



Shell Catalysts & Technologies

PERFORMANCE OF JEFFTREAT® ULTRA SOLVENT AT SHELL NORCO REFINERY'S SCOT² UNIT

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Agenda

- Gas processing overview
- Tail-gas treating technologies
- The SCOT ULTRA process
- JEFFTREAT ULTRA solvent at Shell Norco refinery
- Demonstration of upset resilience
- Demonstration of high-temperature operation
- Summary
- Questions

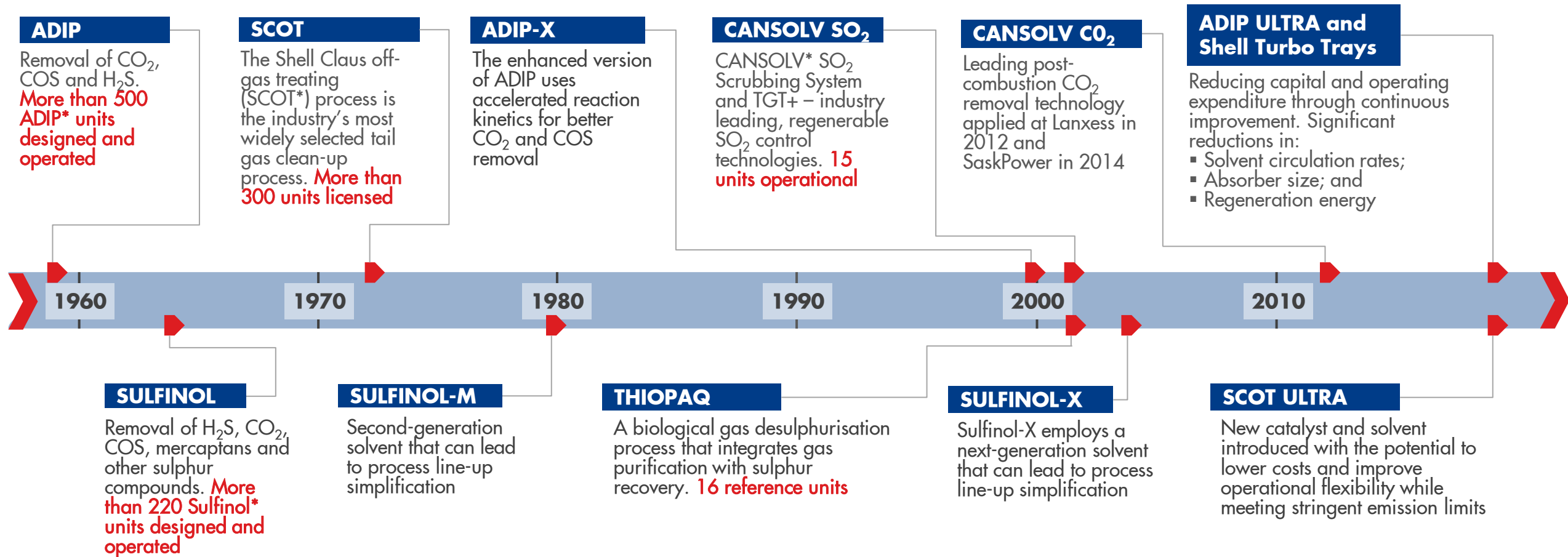


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Gas processing and the SCOT ULTRA process – An overview

60 years of continuous gas-processing innovation



More than 1,200 Shell-operated plants and third-party licensees worldwide

*Trademark owned by the Shell Group of companies

Tail-gas treating technologies

Long history in technology licensing since the 1950s



More than **1,200** Shell-operated plants and third-party licensees worldwide, including

300
SCOT licences



20
CANSOLV licences

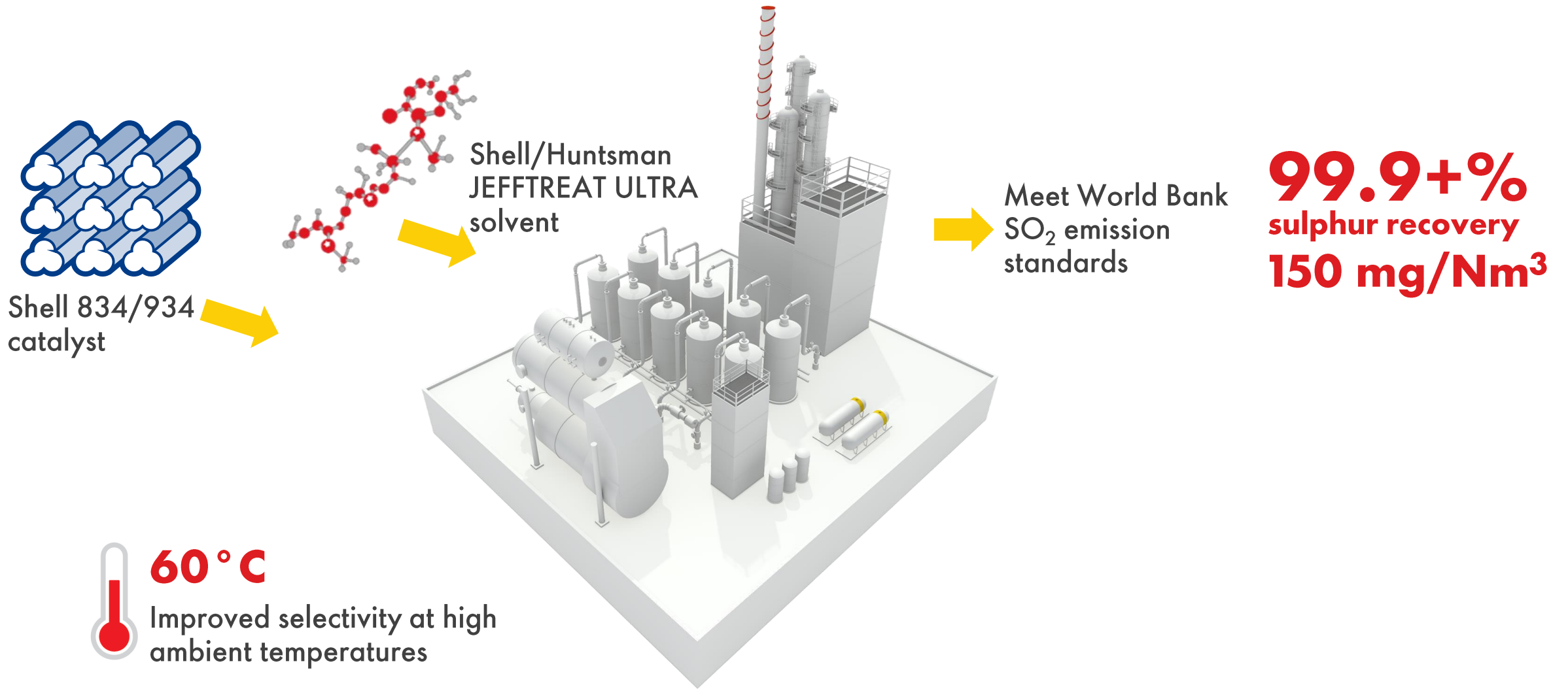
Fit-for-purpose tail-gas treating, depending on the plant's specific requirements:



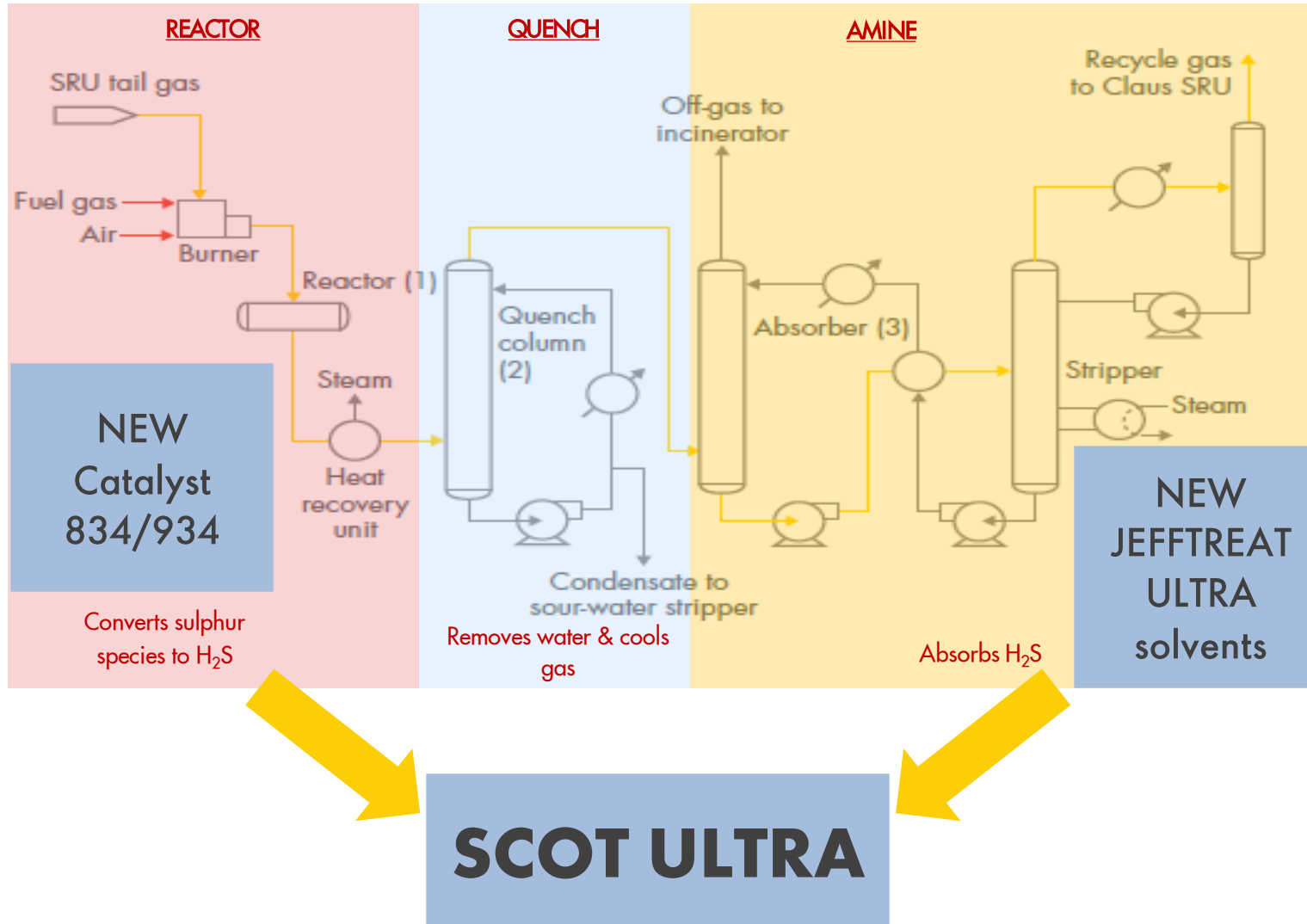
SCOT ULTRA

CANSOLV
TGT+

SCOT ULTRA



SCOT ULTRA tail-gas treating – Process overview



SCOT performance:

- Improved energy efficiency
- High flexibility. Turndown of <10% design throughput is achievable
- Low maintenance requirements
- Excellent reliability (<1% unscheduled downtime has been achieved in Shell-advised units)

SCOT ULTRA adds:

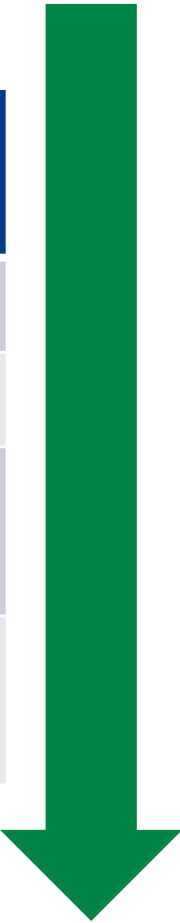
- More energy efficiency
- Higher flexibility...including improved *upset resilience*
- Deeper treating; enables smaller equipment
- Sulphur recovery up to >99.9+%
- Meet World Bank Standards 150 mg/Nm³ SO₂

SCOT solvents – Types, features

SCOT solvents must remove maximum H₂S and avoid removing too much CO₂

Solvent	Amine type	CO ₂ removed	H ₂ S removed
DIPA	Secondary	Some	High
MDEA	Tertiary	Little	High
Formulated MDEA	Tertiary + Additives	Little	Higher
JEFFTREAT ULTRA	Proprietary	Least	Highest

Increasing
performance



- Secondary amines (DIPA) remove more CO₂
- Tertiary amines (MDEA) “slip” more CO₂
- Formulated MDEA provides better H₂S removal
- JEFFTREAT ULTRA outperforms formulated MDEA and features:
 - **Deeper H₂S removal (less SO₂ emissions)**
 - **More capacity**
 - **Ability to “slip” more CO₂**
 - **Better upset (H₂S spike) resilience**

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JEFFTREAT ULTRA solvent at Shell Norco refinery

Background

Sulphur capacity

- Shell Norco S-3 nameplate capacity is at 125 ELTPD
- Desired ability to run higher sulphur (higher margin) feed streams throughout the plant

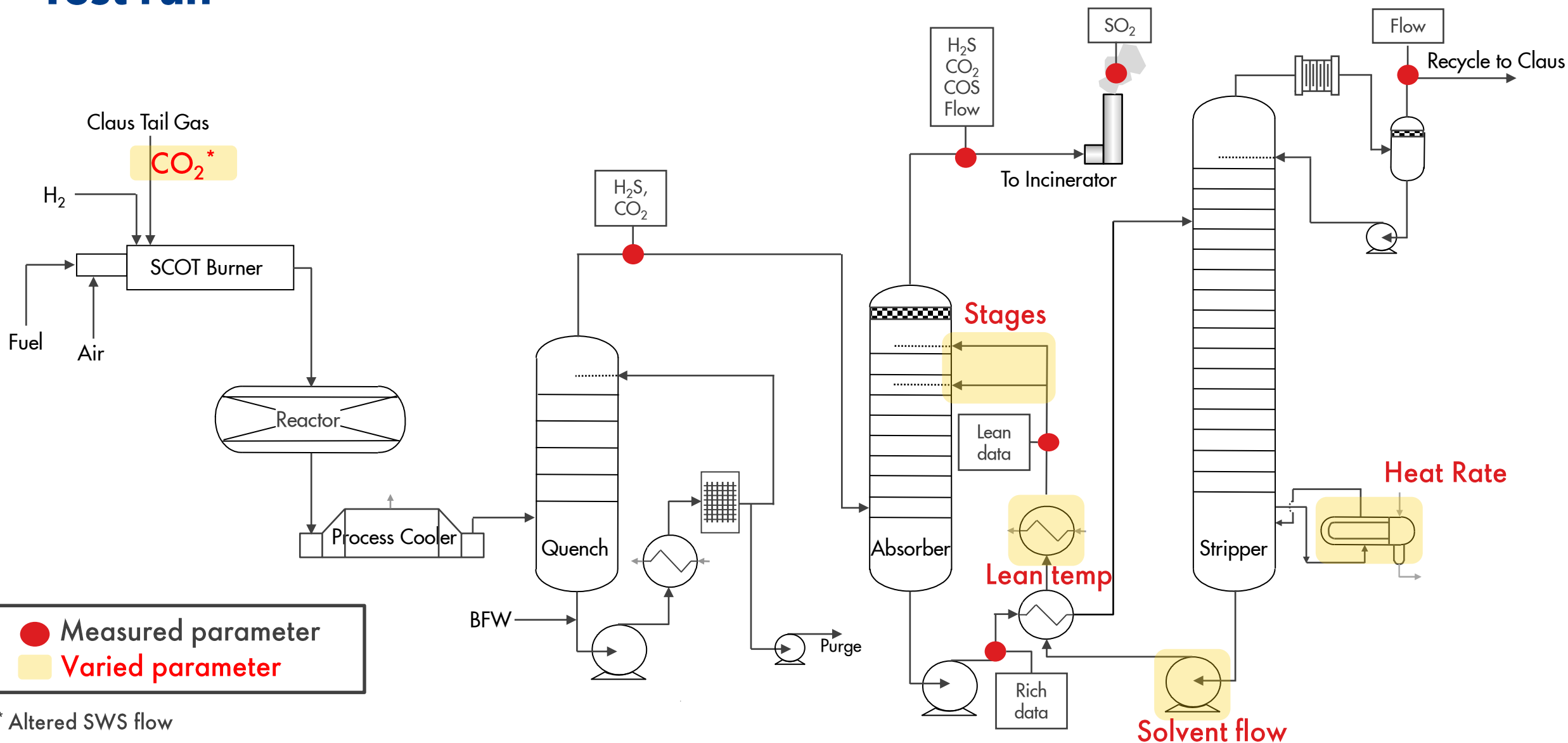
Oxygen enrichment

- Potential to increase S-3 capacity to 190 ELTPD with oxygen enrichment
- S-3's acid gas feed is high in CO₂. **Chiller system is required for MDEA.** CAPEX cost. Desire to reduce CO₂ co-absorption to avoid capacity constraints

JEFFTREAT ULTRA solvent

- Huntsman and Shell develop new amine formulation – JEFFTREAT ULTRA
- Performance test run at refinery in “Air” mode as precursor to oxygen enrichment operation

Test run



* Altered SWS flow

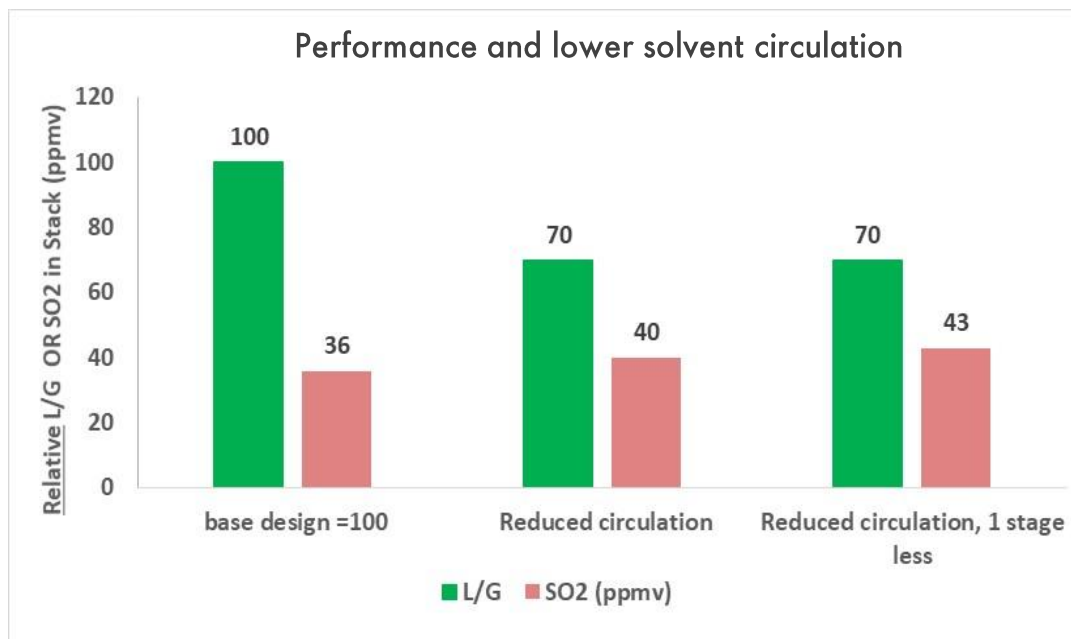
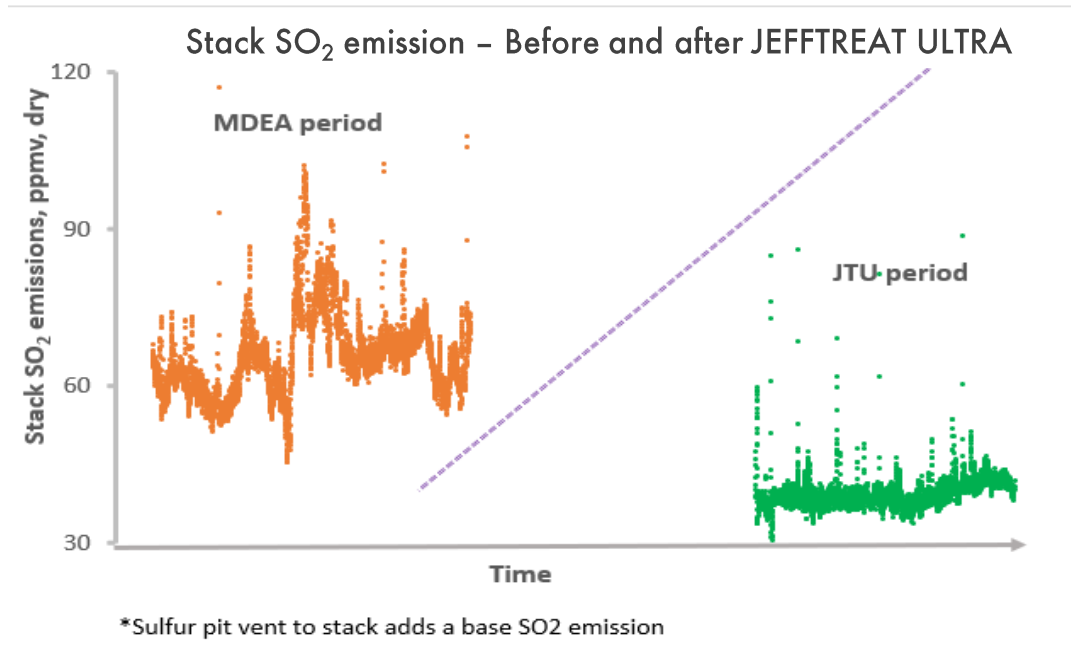
Solvent swap

SO₂ emissions

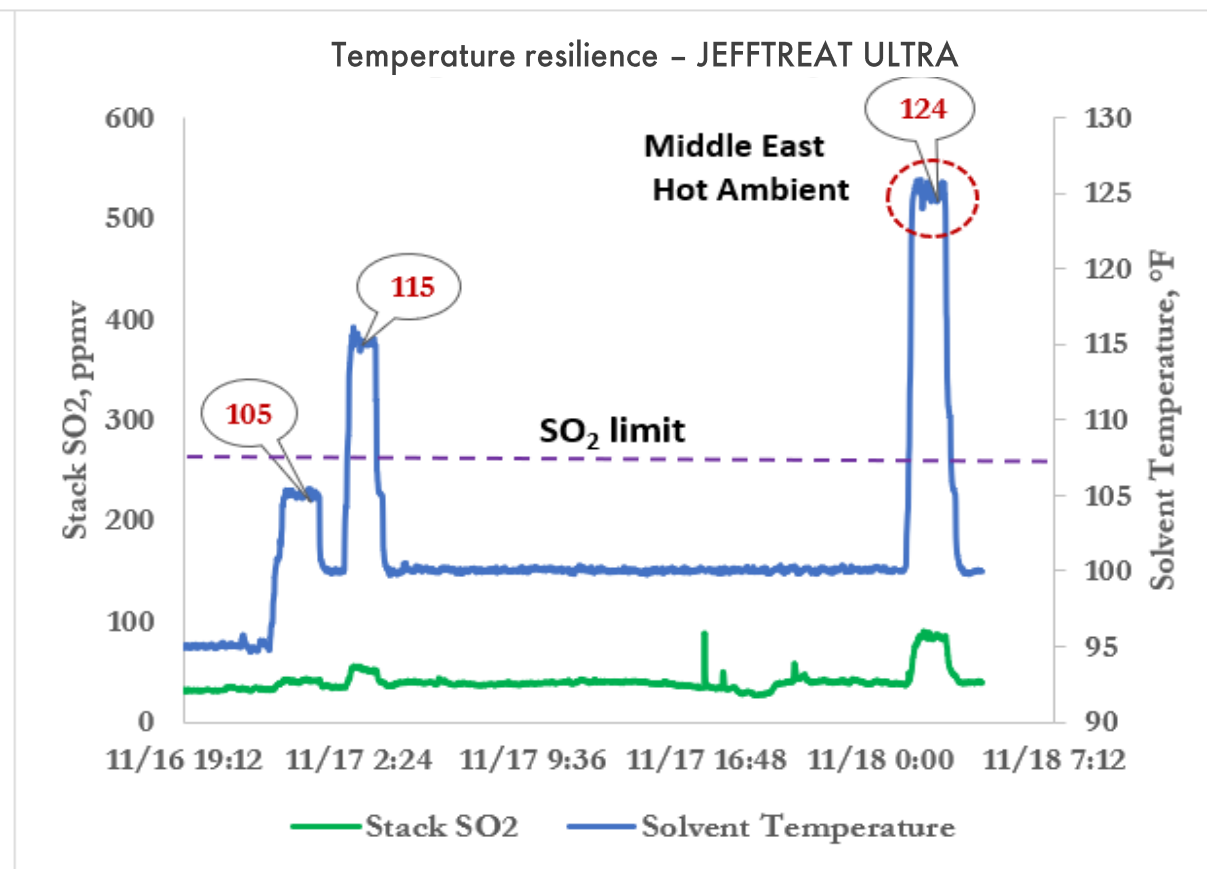
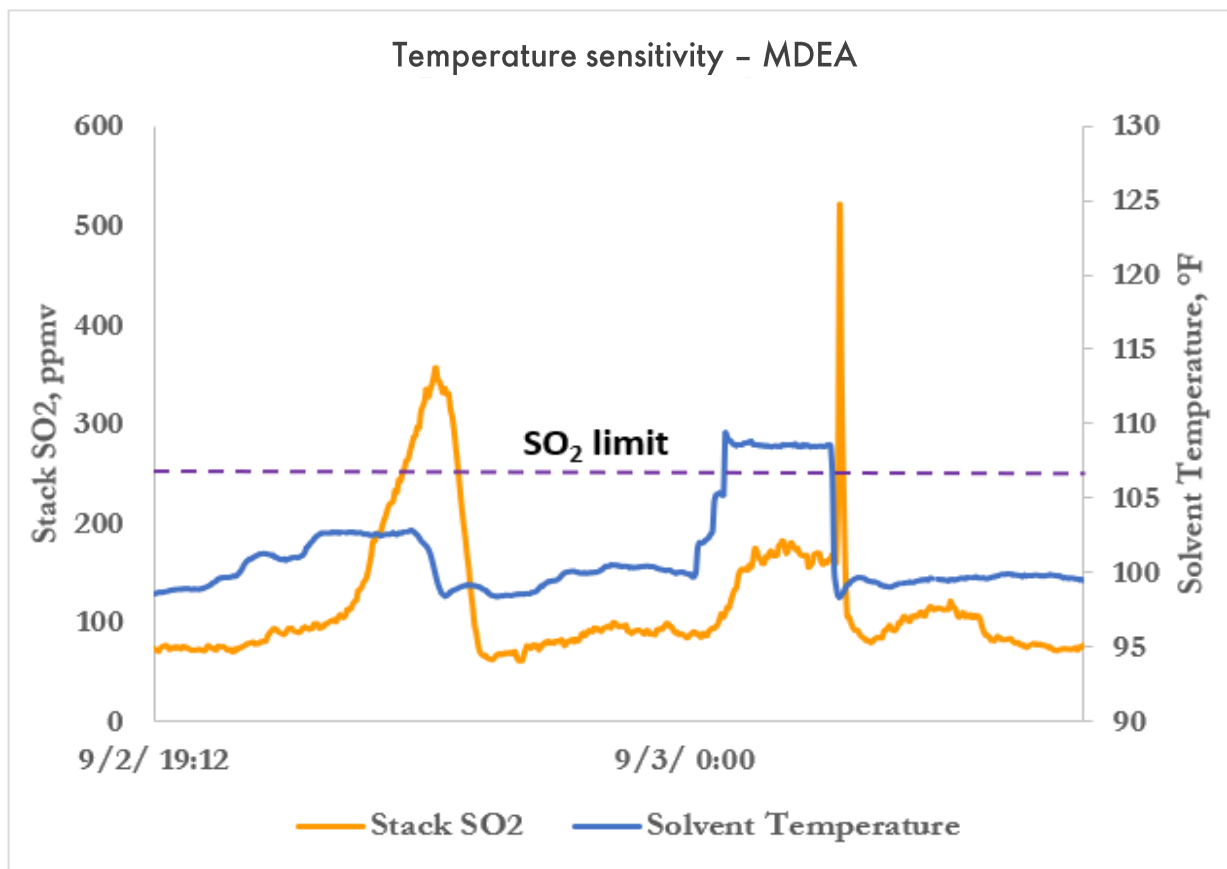
- Post swap, significant reduction in SO₂ observed (decreased from 60–80 ppmv to circa 40 ppmv)
- Single foaming incident, mitigated with anti-foam; no exceedance in emission during foaming incident
- Post swap, unit operates successfully with new solvent

Solvent circulation

- Unit was tested at 70% solvent circulation and lower stages
- No change in performance indicating additional absorption capacity
- Potential to operate future higher flows

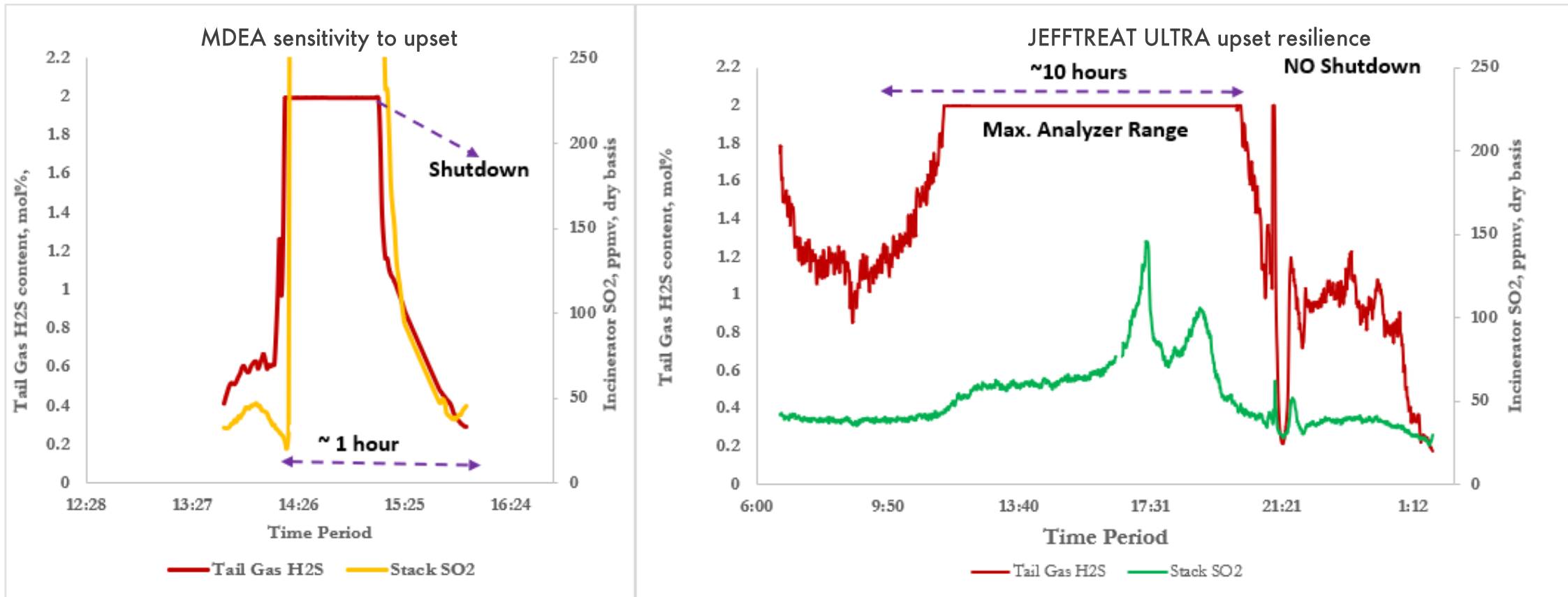


High-temperature operation



- Unit tested at multiple lean solvent temperatures (95–124°F)
- JEFFTREAT ULTRA solvent demonstrated superior resilience to MDEA at high temperature
- Cooling load benefit reduction, alleviates need for chilling post capacity increase

Upset resilience – H₂S



- Charts are for similar load and operating conditions based on historical data
- No emission exceedance/shutdown even operating during “sustained upset”

Performance summary

The solvent swap provides the site with flexibility to operate at future higher capacity at no additional CAPEX

The unit currently operates with the new solvent and has demonstrated superior resilience:

- Site equipped to handle SRU upsets "better"

- Site has identified margin improvement opportunities based on the current solvent



Solvent swap at Shell Norco refinery was successful

JEFFTREAT ULTRA summary

Lower OPEX/CAPEX: May not require solvent refrigeration in high temperature regions

Environmental: Sweet gas can have half as much H₂S

Flexibility: Handle larger feed fluctuations; Better handle upsets/spikes

Lower OPEX: Less energy consumption from lower required solvent circulation

Lower CAPEX: Half the trays or packing length can treat as deeply

Lower OPEX/CAPEX: Lower required solvent circulation, as much as 50% less to achieve H₂S target

Note: Not all benefits can be realized simultaneously – Stated benefits for sweet gas quality, trays/packing high, and solvent circulation are exclusive

Q&A

