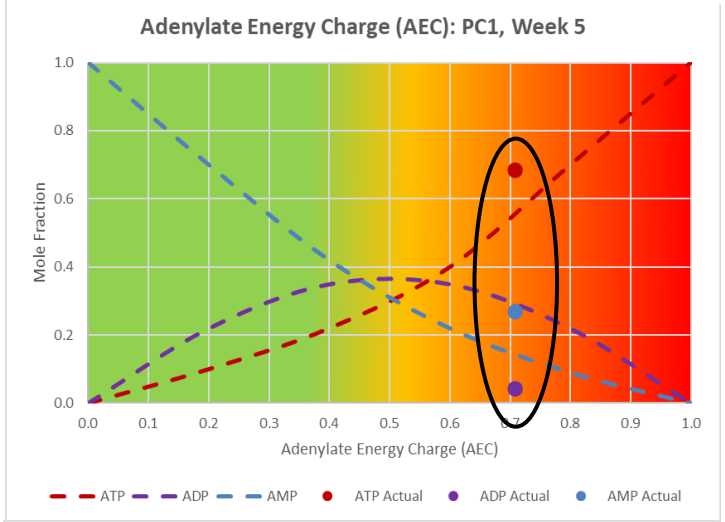
AMP	Interpretation
< 0.1	No microbial stress
> 0.1 - 1.0	Minor microbial stress
1.0 - 3.0	Microbial Stress
3.0 - 10.0	Lethal microbial stress
> 10.0	Lethal Stress for at least one day

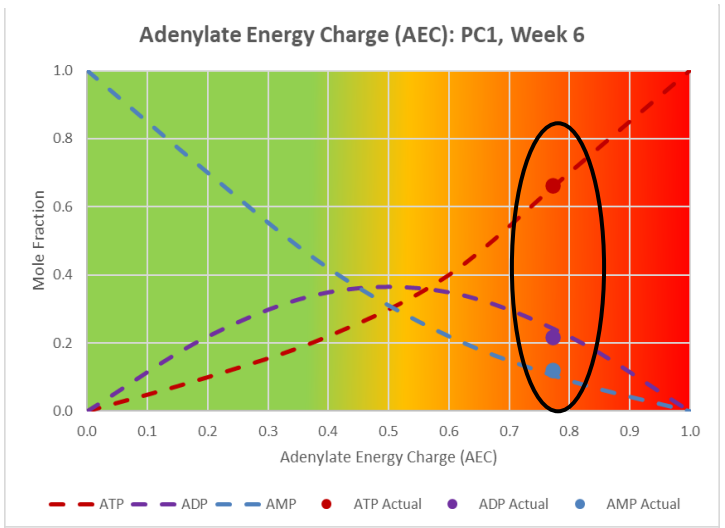
Immediately before dosing

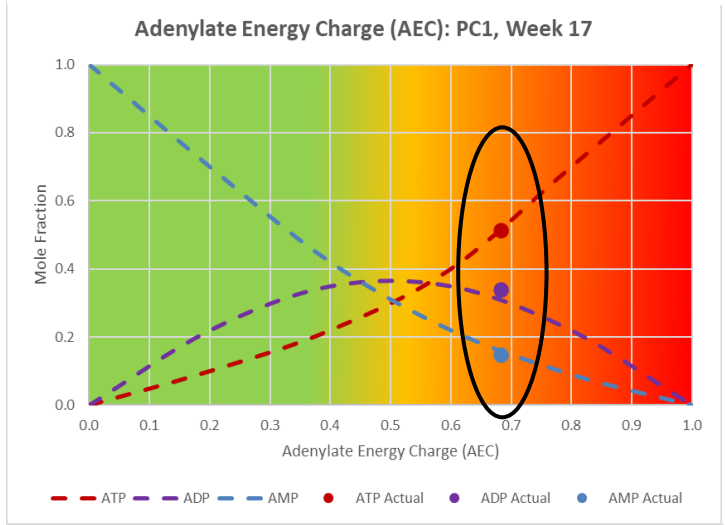
1-week post-dose

12-weeks post-dose

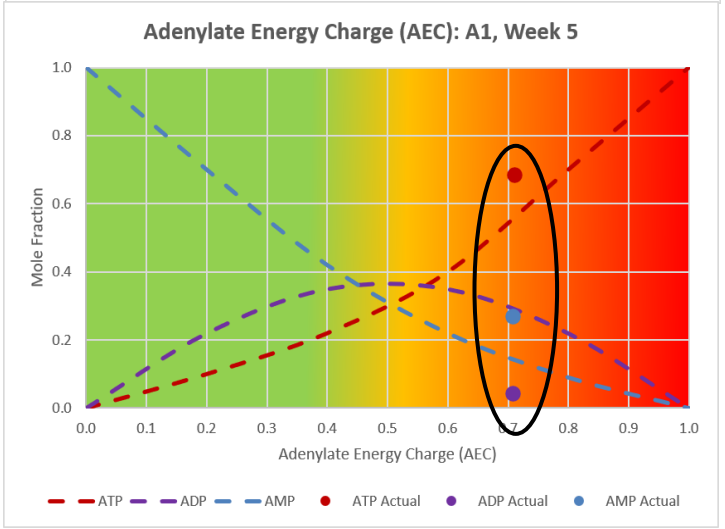
Positive Control (PC1)

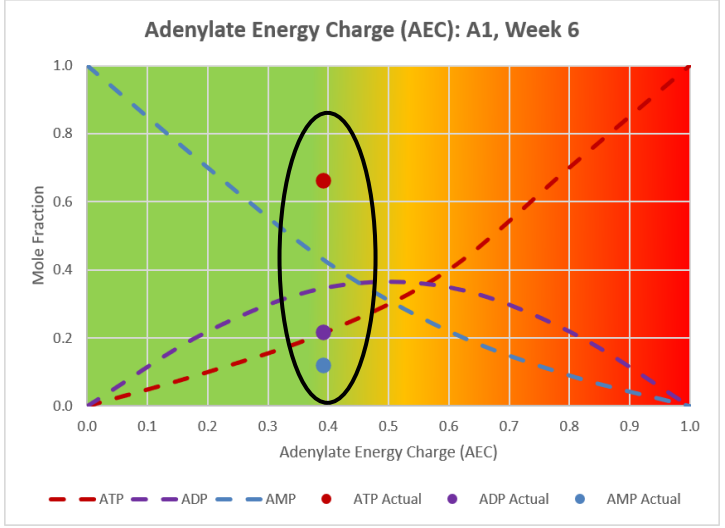


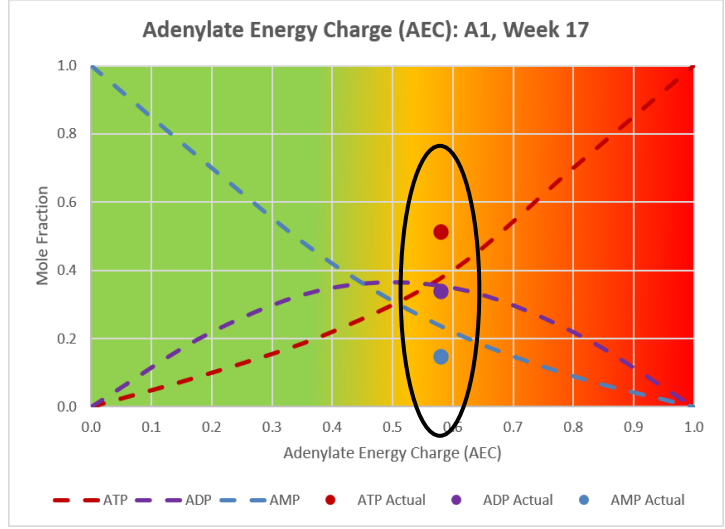




Glutaraldehyde Test A (A1)







Results

AEC	Interpretation
> 0.8	Microbes are actively growing
0.5 - 0.8	Microbes are viable but not actively growing
< 0.5	Microbes are dying or have gone dormant

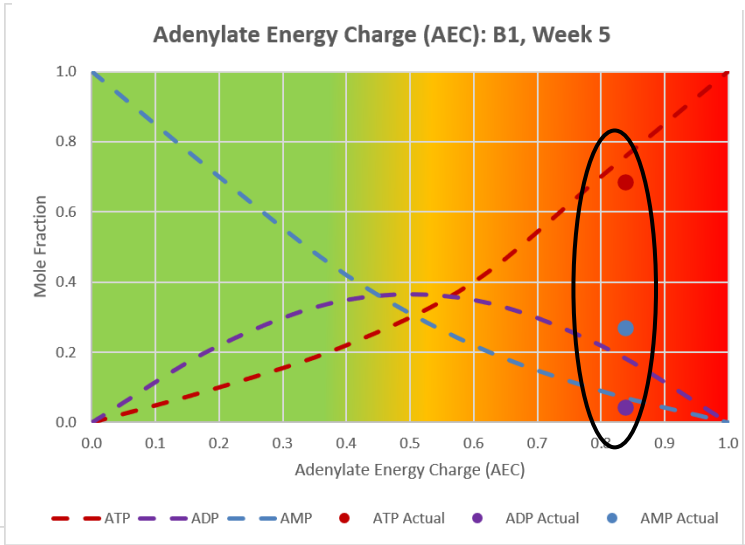
AMP	Interpretation
< 0.1	No microbial stress
> 0.1 - 1.0	Minor microbial stress
1.0 - 3.0	Microbial Stress
3.0 - 10.0	Lethal microbial stress
> 10.0	Lethal Stress for at least one day

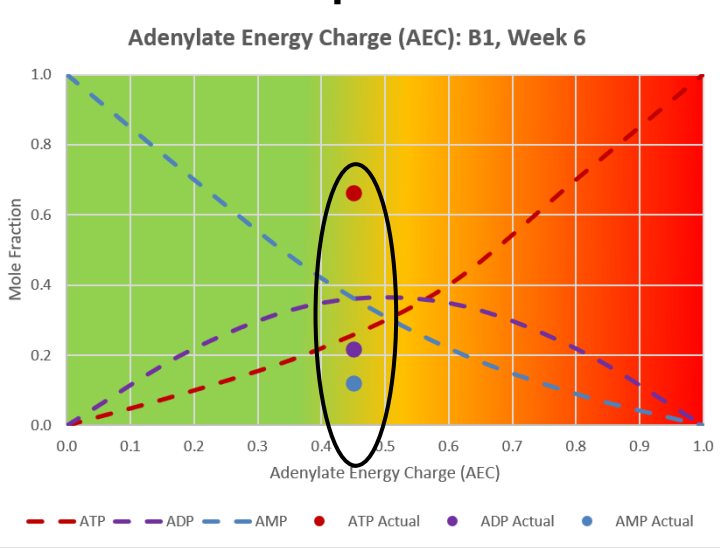
Immediately before dosing

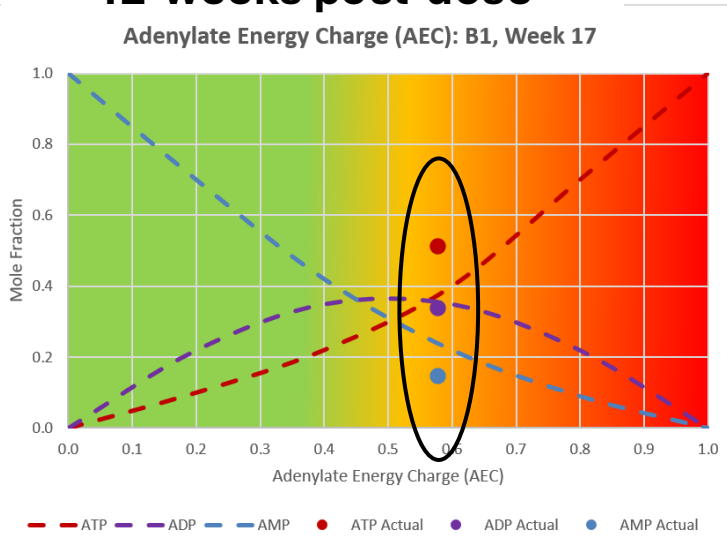
1-week post-dose

12-weeks post-dose

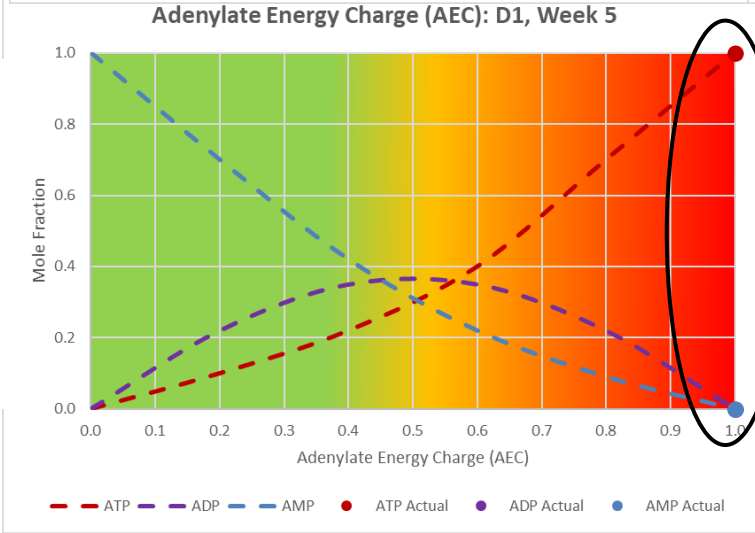
THPS Test B (B1)

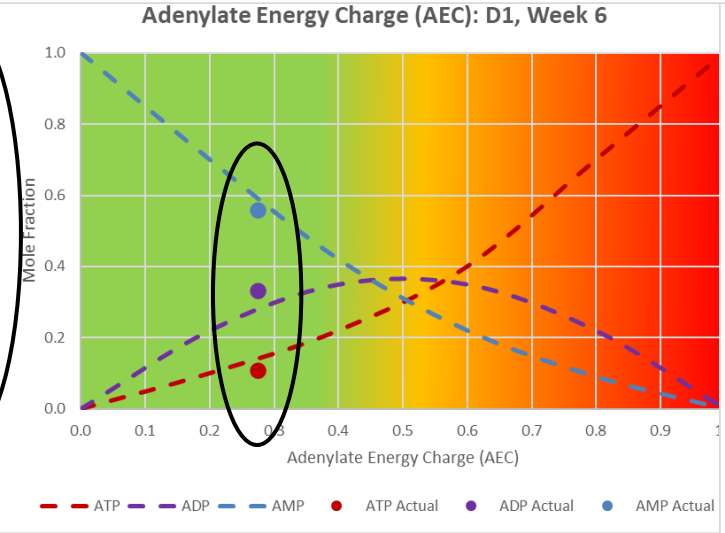


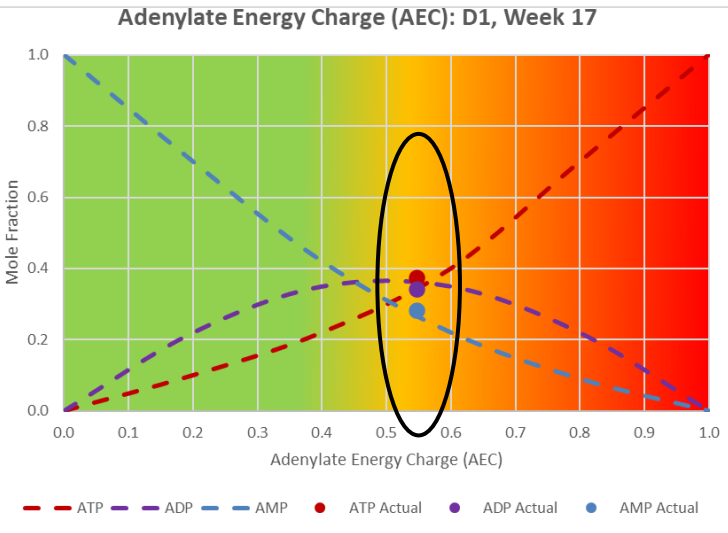




Grotan OX Test D (D1)







Conclusions

- **grotan® OX** outperforms THPS and Glut as biocides for production water preservation and protection.

- **grotan® OX** has the strong added value of being one of the most potent H2S scavengers on the market allowing it to treat rapidly both the cause and effect of biogenic souring.

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Republic of Namibia

4th Edition

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