Long-Life Moving-Bed Zinc Ferrite Sorbent

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Introduction

- Coal gasifiers coupled with combined cycle power plants (IGCCs) are potentially the lowest cost source of baseload electricity
- Coal contains sulfur that is converted to H_2S in the gasifier
- The H_2S must be removed before the gases are fed to the gas turbine

Hot-Gas Cleanup

- It is better to remove the H_2S (as well as COS and CS_2) at high temperatures than to suffer the cost and inefficiencies involved with cooling the gases and removing sulfur at near-ambient temperature

Objective

- Design a regenerable sorbent that removes H_2S from hot reducing-gases
- Suitable for use in a moving-bed hot-gas cleanup system (for example, the G.E. Moving Bed System at the Tampa Electric Polk Power Station)

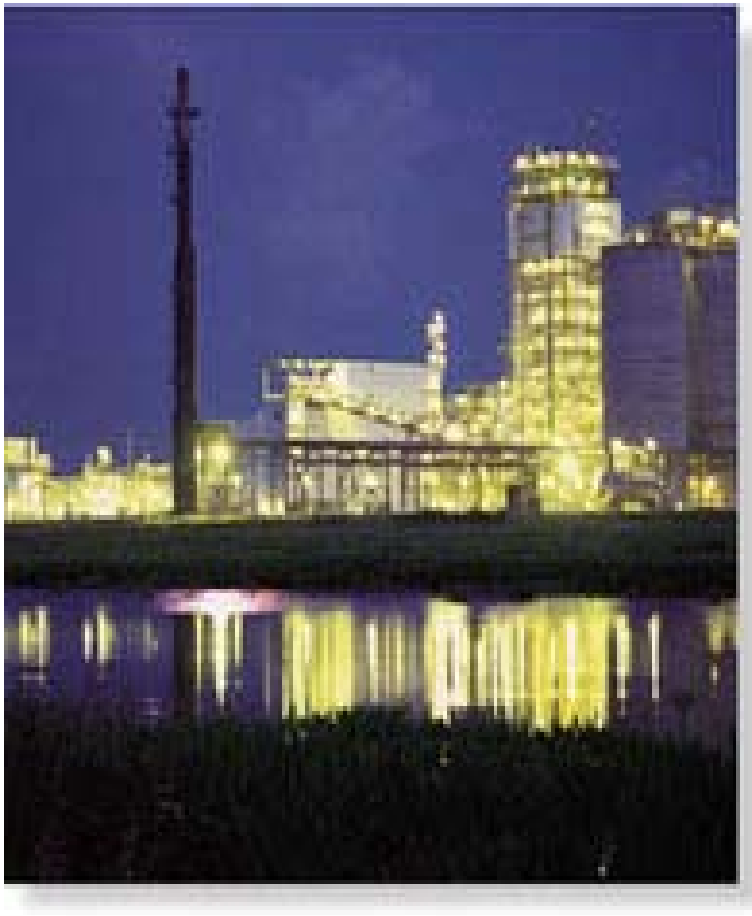
Polk County Plant

- A state-of-the-art integrated coal gasification combined-cycle (IGCC) power plant, Tampa Electric's Polk Power Station produces enough electricity to serve 75,000 homes.

- 250-megawatt IGCC facility is among the nation's cleanest, most efficient and most economical power generation units. The plant is a first-of-its-kind combination of two leading technologies.

- The first technology is called "coal gasification," which uses coal to create a clean-burning gas. The second technology is called "combined-cycle," which is the most efficient method of producing electricity commercially available today.

The plant combines coal with oxygen in the gasifier to produce the gaseous fuel. After processing, the clean coal gas is used in the combustion turbine to produce electricity.



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In this Presentation

- **Test the ability of the TDA's sorbent for multiple cycles**
- **Measure the cyclic capacity, strength, and other properties when regenerated**
  - Without SO_2 in the regenerating gas inlet
  - With SO_2 in the regenerating gas inlet and at pressure

The TNT- MB Sorbent

- **TDA and Norton - Moving Bed**
- **Zinc Ferrite + Inert Binders**
- **Absorbs at 600 - 700 °F**
- **Regenerates at 700 F in 4% O_2**
- **> 13 Lb (Sulfur) Per Ft^3 Bed**
  - Tenth absorption to breakthrough > 7 hours
  - 900 F, 20 atm, 1.2% H_2S, 2000 hr^{-1}

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Previous Work On $ZnFe_2O_4$

- **GE Pilot Plant Run 2B > 1200 °F Regeneration = *No Sulfate***
  - Cook et al. (1992) Twelfth Annual Gasification and Gas Stream Cleanup Systems Contractors Review Meeting
- **RTI: "Zinc Ferrite Sorbents Were Found to Be Limited to 550 C" (1022 F)**
  - Gangwal and Gupta (1991) Eleventh Annual Gasification and Gas Stream Cleanup Systems Contractors Review Meeting
- **RTI and SRI International: "Carbon Deposition Rate Exceeds the Rate of Removal by *Steam*, and Hence Carbon Is Likely to Accumulate on the Sorbent"**
  - Krishnan et al. (1991) *A Preliminary Study of Carbon Deposition on Zinc Ferrite Sorbents*, DOE/MC/25006-3057, contract AC21-88MC25006

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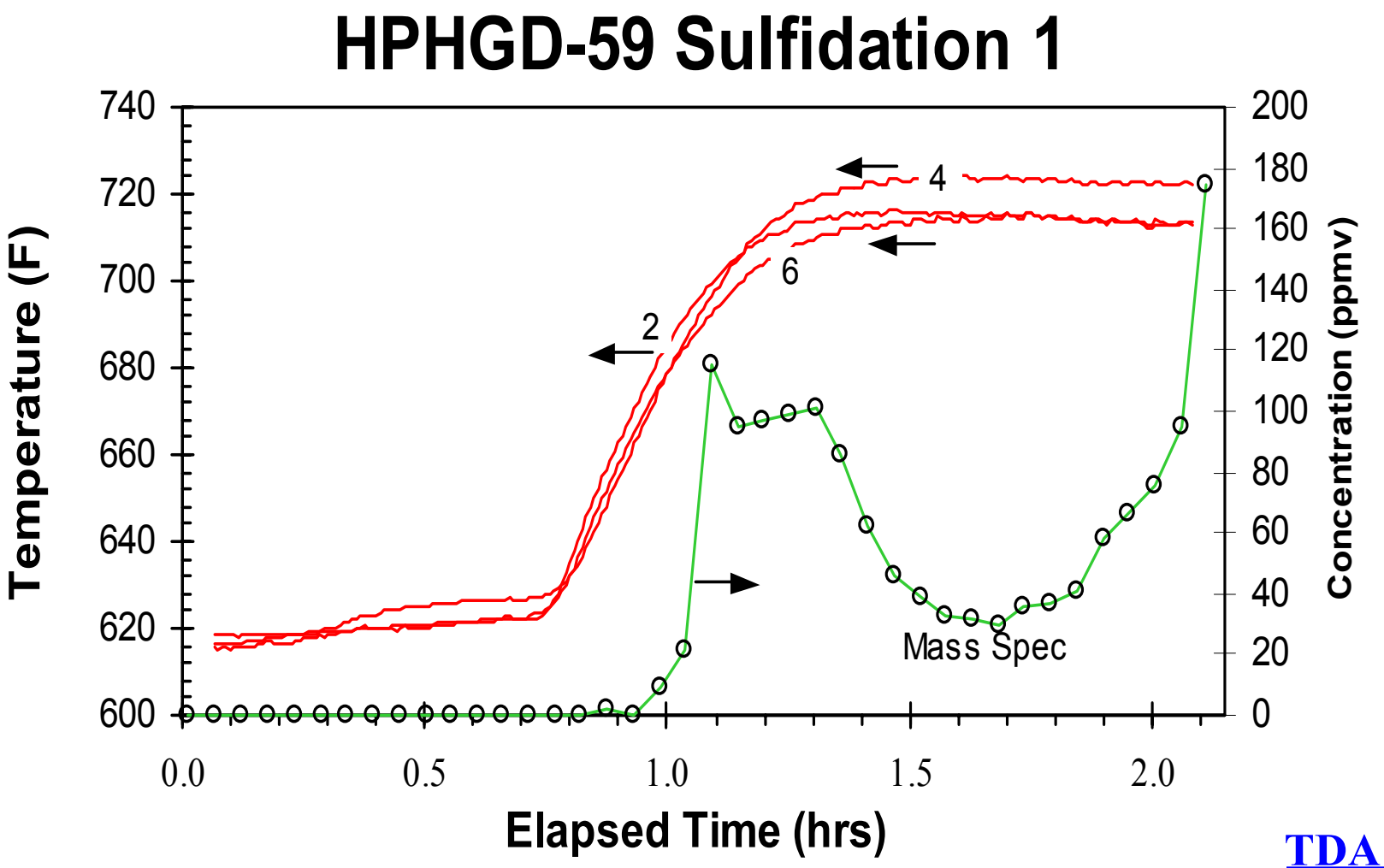
Testing of TNT-MB

- **10-Cycle Tests without SO_2 at DOE-FETC-Morgantown (CRADA) completed**
  - Low Temperature Scoping Tests
  - 10 cycles at 7 atm regeneration
  - TGA tests at IGT
- **3 1/2-Cycle Scoping Tests with SO_2 completed at Institute of Gas Technology**
- **25-Cycle Test at IGT planned in August**

Low Temperature Absorption of "114" TNT-MB (i.e., 600/700 F) at FETC



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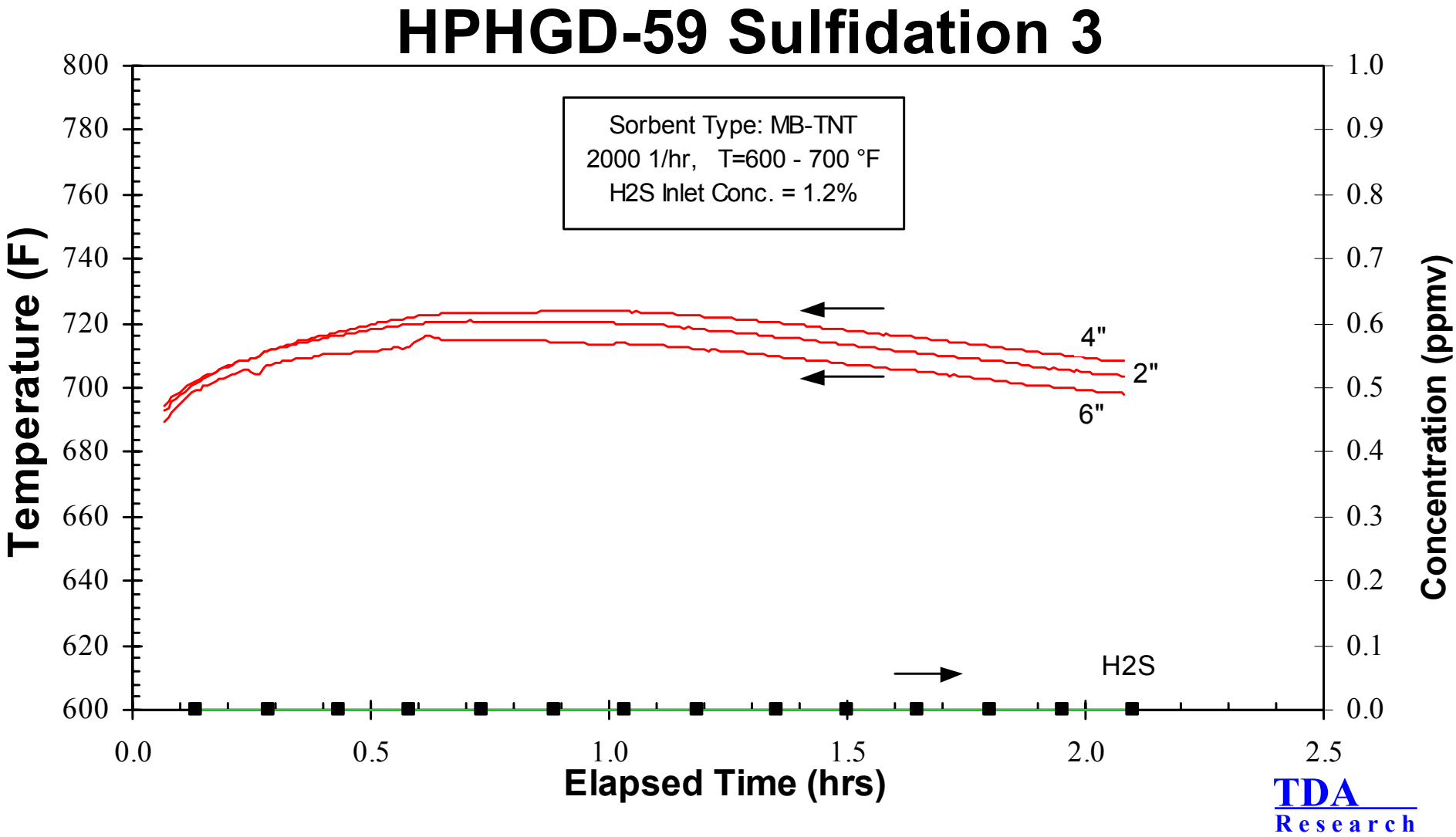
Low Temperature Absorption at 700 F at FETC



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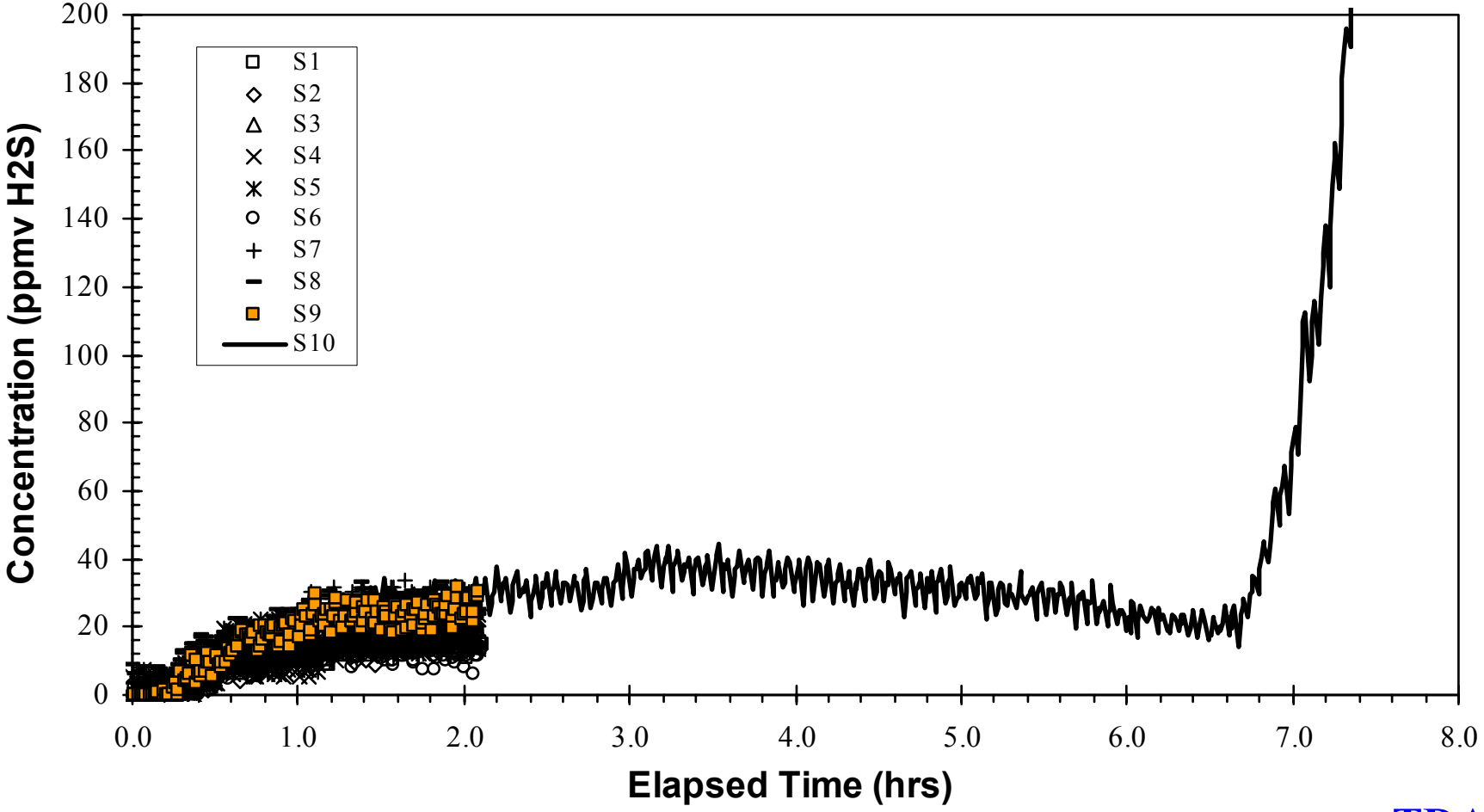
Breakthrough at FETC at 900ºF (482ºC), 10th Sulfidation



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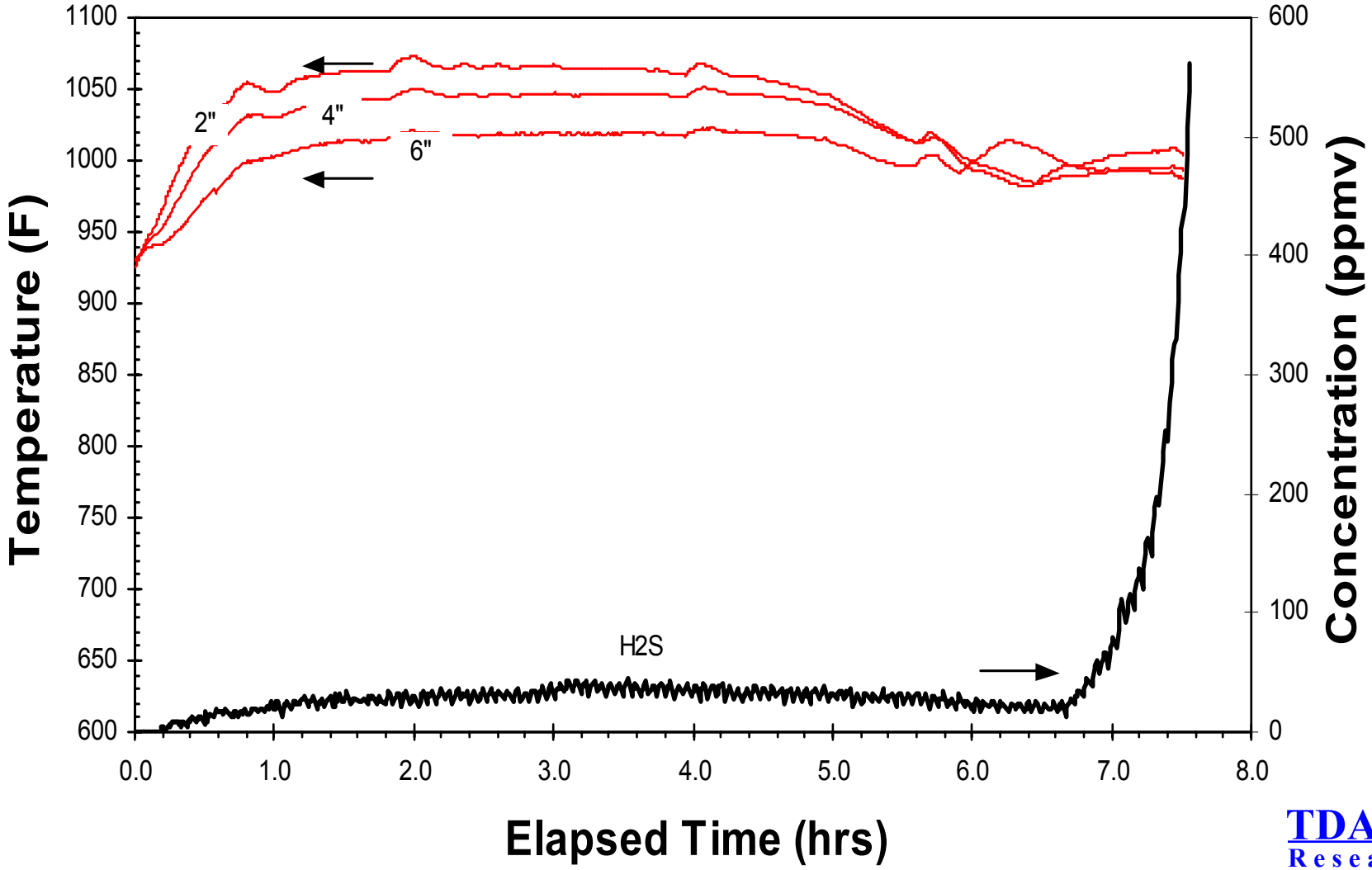
10th Sulfidation at FETC



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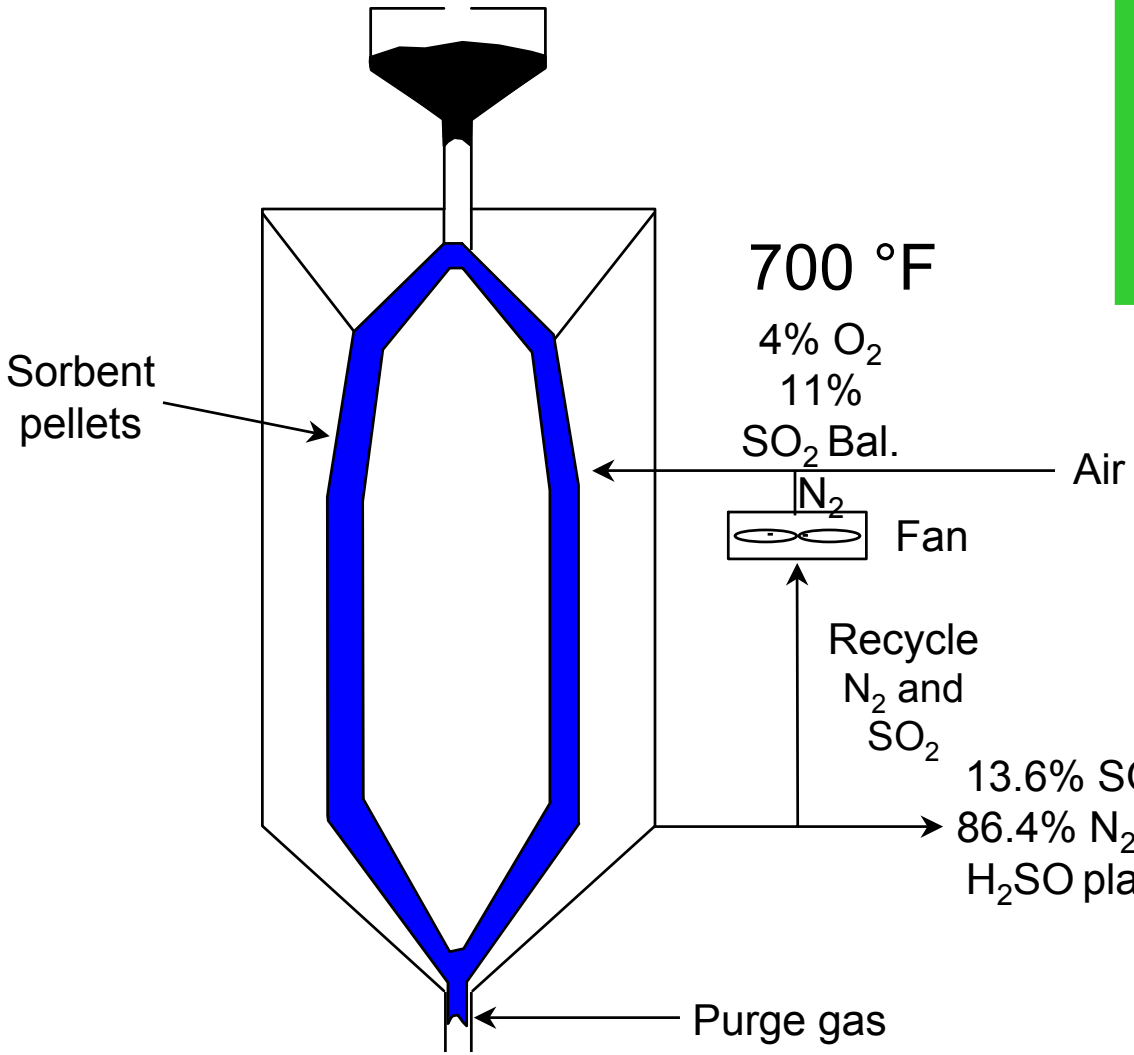
Regeneration of TNT-MB



Simple Co-Flow

One Inlet, One Exit

O_2 / H_2S = 1.67

1250 °F

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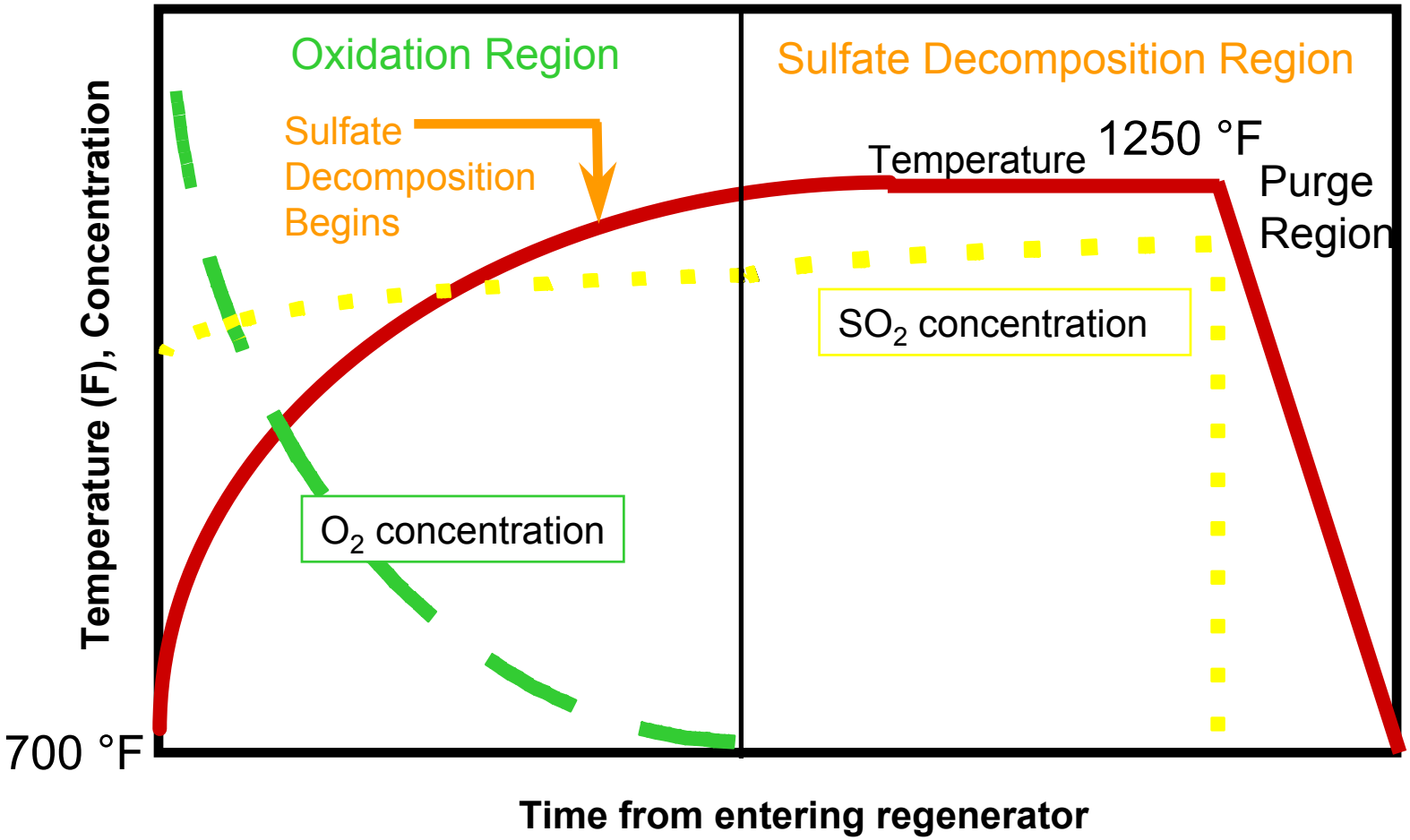
Temperatures & Concentrations



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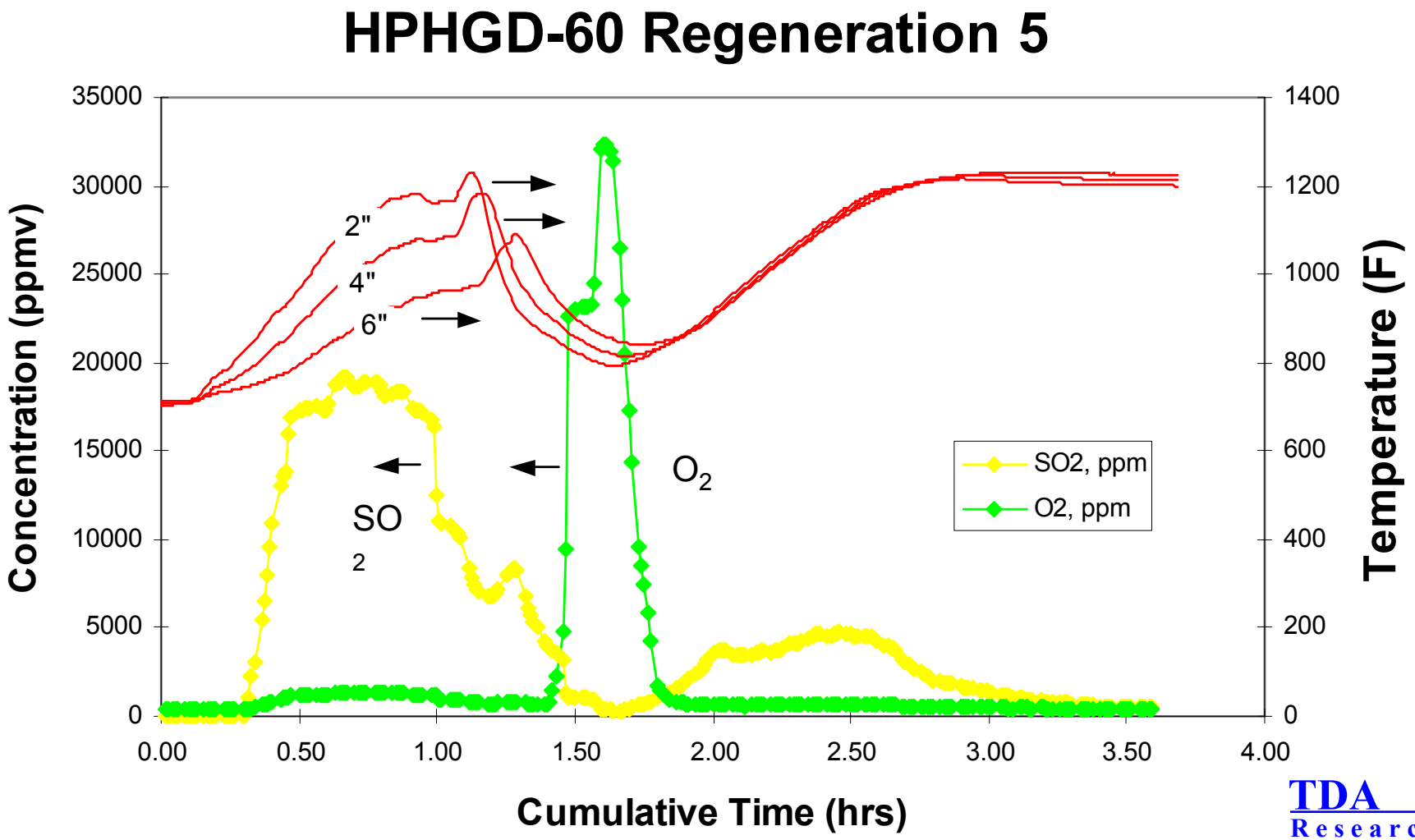
Regeneration at FETC
7 atm, 700 F (372 C), No Inlet SO_2



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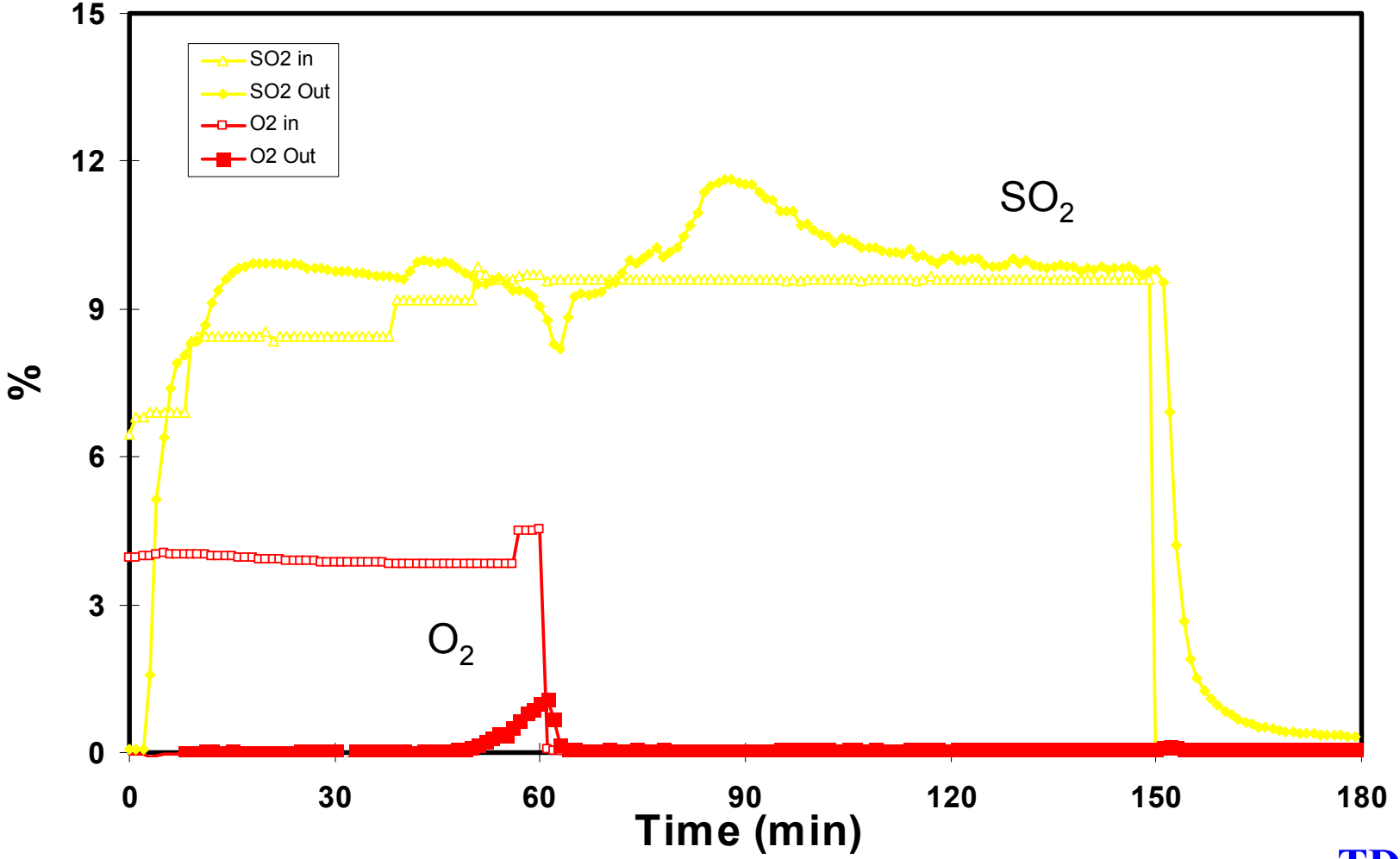
Regeneration of TNT-MB at IGT, 5 atm



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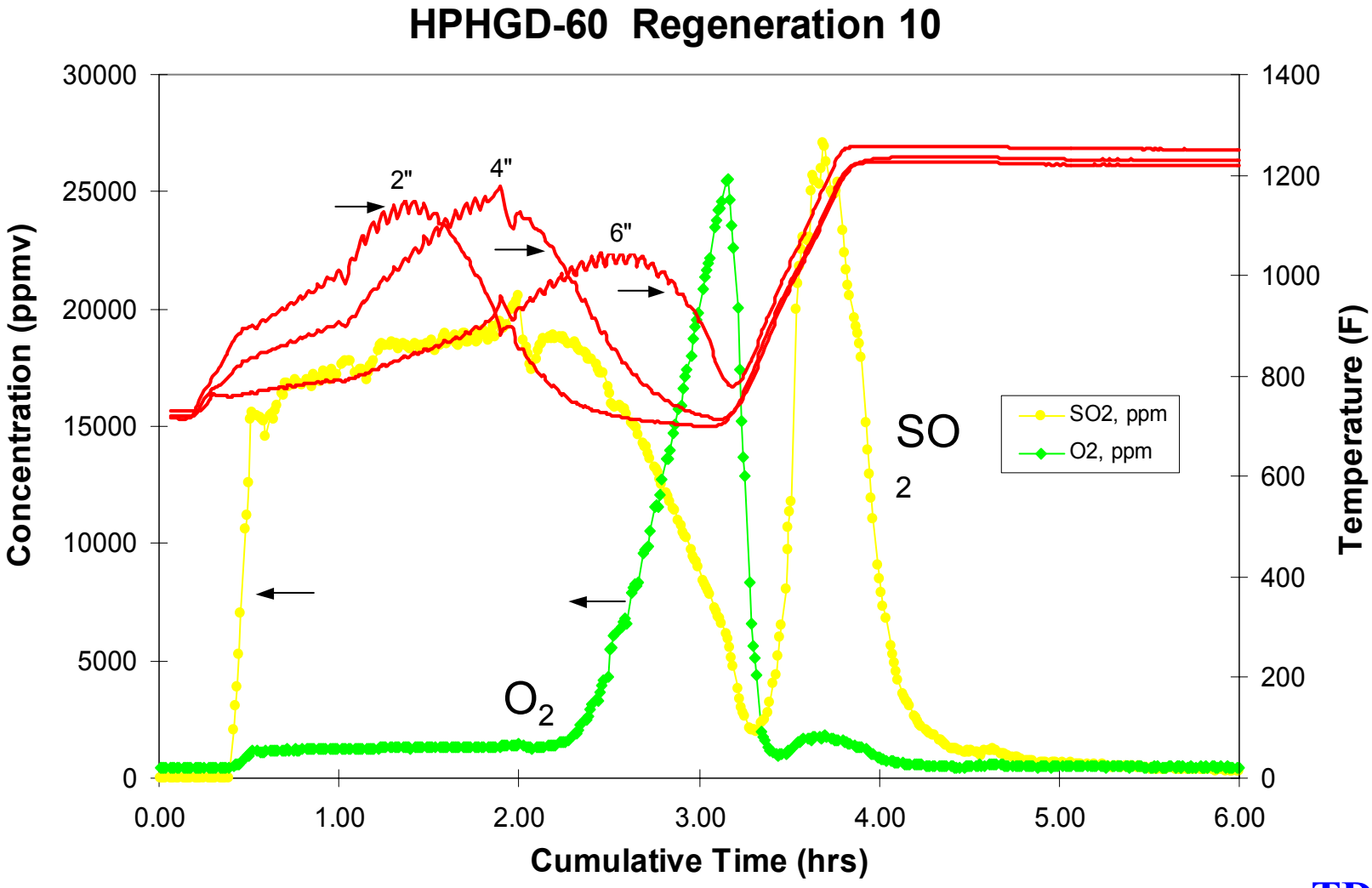
10th Regeneration at FETC



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Properties of Norton Produced TNT-MB Sorbent

Property	Fresh	4th Reg	5th Abs	10th Abs	10th Reg
Sulfur (wt%)	0.44	2.0	16.8	14.4	2.8
ASTM Attrition (wt.%)	1.8	1.3	1.1	NA	0.87 bot. (0.64 top)
Sulfate Sulfur (wt%)	0.42	0.30	NA	0.07	0.27
Carbon (wt%)	NA	< 0.05*	0.05	< 0.5*	NA

4th Regeneration with 10% SO_2 at 2 - 3 ATM at TDA

5th Absorption at 20 ATM at TDA

10th Cycle at FETC: NO SO_2 in the inlet during regeneration, bottom of bed = inlet.

*** Limit of Detection**

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Closure

- **TNT-MB is a NON-SPALLING Zinc Ferrite Sorbent**
- **TNT-MB Reduces Regenerator Size & Complexity**
  - Only one inlet
  - Half the current TECo regenerator used
  - Very high sulfur loadings make reduced sorbent circulation and/or reactor sizes possible in future moving beds
- **The Sorbent Retains Its Activity for Multiple Cycles**
  - 600ºF: > 30 minute breakthrough
  - 700ºF: > 3 hour breakthrough
  - 900ºF: > 7 hour breakthrough
  - Attrition resistance improves with cycling

Acknowledgments

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