

Sorbents for Mercury Removal from Coal-Fired Power Plants

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Objective: TDA Research, Inc. is developing expendable dry injection sorbents to remove mercury from flue gases

Motivation: Mercury emissions from coal fired utilities will be regulated due to its effect on humans and wildlife. Removing the mercury is potentially an expensive and difficult task

Requirements of the Sorbent

- High mercury absorption capacity
- Low cost
- Achieve greater than 95% mercury removal efficiency
- Tolerance to possible flue gas contaminants (e.g., residual SO₂, NO_x)
- Easy disposal
- Non-carbon material will not alter properties of the fly ash
- Stabilizes mercury permanently (no leaching out of mercury once disposed)

Analytical System

Total mercury analysis

- Genesys Lab Process Sentinel Analyzer
- Humidity is removed from the sample before analysis

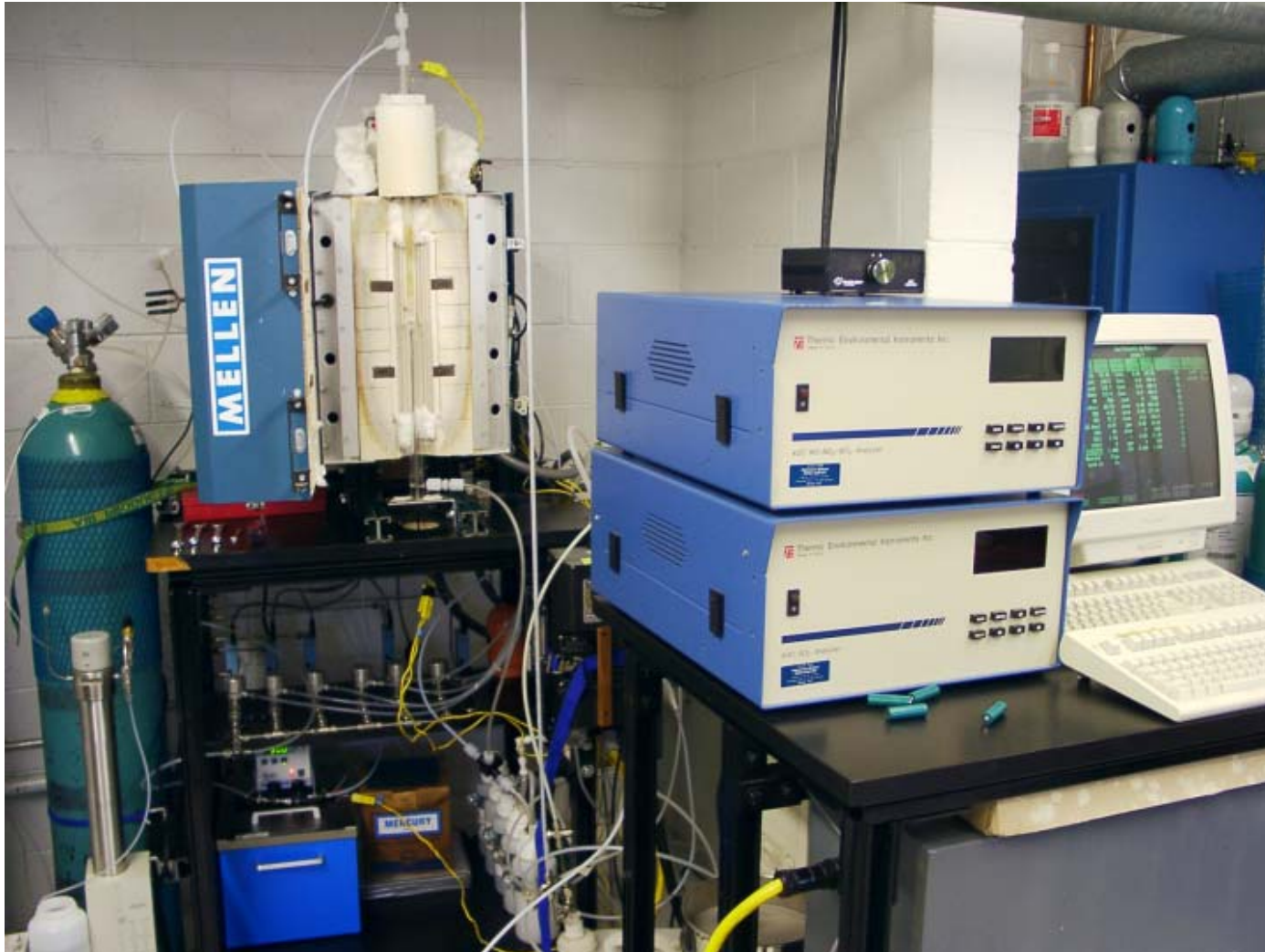
Metallic mercury analysis

- Arizona Instruments Jerome 431X Analyzer
- Acid gases are removed before analysis using a NaOH impinger

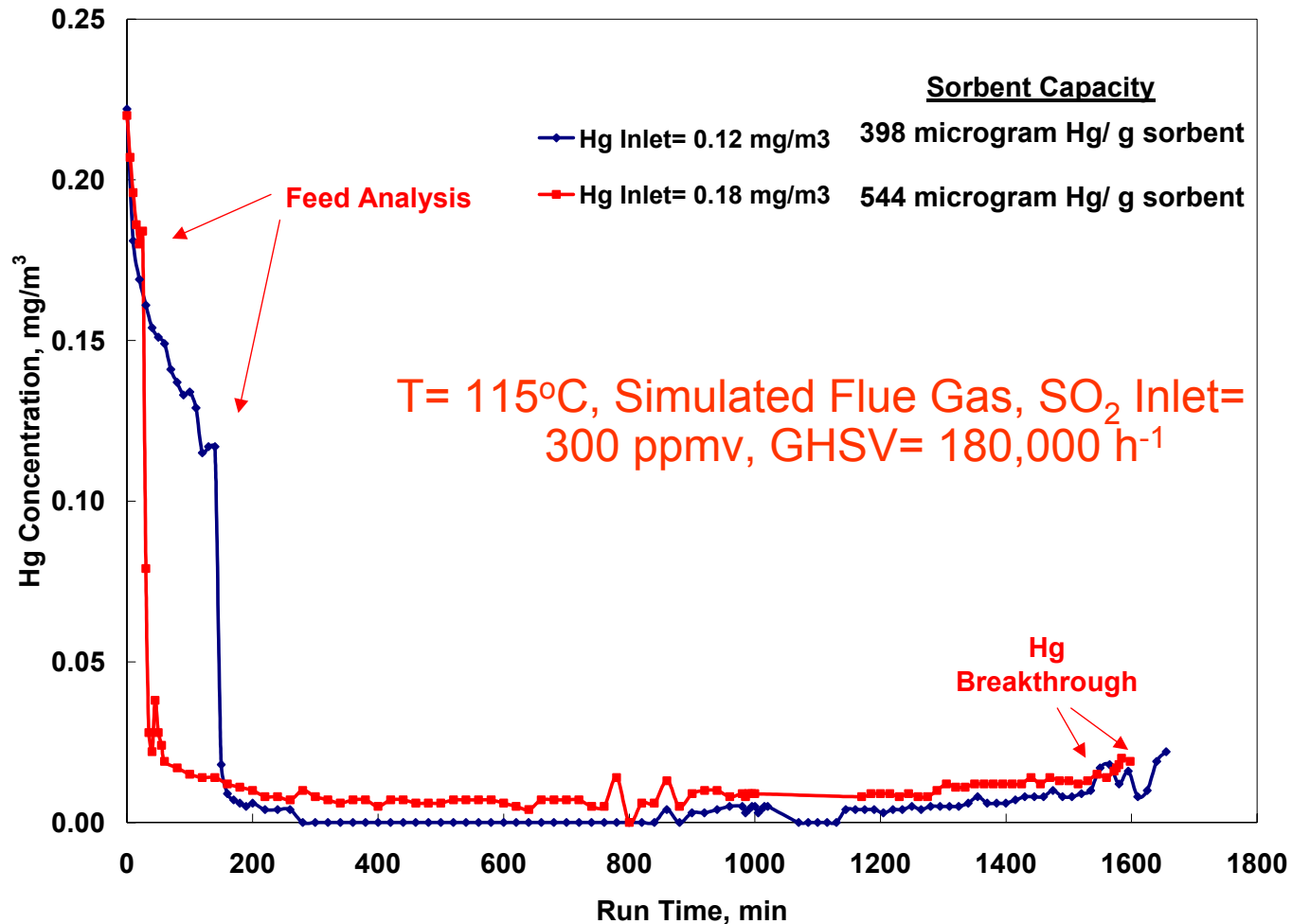
SO₂ and NO_x analysis

- Thermoenvironmental on-line chemiluminescence analyzers

Testing Apparatus

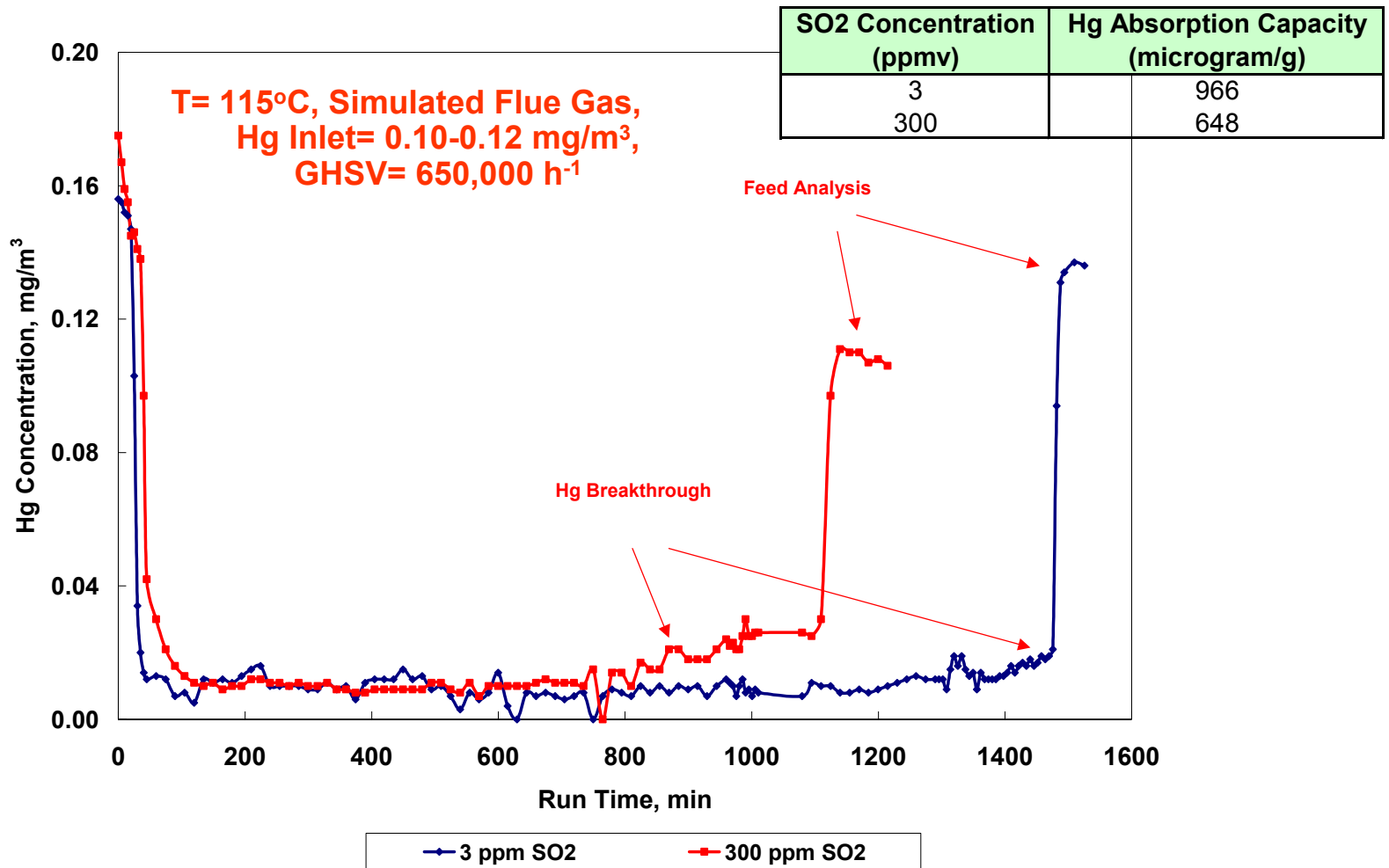


Effect of Inlet Hg Concentration



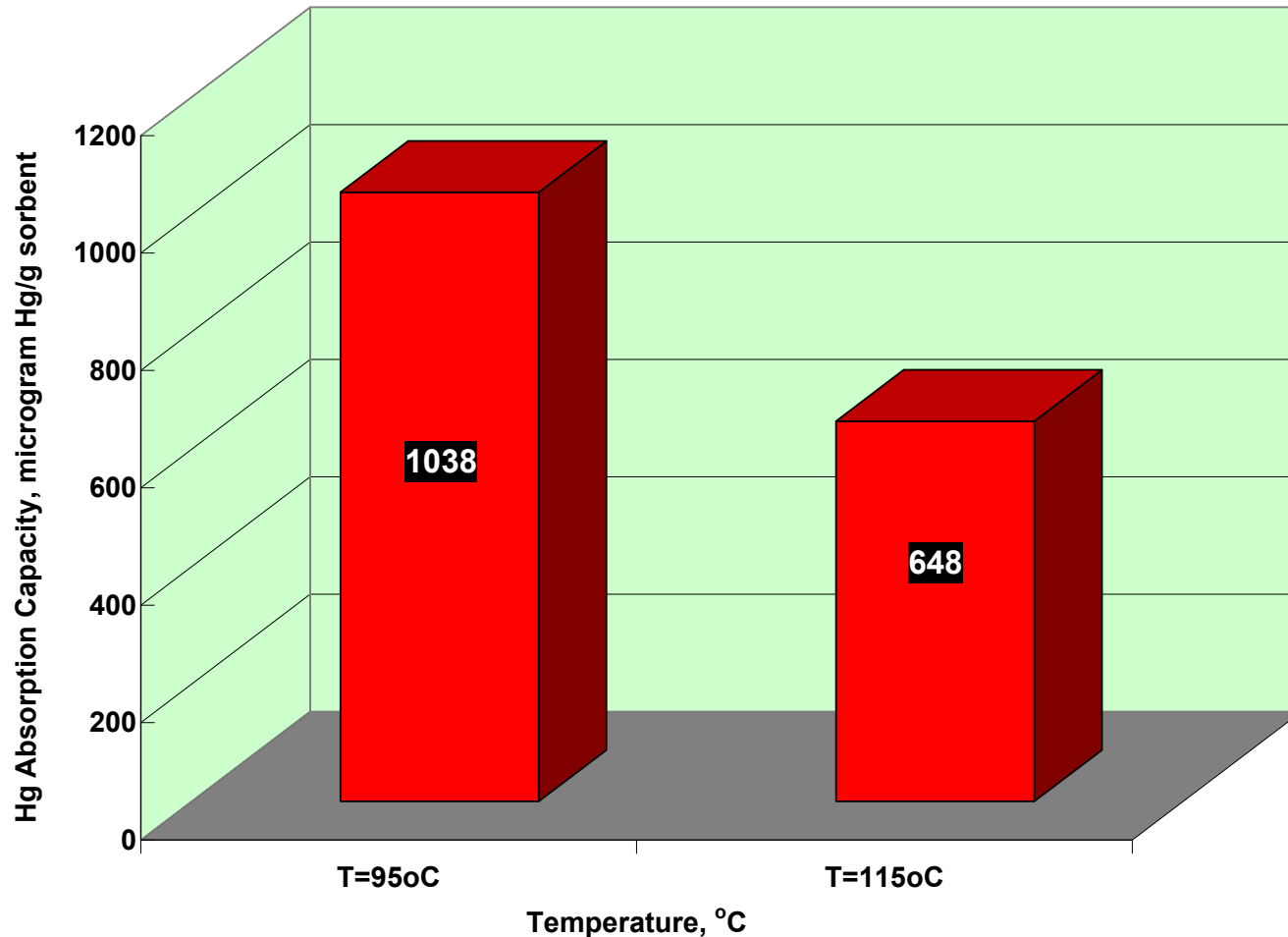
The sorbent showed 398 and 544 $\mu\text{g/g}$ absorption capacity for Hg inlet concentrations of 0.12 and 0.18 mg/m^3 , respectively

Effect of SO₂ Concentration



The sorbent showed 966 and 648 $\mu\text{g/g}$ absorption capacity (90% Hg removal) in the presence of 3 and 300 ppmv SO₂, respectively

Effect of Temperature



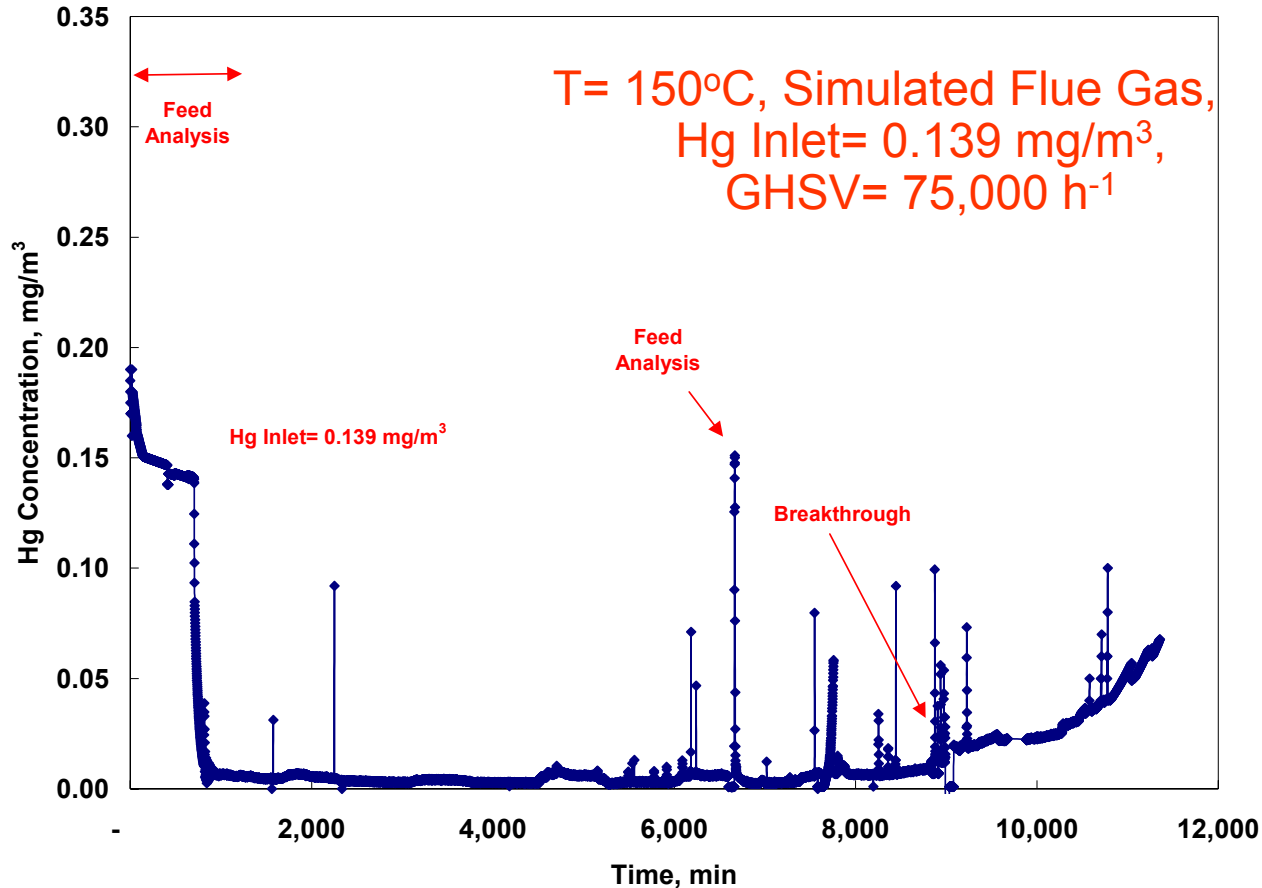
Hg absorption capacity of the sorbent increases at lower temperatures

Test Conditions for Material Comparison

- Temperature = 150°C
- Pressure = 13.5 psia
- Hg Inlet = 13 – 16 $\mu\text{g}/\text{m}^3$
- Particle size = 4-8 μm
Norit carbon, 15-50 μm
TDA sorbent

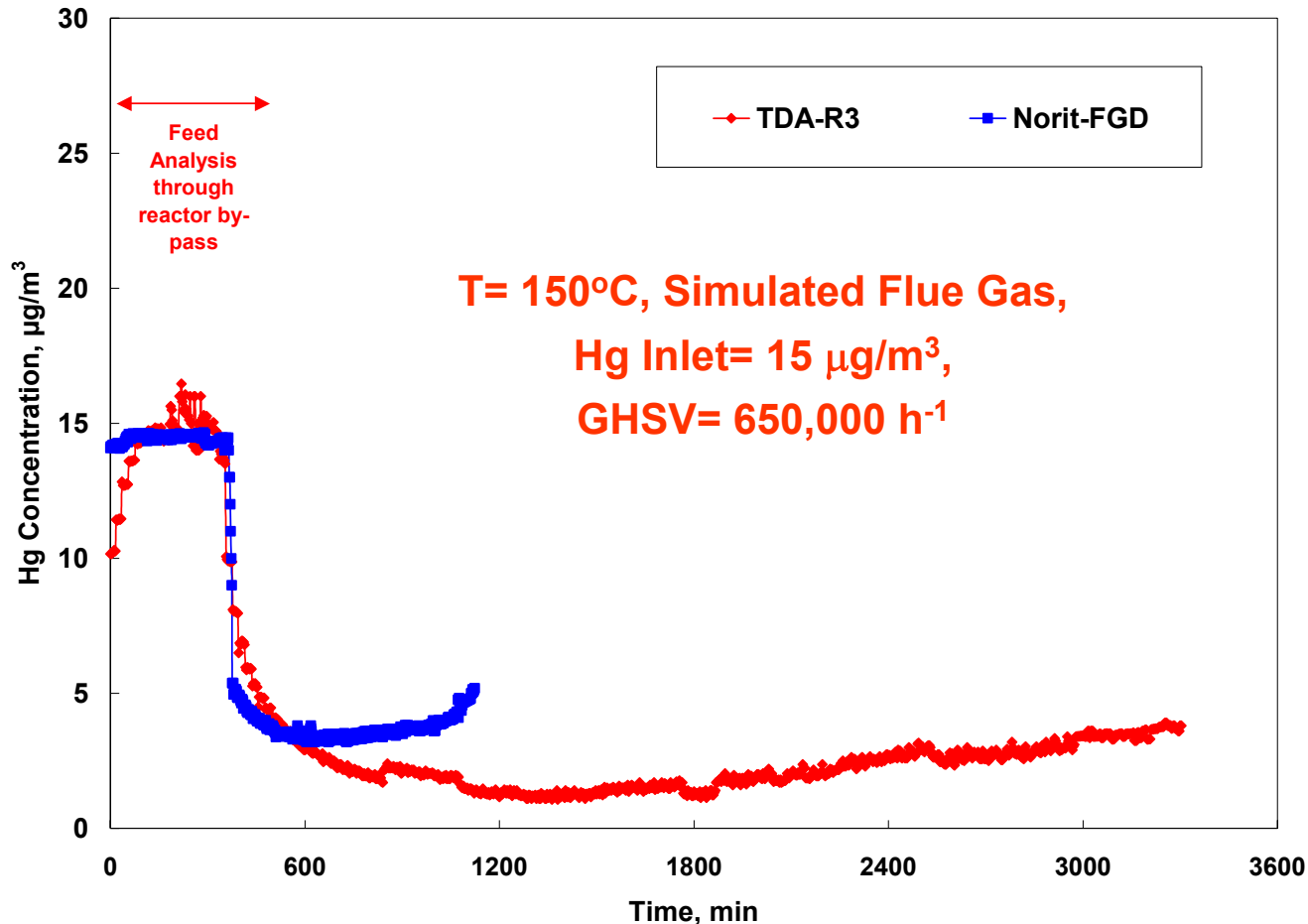
Component	Flow sccm	Concentration % vol.
O2	19	1.5%
CO2	75	6.0%
H2O	85	6.8%
N2	1071	85.7%
SO2	0.2	180 ppm
Total	1250	100.0%

Higher Temperature and Lower Pressure



Sorbent can achieve 2,329 $\mu\text{g/g}$ Hg absorption capacity with 90+% Hg removal efficiency at 150°C at high gas solid contact times.

Comparison Against Activated Carbon



TDA's sorbent achieved a higher absorption capacity and higher mercury removal efficiency than Norit FGD carbon

Economic Feasibility

- TDA's sorbent has a considerably higher mercury capacity than conventional sorbents
- In presence of 300 ppmv SO₂ we observed absorption capacity of 544 to 638 μg Hg/g sorbent
- Sorbent cost is estimated as ~\$5/lb
- Based on the above assumptions, sorbent replacement is estimated as \$7,800 to 9,200/lb Hg

Economic Feasibility

Sorbents	Capacity (mg/g)	Temp. (oC)
TDA's sorbent	10.85*	120
Iodine impregnated Act. Carbon	4.8	180
Sulfur impregnated Act. Carbon	3.5	140
Chlorine impregnated Act. Carbon	4.0	60
Alumina	0.4	60
Celkate	0.5	140
Chlorine impregnated Celkate	0.8	140
Cr ₂ O ₃ /Al ₂ O ₃	3.3	180
MnO ₂ /Al ₂ O ₃	3.5	140
V ₂ O ₅ /MgSiO ₃	0.4	180
MoS ₂	5.6	60
MoS ₂	5.2	140
FeS ₂	0.2	140
CaCl ₂ /Al ₂ O ₃	0.6	60
Pt wool	5.1	140

* no SO₂

Source: Granite et al, 2002

Efficiency Comparison

TDA's Sorbent	Hg Removal Efficiency	
	90%	75%
Hg Inlet, mcg/m ³	15.1	15.1
Breakthrough Time, min	1377	2952
Hg Absorption Capacity, mcg/g	743	1592

Norit FGD Carbon	Hg Removal Efficiency	
	90%	75%
Hg Inlet, mcg/m ³	14.5	14.5
Breakthrough Time, min	N/A	536
Hg Absorption Capacity, mcg/g	N/A	278

- TDA's sorbent achieves 90% Hg removal efficiency, while the Norit carbon can only remove 75% of the mercury
- TDA's sorbent exhibited an absorption capacity of 1,592 µg Hg/ g sorbent, 6 times better than can be achieved by Norit carbon