Pilot Testing of Oxidation Catalysts for Enhanced Mercury Control by Wet FGD

Gary Blythe

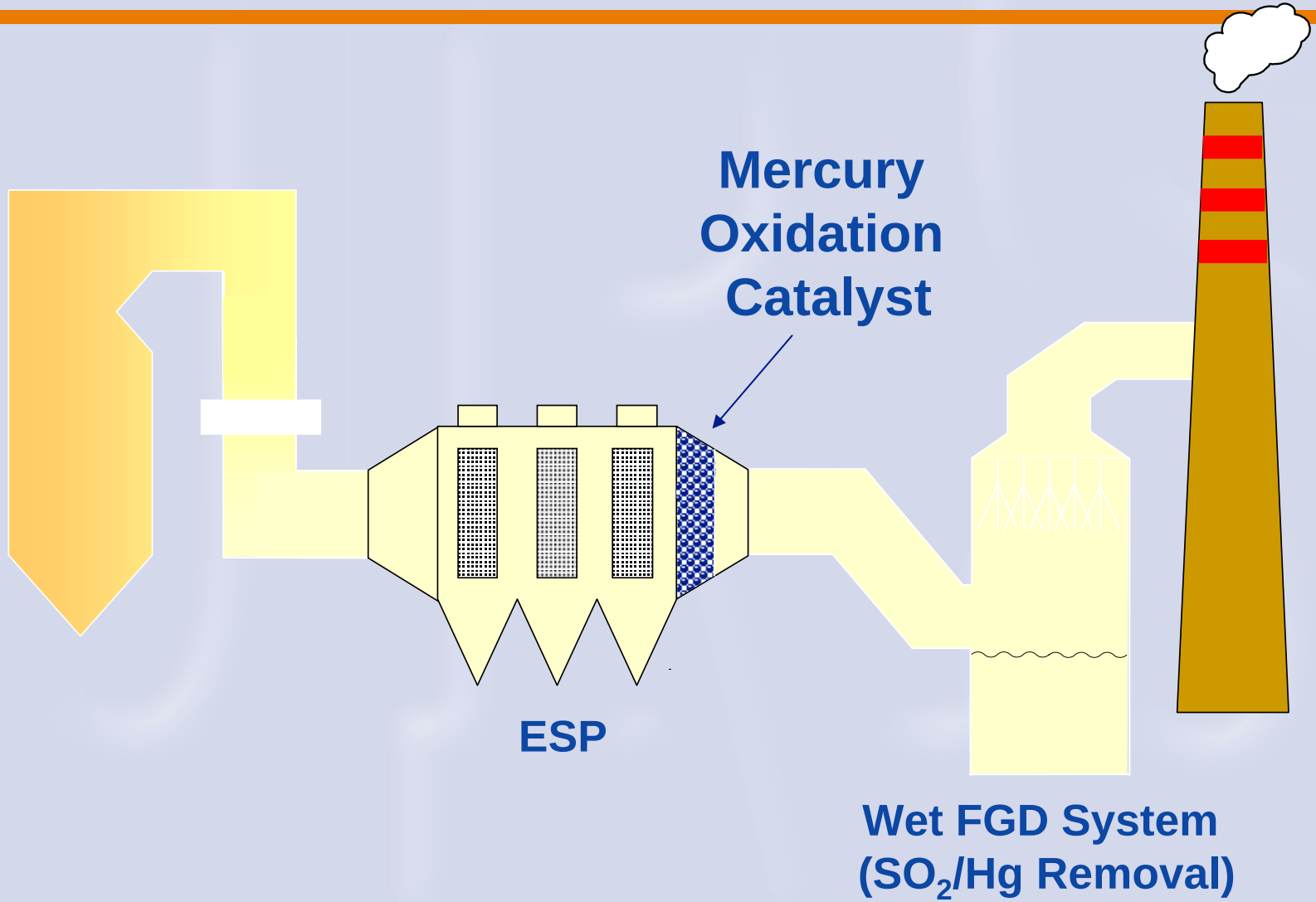
URS Corporation

Austin, TX

Hg Control Technology Concept

- Oxidized forms of Hg are effectively removed in most wet scrubbers
  - Hg^0 is not removed
- Hg^0 fraction in coal flue gases can range from 5% to >90%
  - Lower percentages typical with PRB and lignite fuels
- Catalytic oxidation of Hg^0 in flue gas could increase overall Hg removal across wet FGD systems

Proposed Process



Process Development Background

- **Initial concept development funded by EPRI (early 1990s)**
- **Further development with DOE NETL/ EPRI co-funded MegaPRDA Project**
  - **6-month sand bed catalyst tests at three coal fired sites**
  - **Completed in 2001**

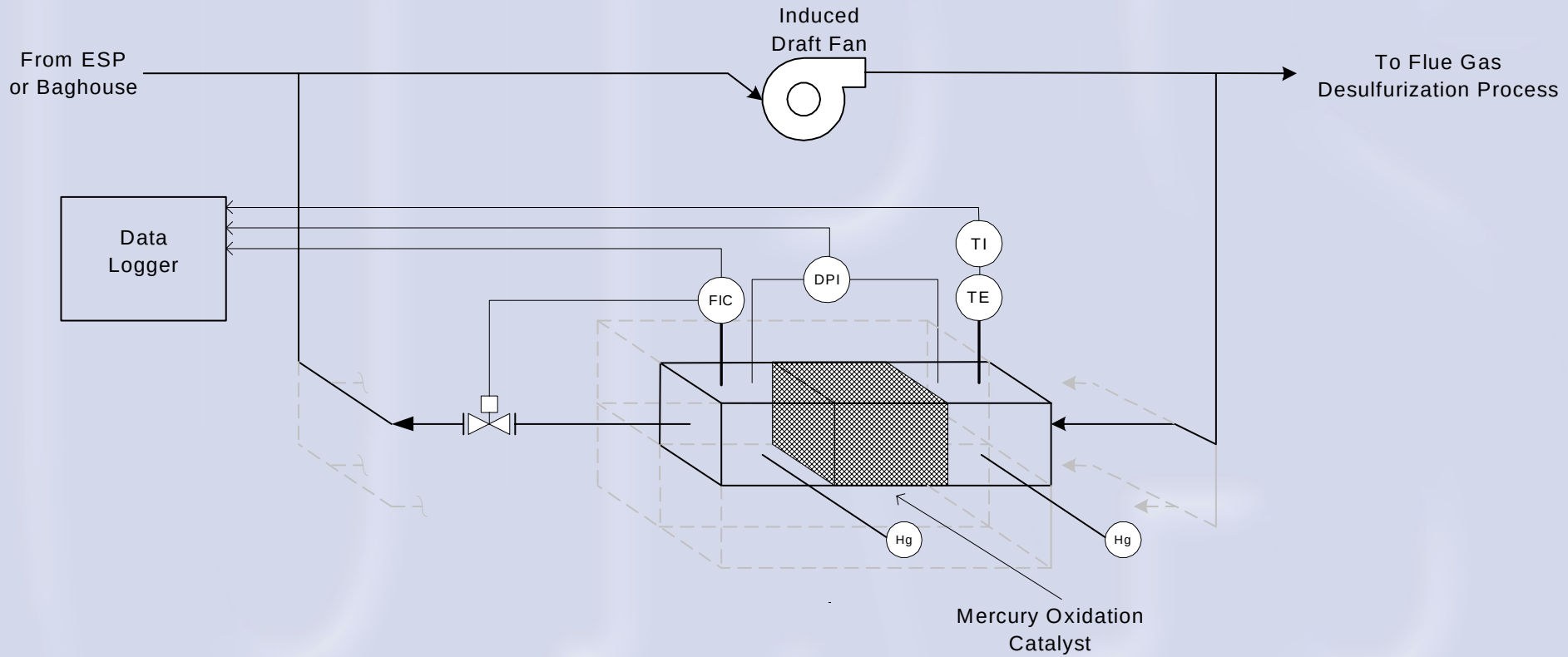
Current Project

- Conduct pilot-scale tests of honeycomb Hg^0 oxidation catalysts at two sites
  - 8000 acfm total flue gas flow
  - 4 catalysts tested in parallel (2000 acfm each)
  - 14-months automated operation at each site
  - Monthly activity measurements with Hg SCEM
- DOE/NETL, EPRI, utility co-funded
- Host stations include ND lignite (GRE's Coal Creek), PRB fuels (CPS's Spruce)

Catalyst Types Tested

- Metal-based
  - Palladium (Pd #1)
  - Ti/V (SCR)
- Carbon-based
  - Commercial activated carbons
  - Experimental activated carbons (C #6)
- Fly-ash-based
  - One subbituminous coal ash has been particularly effective (SBA #5)

Pilot Unit Concept



Pilot Testing Status

- First pilot unit built in 2002
- Started up at Coal Creek in October 02
  - 2 of 4 catalysts installed (Pd #1 and SCR)
  - Delivery of other two catalysts delayed due to developmental nature of their production
- Third catalyst (SBA #5) installed December 02
- Fourth catalyst (C #6) ready for installation

Pilot Unit at Coal Creek Station

Catalyst Selection for Pilot Unit

- Candidate catalysts identified from previous MegaPRDA sand-bed field tests
- Honeycomb catalyst activity measured in laboratory with simulated Coal Creek and Spruce flue gases
- Mass transfer model used to project pilot catalyst performance as a function of catalyst cell pitch, cross section, length

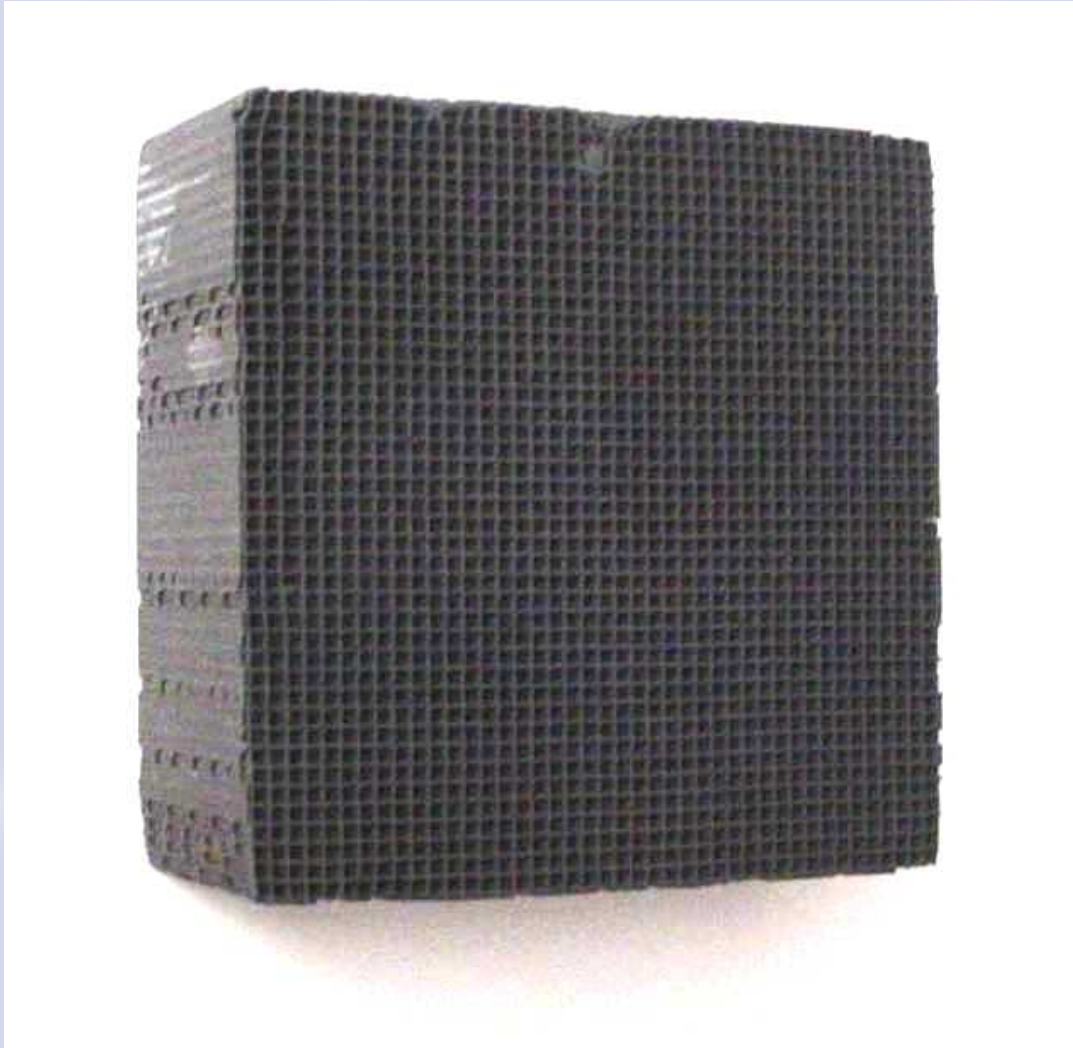
Catalyst Dimensions Selected for Pilot Unit

Catalyst	Cells per $in.^2$ (cpsi)	Cross Section (in. x in.)	Length (in.)	Area Velocity (sft/hr)
Pd #1	64	30 x 30	9	49
C #6	64	36 x 36	9	33
SBA #5	64	36 x 36	9	33
SCR (from Ceramics Gmbh)	46	35.4 x 35.4	19.7	19

Photo of Ceramics Gmbh SCR Catalyst Module

One of Three SBA #5 Catalyst Modules

Close-up of One SBA #5 Block

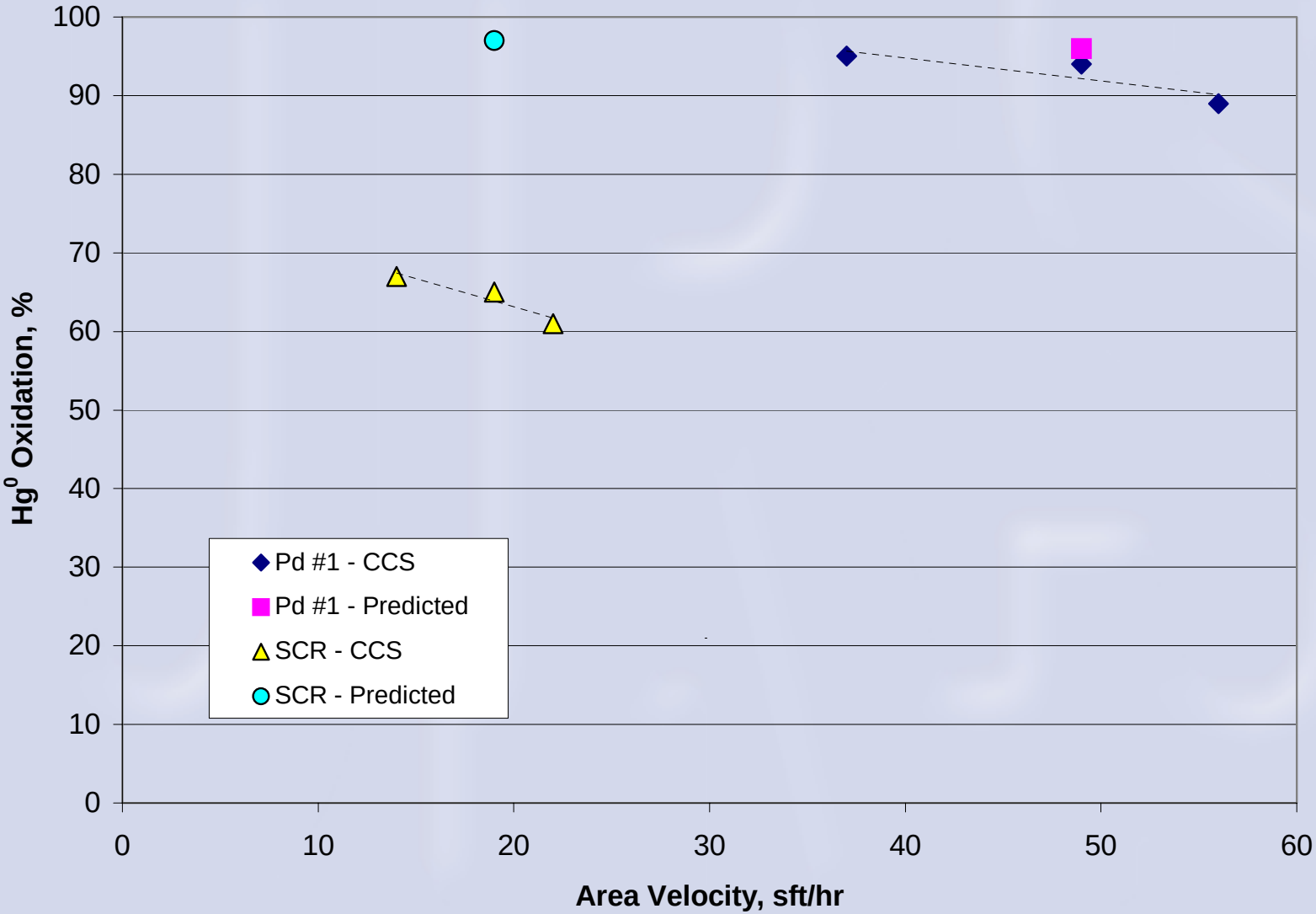


Initial Pilot Catalyst Activity (October 02)

Flue Gas Rate (acfm)	Inlet Hg Oxidation (%)	Pd #1		SCR	
		Hg^0 Ox. (%)	Area Vel. (sft/hr)	Hg^0 Ox. (%)	Area Vel. (sft/hr)
1500	43	95	37	67	14
2000	32	93	49	62	19
2300	42	89	56	61	22

Highlighted values represent selected long-term catalyst operating conditions

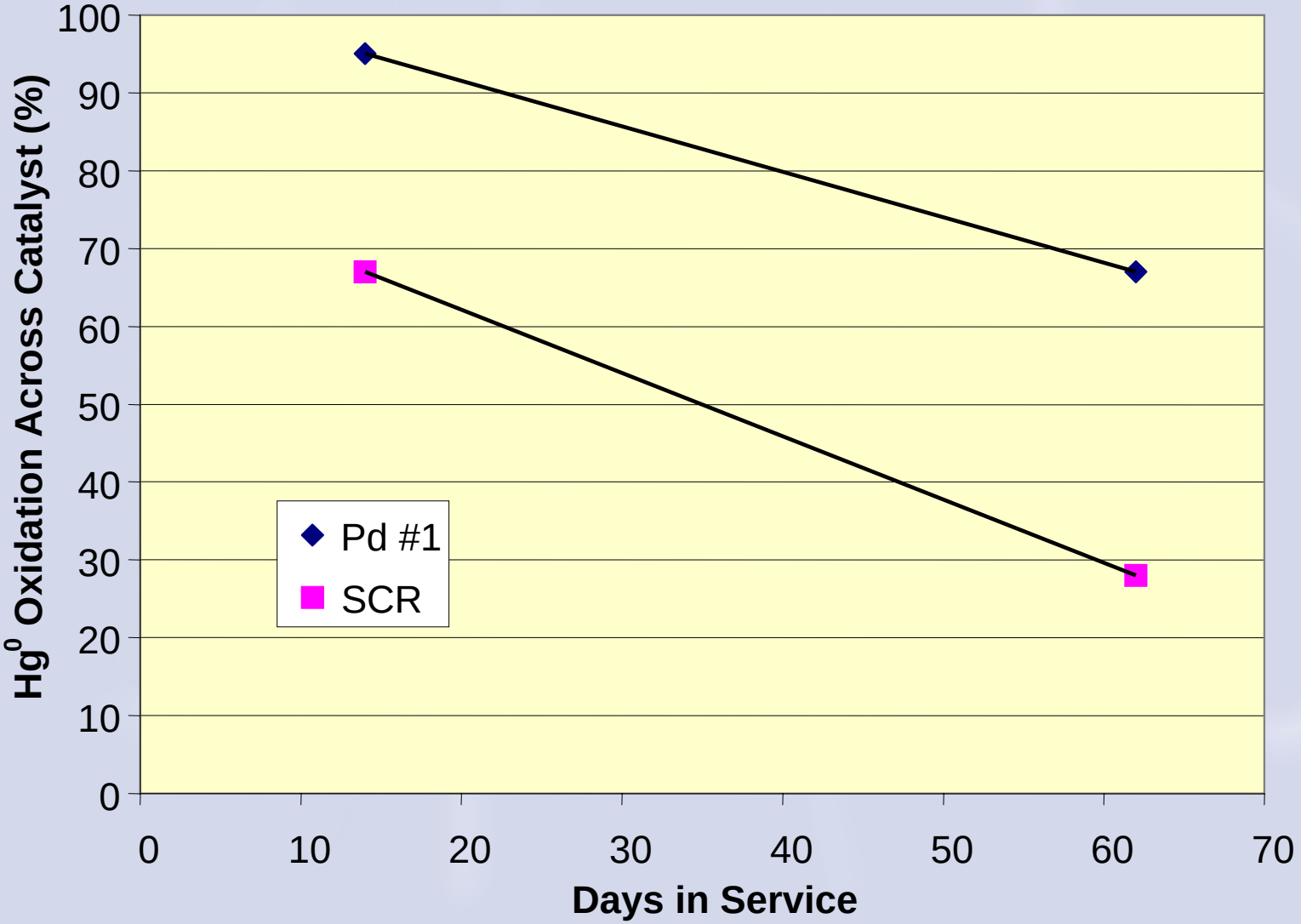
Comparison of Lab and Pilot Activity Results



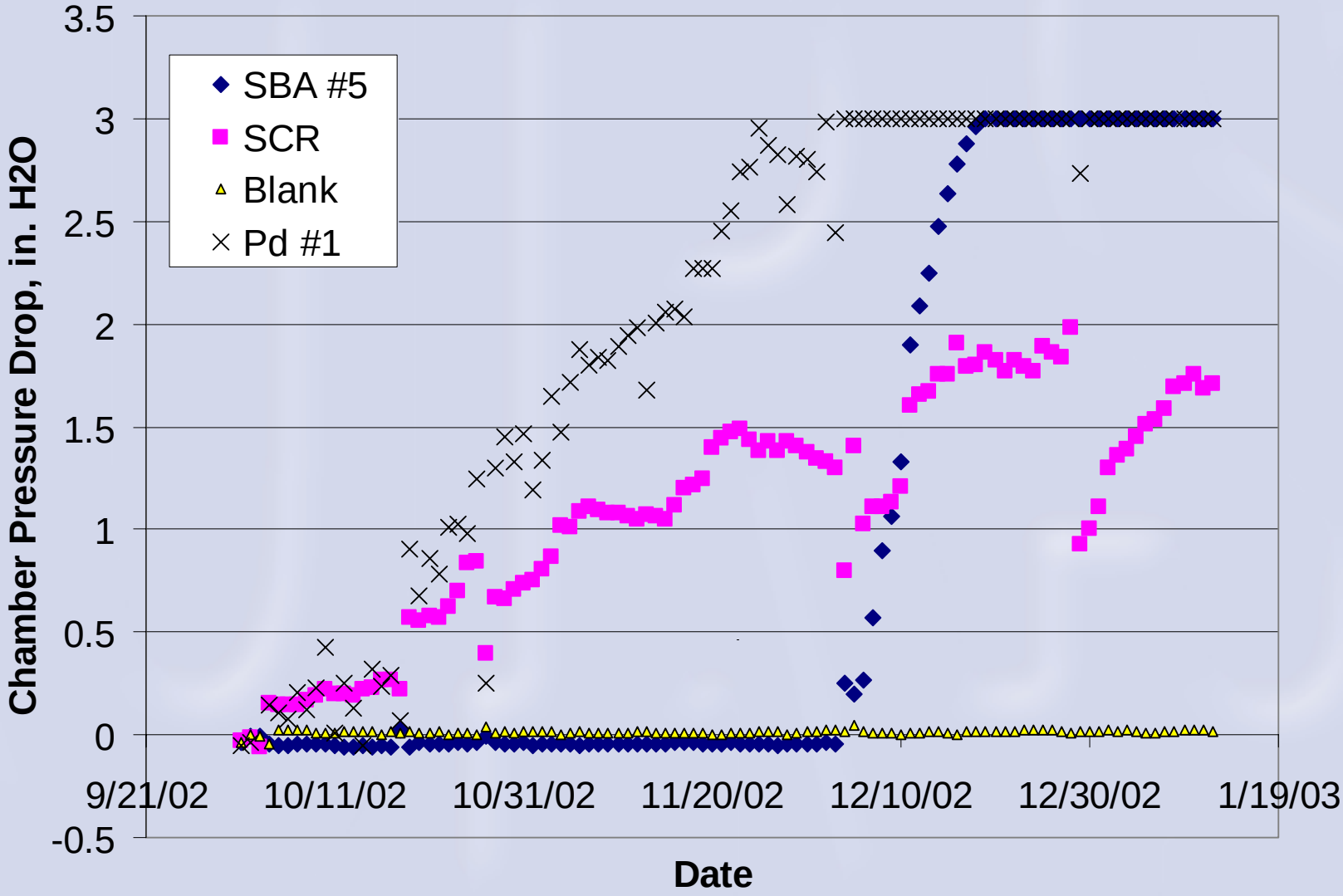
December Measurement Trip

- Installed SBA #5 catalyst
- Measured activity of Pd #1 and SCR catalysts after ~2 months
- Both catalysts showed activity loss
- Pressure drop across both catalysts had substantially increased
- Suspected fly ash buildup in horizontal catalysts

Catalyst Oxidation Activity vs. Time (1500 acfm)



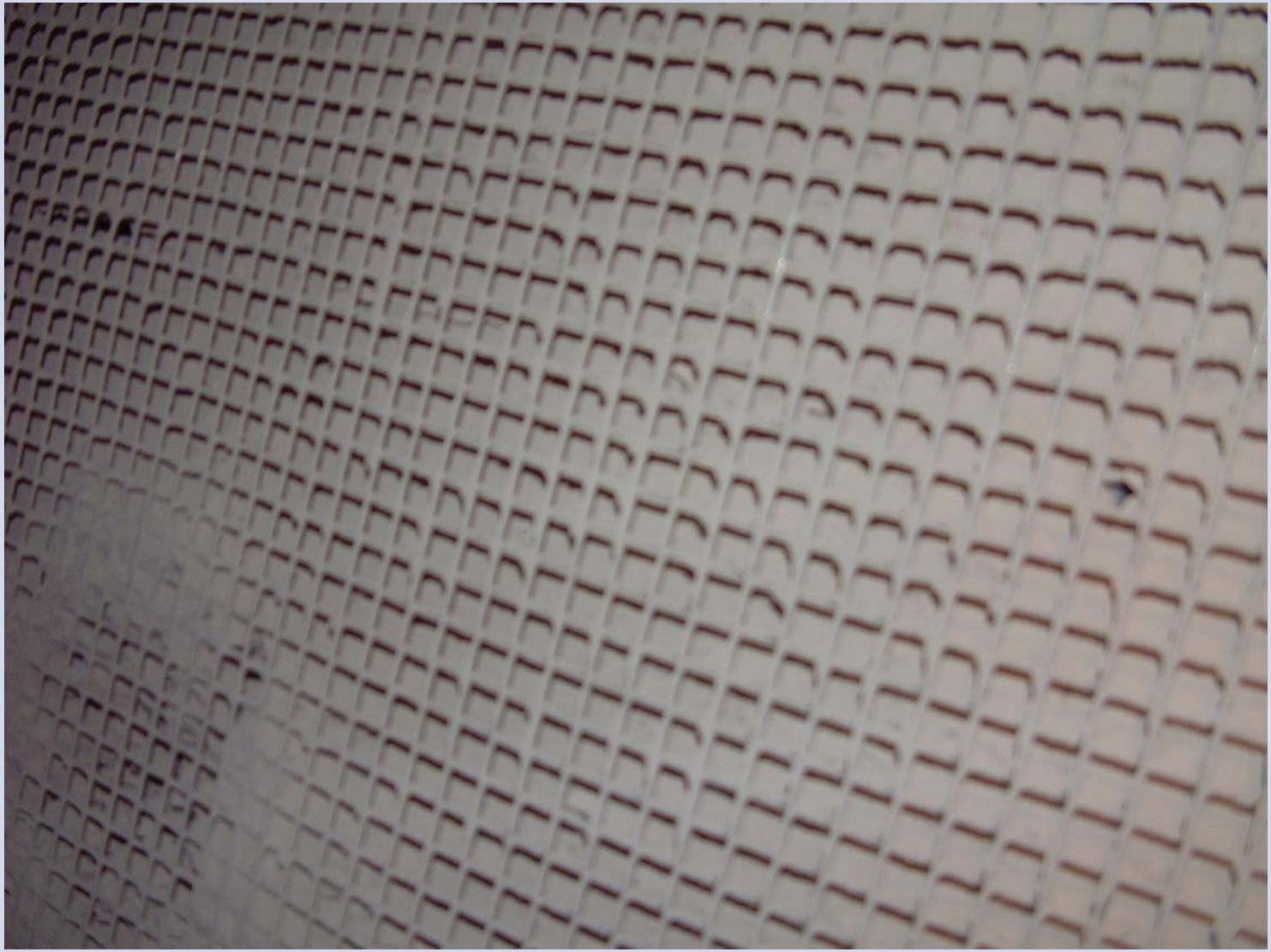
Catalyst Pressure Drop Data



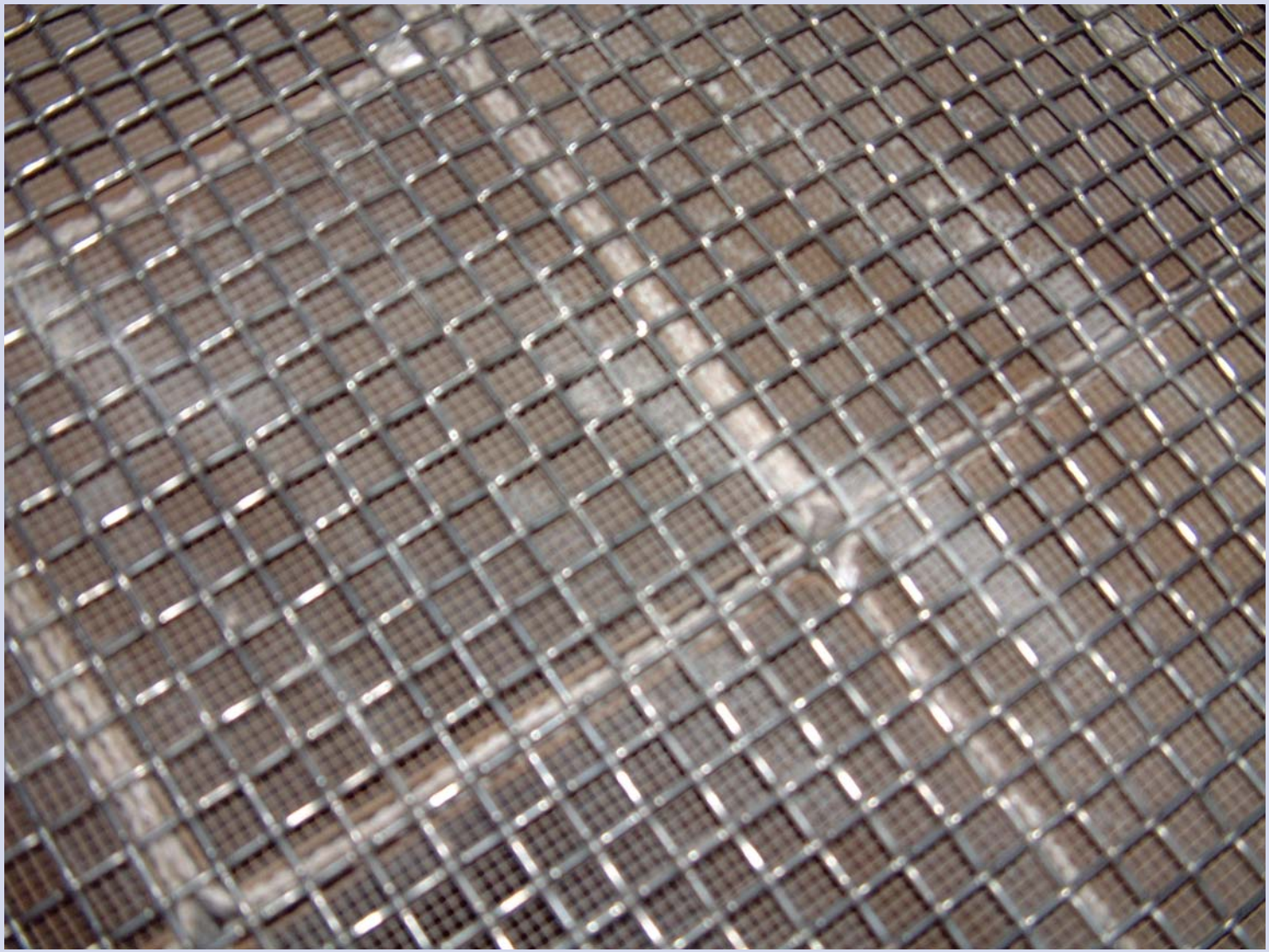
January Measurement Trip

- Measured performance to see if trend for loss of activity continued
  - Activity was slightly improved since December
  - Pressure drop data indicated continued ash buildup
- Opened catalyst boxes to confirm fly ash buildup
- Used plant air and vacuum to clean
- Re-measured performance

Surface of Pd #1 Catalyst Prior to Cleaning



Surface of Pd #1 Catalyst after Cleaning



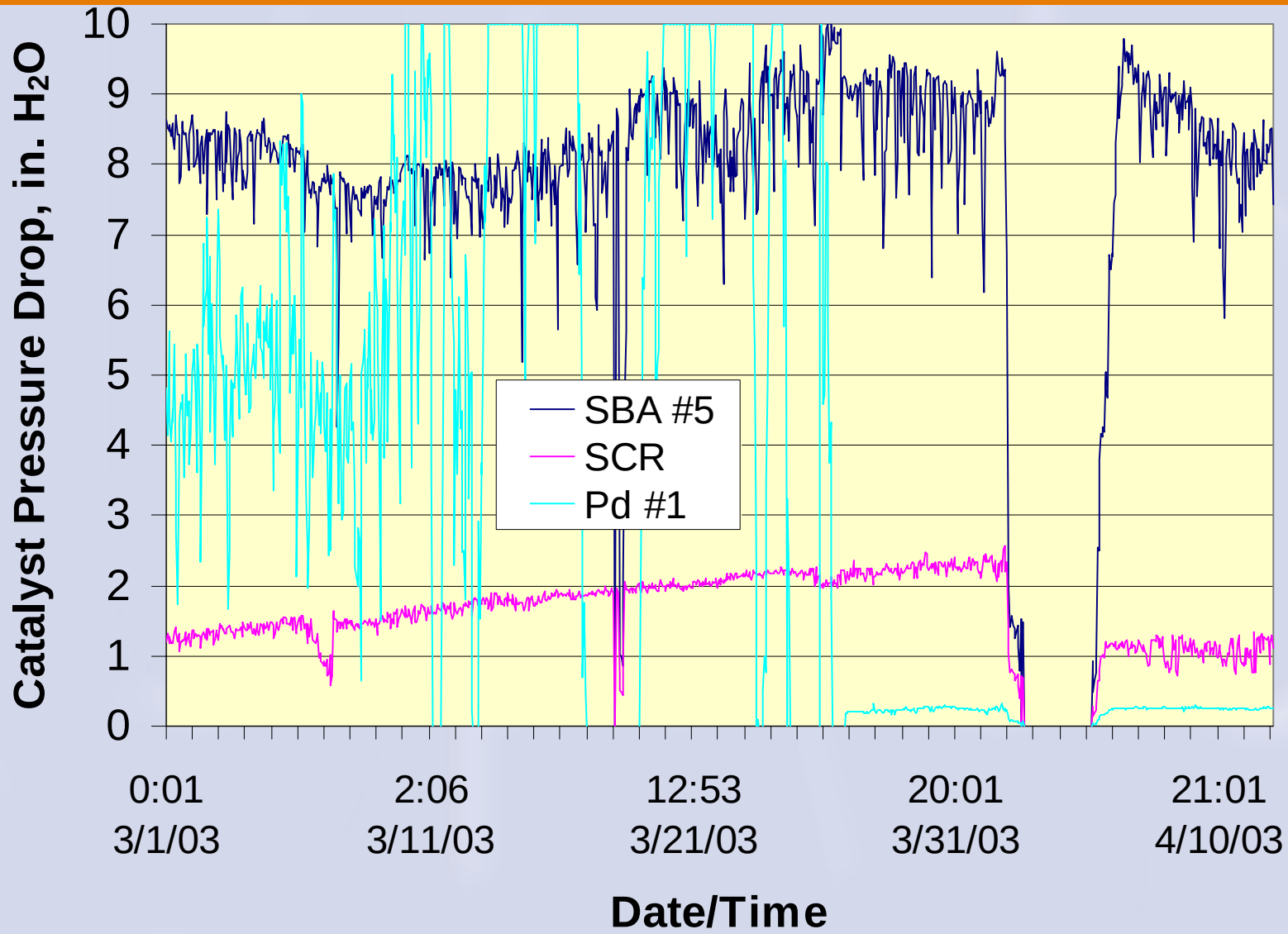
Catalyst Activity Results

	Hg^0 Oxidation across Catalyst (%)			
Catalyst (Flow Rate, acfm)	**October**	**December**	**January**	**January (after cleaning)**
Pd #1 (2000)	93	53	58	91
SCR (1500)	67	28	37	61
SBA #5 (2000)	na*	na*	59	75

Efforts to Resolve Ash Buildup

- Identified sonic horns as a likely mechanism to limit fly ash buildup
  - Commonly used to clean SCR catalysts
- Tested horn (Analytec 17”) on Pd #1 catalyst chamber
  - Installed perpendicular to chamber inlet transition
  - In service ~6 weeks to date
  - Appears to be effective, will install on other chambers

Catalyst Pressure Drop Data after Sonic Horn Installation



Catalyst Activity Results - Pd #1

Date	Hg^0 Oxidation Across Catalyst (%)
October 02	93
December 02	53
January 03	58
January 03 (after cleaning)	91
March 03 (after cleaning)	92
April 03 (with sonic horn)*	89

*Confounded by Hg adsorption

October Flue Gas Characterization Results - Hg

- Ontario Hydro measurements on pilot unit inlet/outlets, full-scale wet FGD
  - Confirms catalyst oxidation results measured with EPRI semi-continuous Hg analyzer
  - Confirmed low oxidation percentage in ESP outlet flue gas (inlet to pilot)
  - Showed high removal of oxidized Hg, little or no Hg^0 re-emissions across FGD absorbers

Flue Gas Characterization Results - Other Species

- Controlled Condensation results showed no oxidation of SO_2 across either catalyst
  - Catalyst inlet and outlet SO_3 ~0.1 ppmv
- Draeger tubes showed little or no oxidation of NO across either catalyst
  - Inlet and outlet NO, total NO_X values agree within 10 ppm (precision level of technique)
- M26a showed no change in HCl (~1 ppm) or HF (~6 ppm) across catalysts

Current Schedule

- Next Coal Creek measurement trip late May
  - Install sonic horn on other 3 catalyst chambers
  - Evaluate activity of Pd #1,SCR, SBA #5
  - Clean out chambers with the horn being installed
  - Install 4th catalyst (C #6)
- Second (EPRI) pilot unit currently at Spruce plant
  - Being installed at ID fan outlet early June
  - Expect startup summer 03 with Pd, SCR and/or other short lead time catalysts)

Summary

- Pilot tests results verify previous sand-bed results for the ability to catalytically oxidize Hg^0 in flue gases
  - Honeycomb catalysts have achieved 70 to 90% oxidation of Hg^0 in ND lignite flue gas
- On-line cleaning (sonic horns) is needed to prevent fly ash buildup in horizontal gas flow catalysts
- Continued testing will establish catalyst life