Mitigation of the Impact of Platinum Contamination on Cu-Zeolite SCR Catalyst Performance

Xu (Stan) Chen

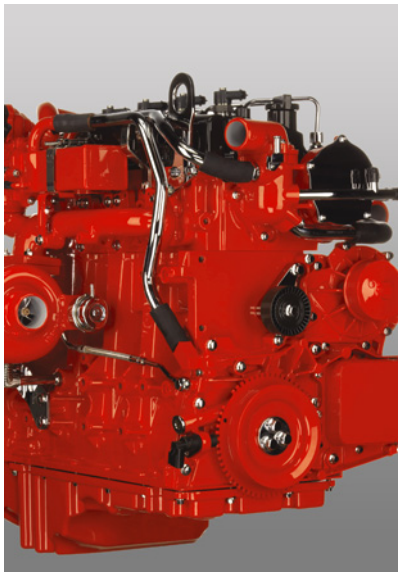
Krishna Kamasamudram
Neal Currier
Aleksey Yezerets

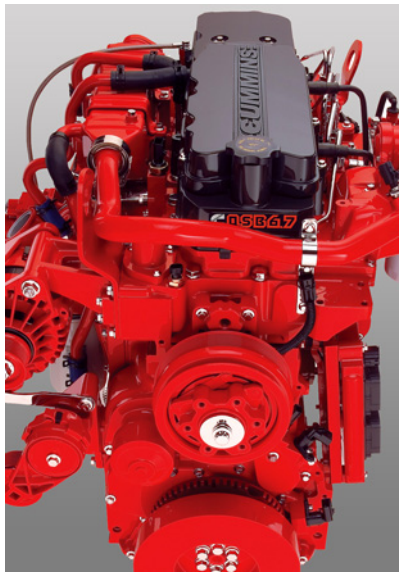
Cummins Corporate Research &Technology

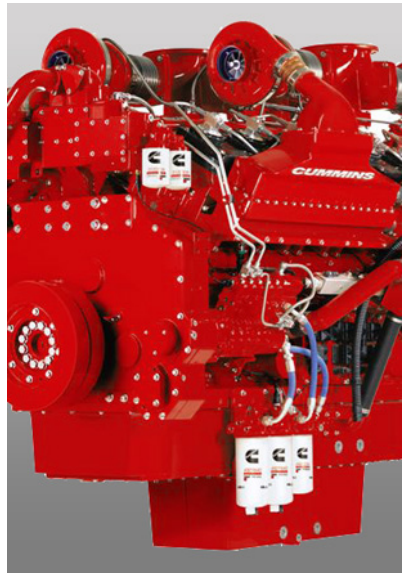
U.S. DEPARTMENT OF ENERGY

DEER 2012 DEARBORN

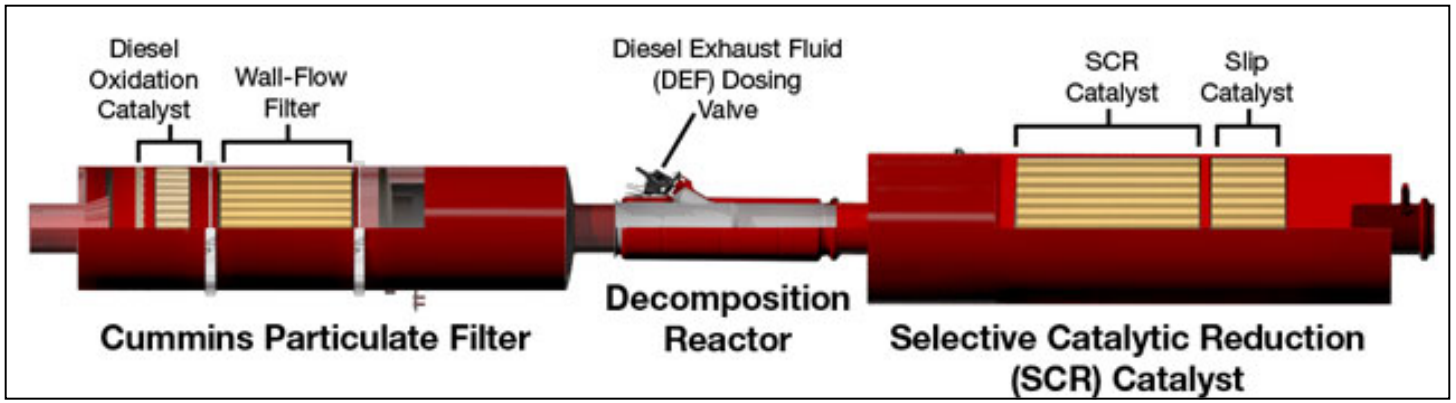
DIRECTIONS IN ENGINE-EFFICIENCY AND EMISSIONS RESEARCH CONFERENCE

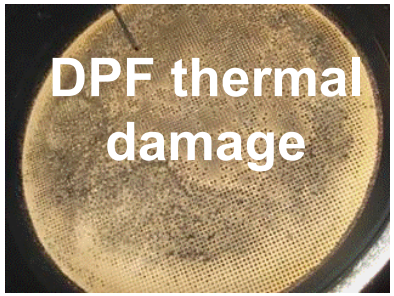






Primary pathway of Pt migration onto SCR catalyst





PtO_x

- High temperature event can cause the migration of Pt species from upstream DOC/DPF
- Pt species can get deposited onto SCR catalyst causing performance degradation

Jen, H.W. et al. SAE Paper No. 2008-01-2488.
Cavataio, G. et al., SAE Paper No. 2009-01-0627

Objective

- Evaluate the axial distribution of Pt on field returned Cu-Zeolite SCR catalysts
- Develop a method to mitigate the impact of Pt contamination on Cu-Zeolite SCR catalyst performance

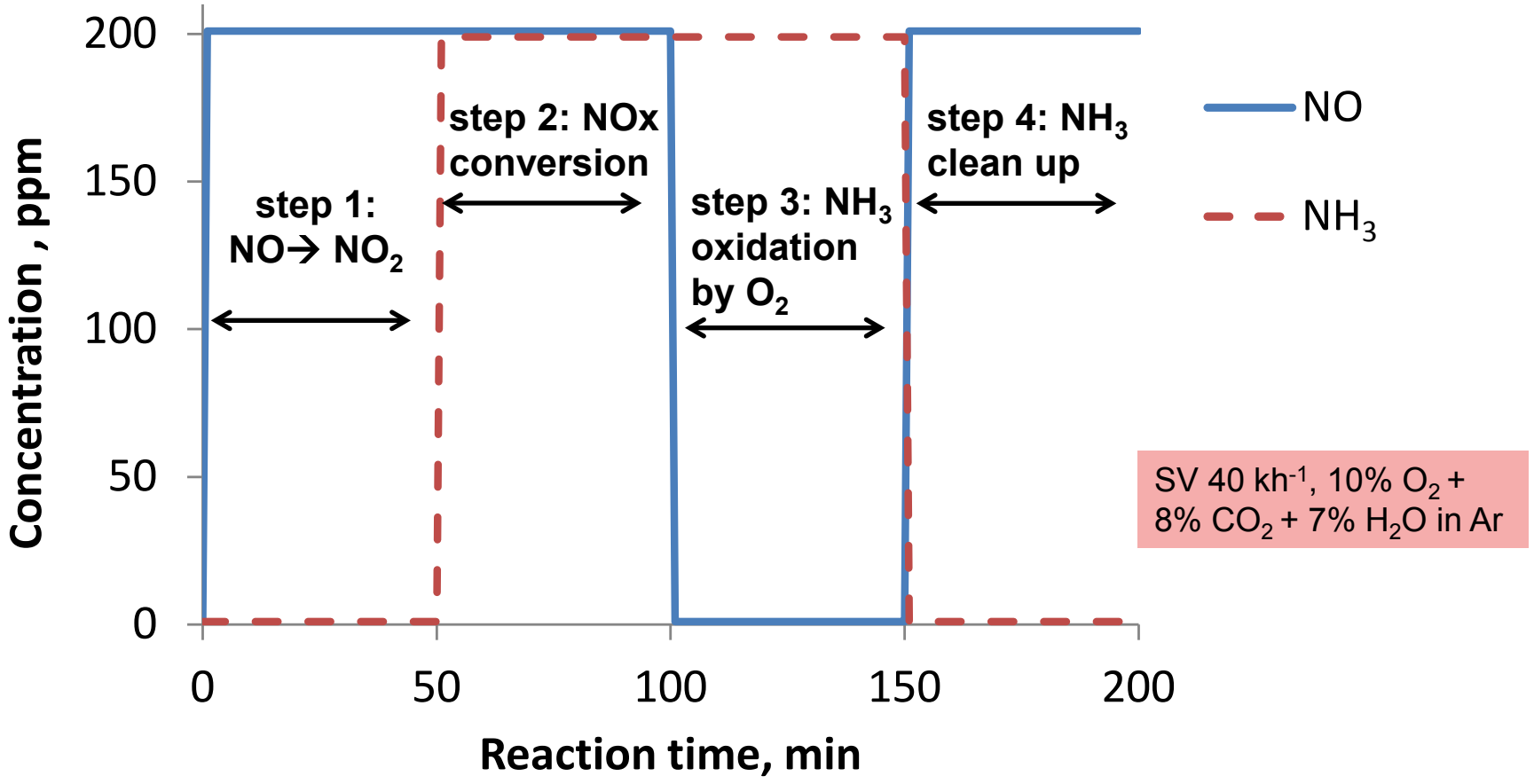
Approach

- Cu-zeolite SCR catalyst samples were collected from aftertreatment systems having DPF melting events
- Uncontaminated reference (aged at 700C 4hrs)

Experimental

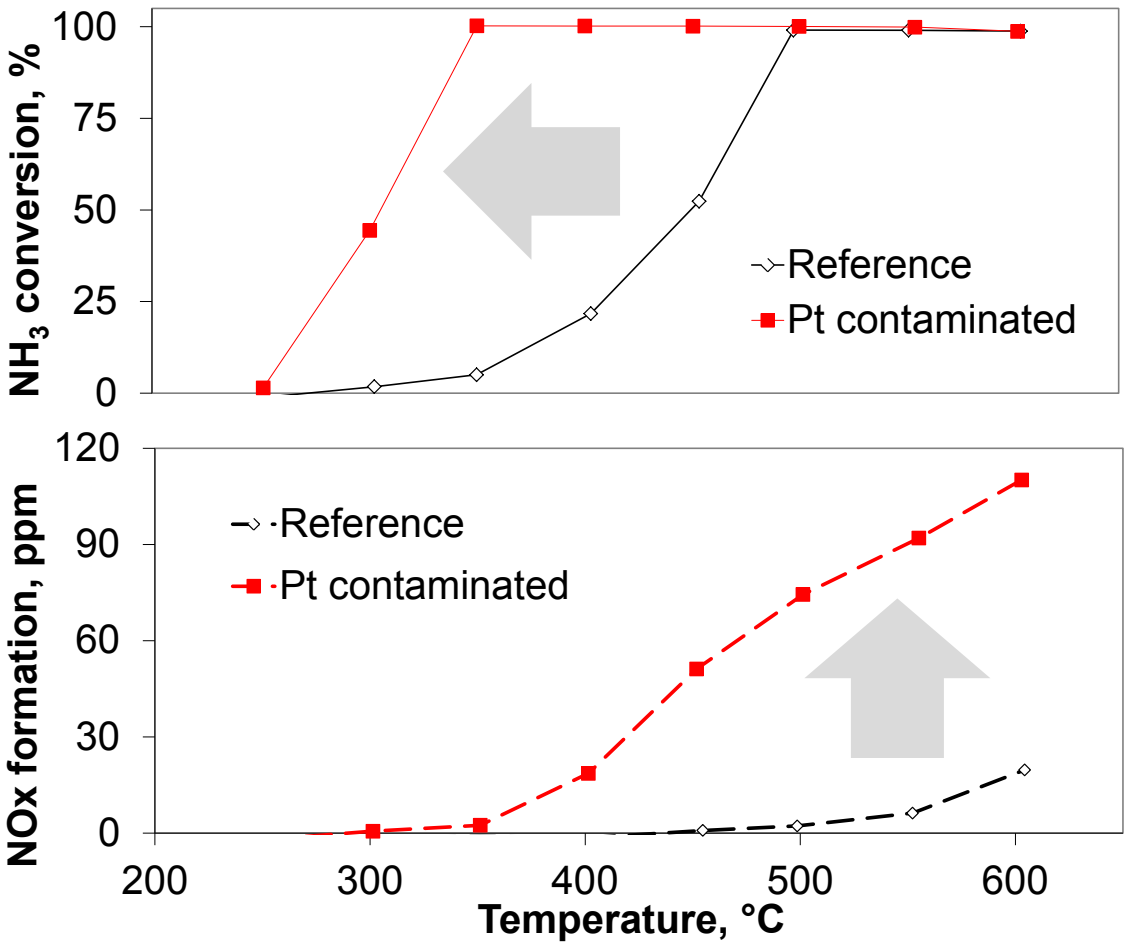
- Key SCR functions were evaluated by 4 step protocol
- Pt levels on SCR samples were analyzed by ICP-MS

4-step protocol to probe key SCR functions of catalyst samples



Kamasamudram et al. Catalysis Today, Vol 151, Issue 3–4, Page 201-414, 2010

Impact of Pt contamination on NH_3 oxidation

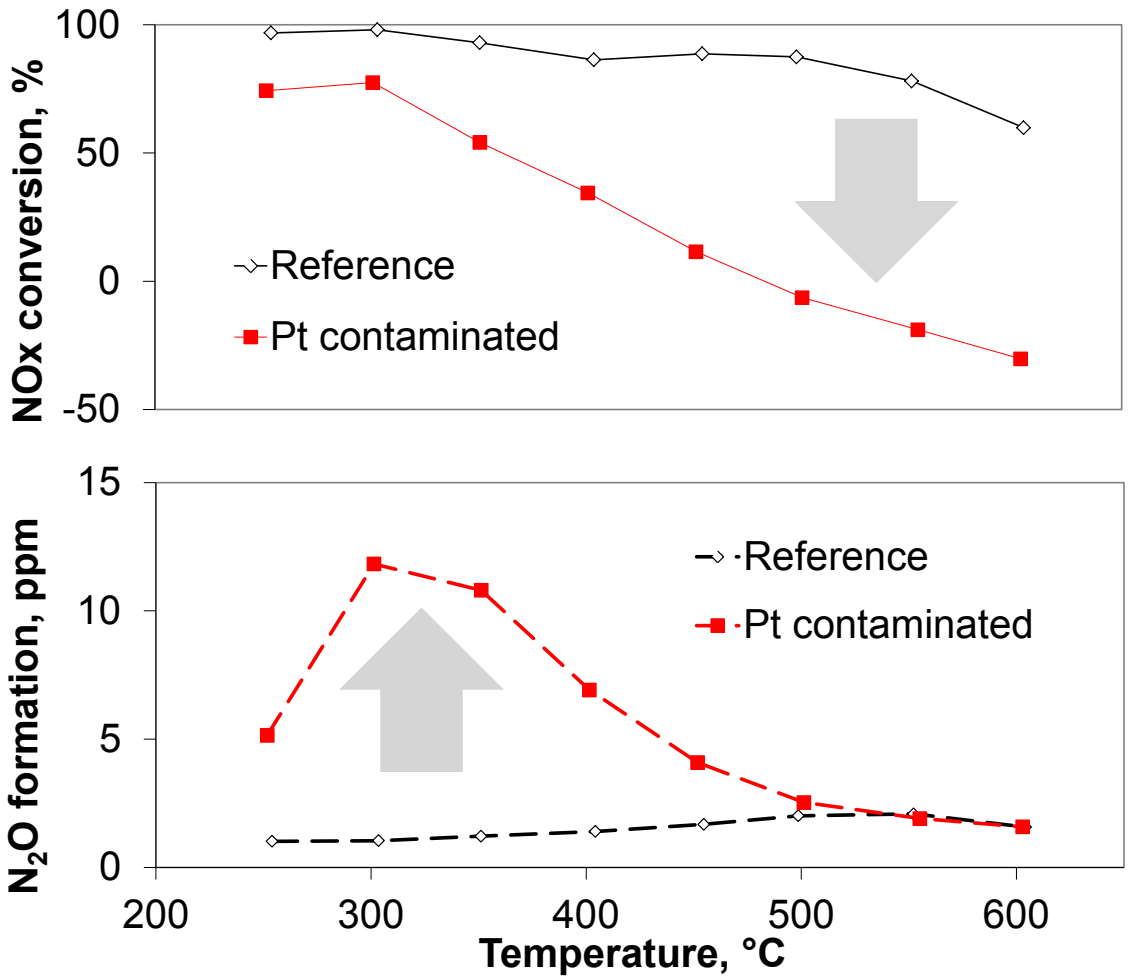


Pt contamination

- Substantially increases NH_3 oxidation activity and selectivity to NOx (T > 300 °C), comparing to the reference sample

Step 3, NH_3 oxidation: SV 40 kh^{-1}, 200 ppm NH_3

Impact of Pt contamination on NOx conversion

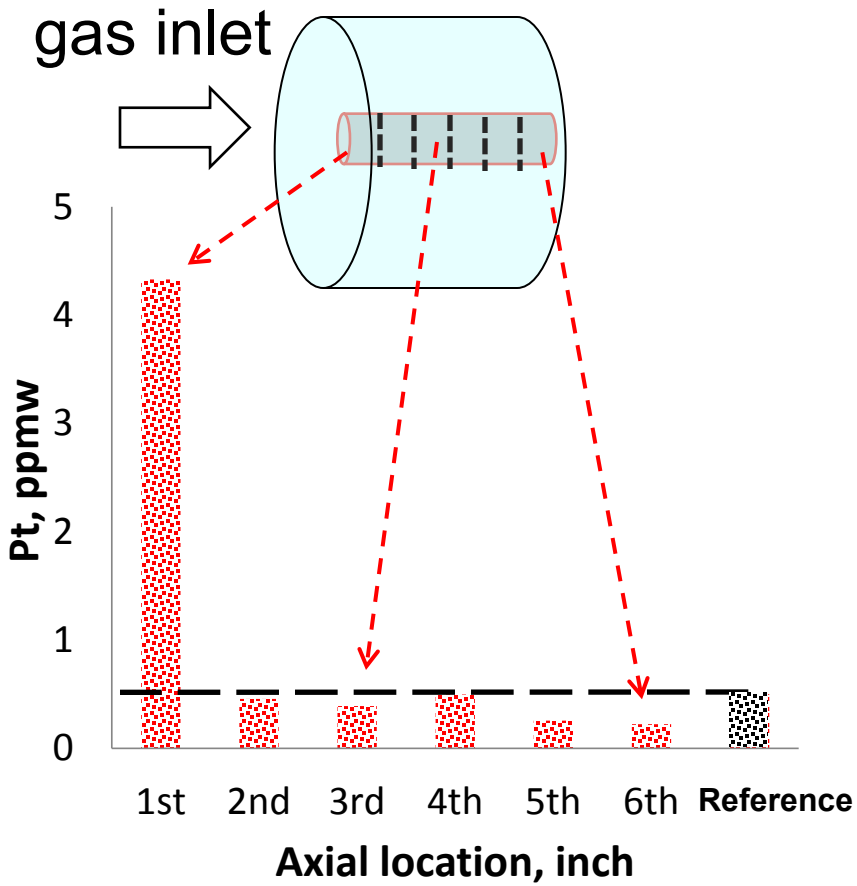


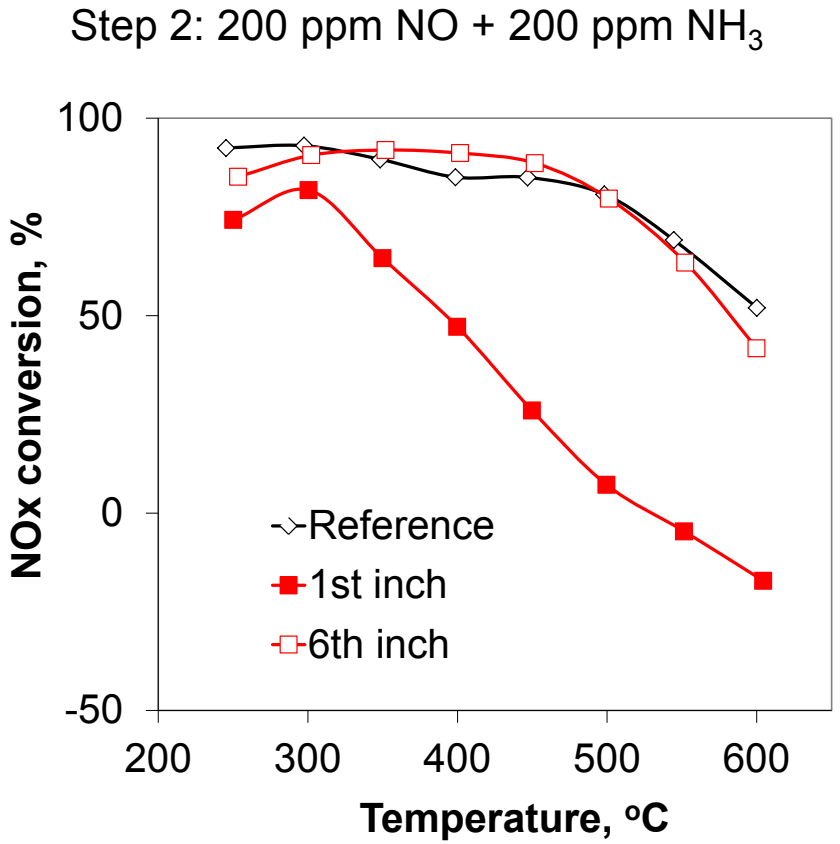
Pt contamination

- Substantially decreases NOx conversion but increases N_2O formation, comparing to the reference sample

Step 2, SCR: SV 40 kh^{-1}, 200ppm NO + 200 ppm NH_3,

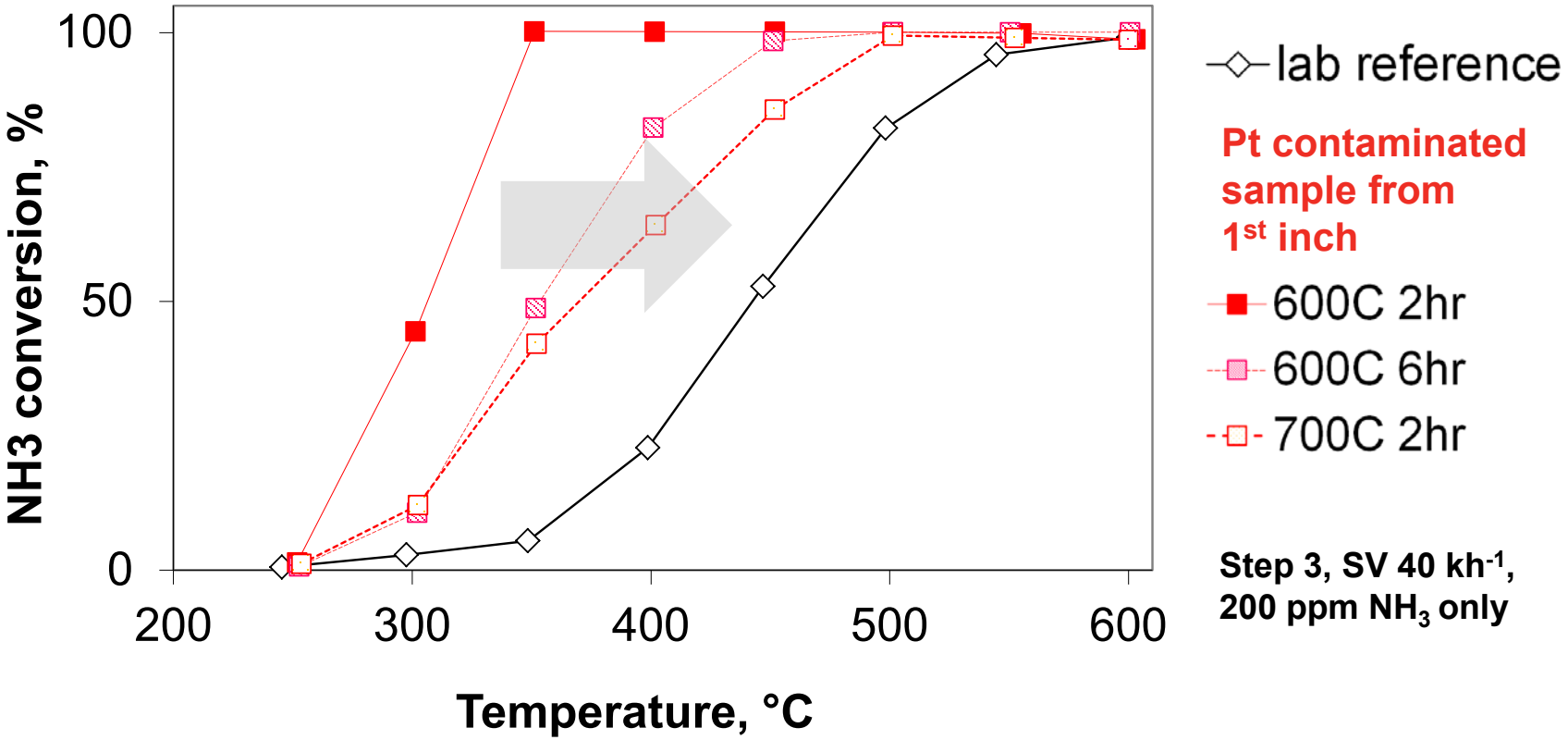
Axial distribution of Pt on a contaminated SCR brick





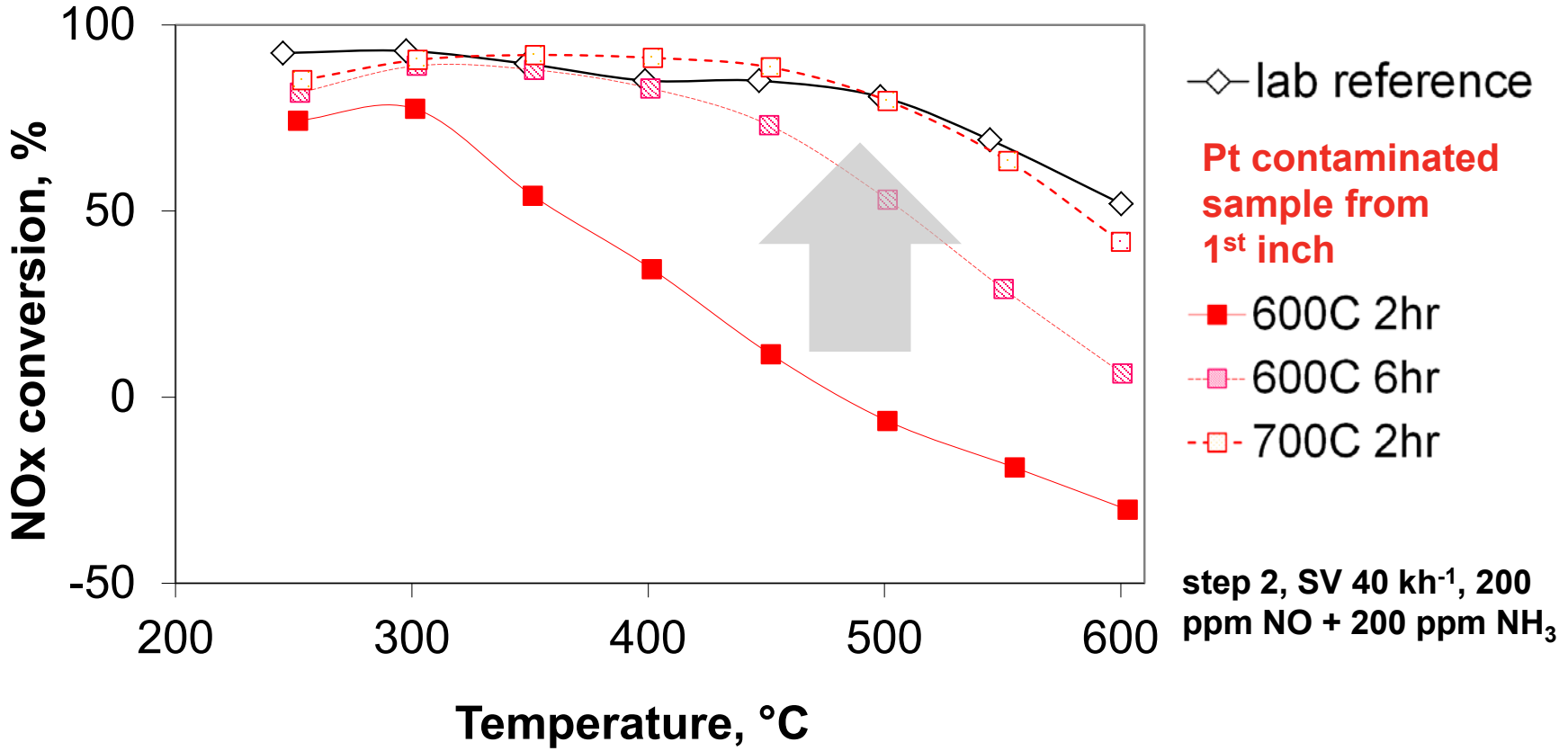
- Substantially higher Pt level at SCR inlet side
  - Pt concentration beyond the first inch of axial length is at the reference level

Impact of progressive heat treatment on NH_3 oxidation



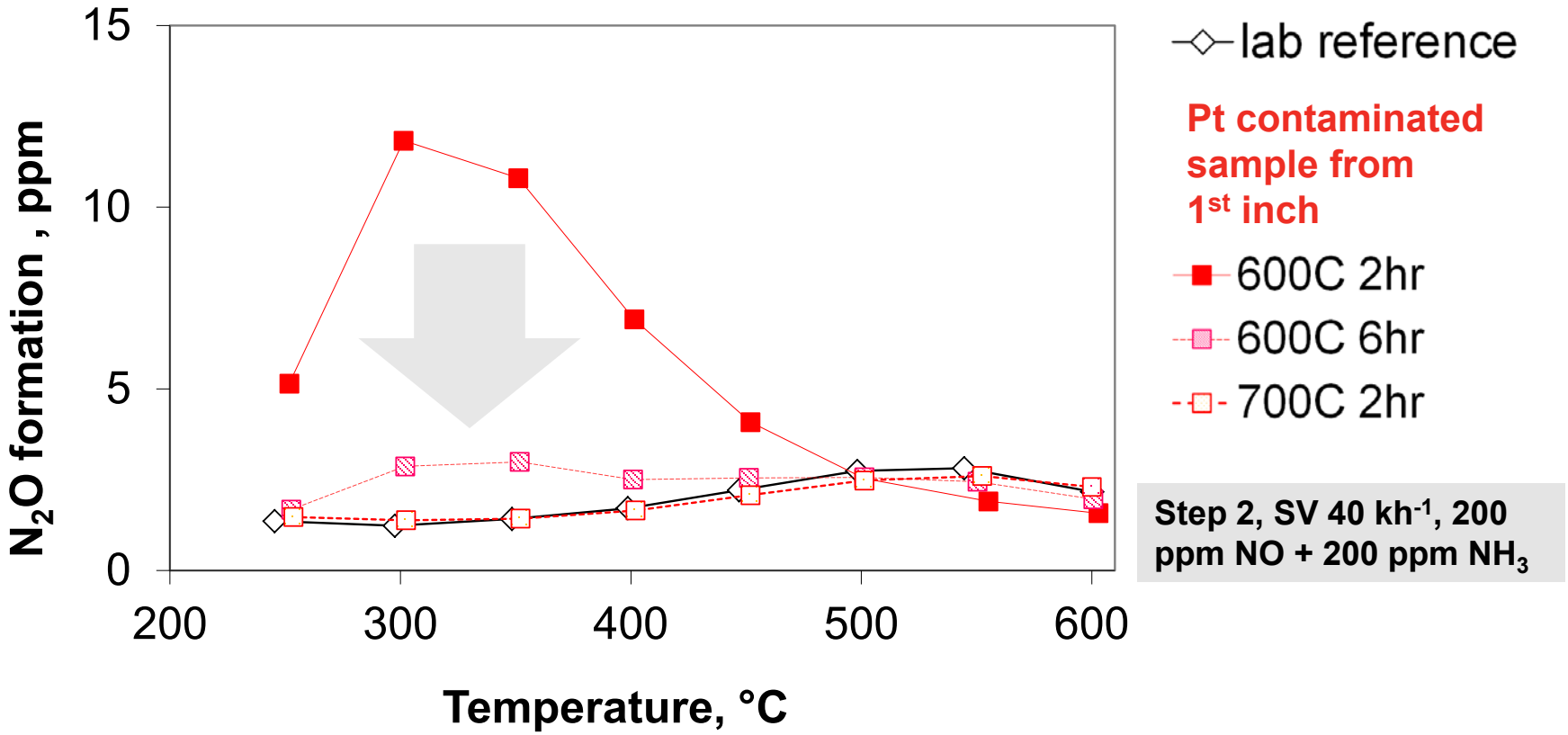
- NH_3 oxidation function was suppressed by progressive high temperature exposure
  - Post 700C 2hr treatment sample still shows a higher NH_3 oxidation activity comparing to the lab reference

Impact of progressive heat treatment on NOx conversion



- The lost NOx conversion at high temperature can be largely recovered after being treated at 700C for 2hr
  - Progressive high temperature exposure has been confirmed as an effective method to recover the lost SCR performance

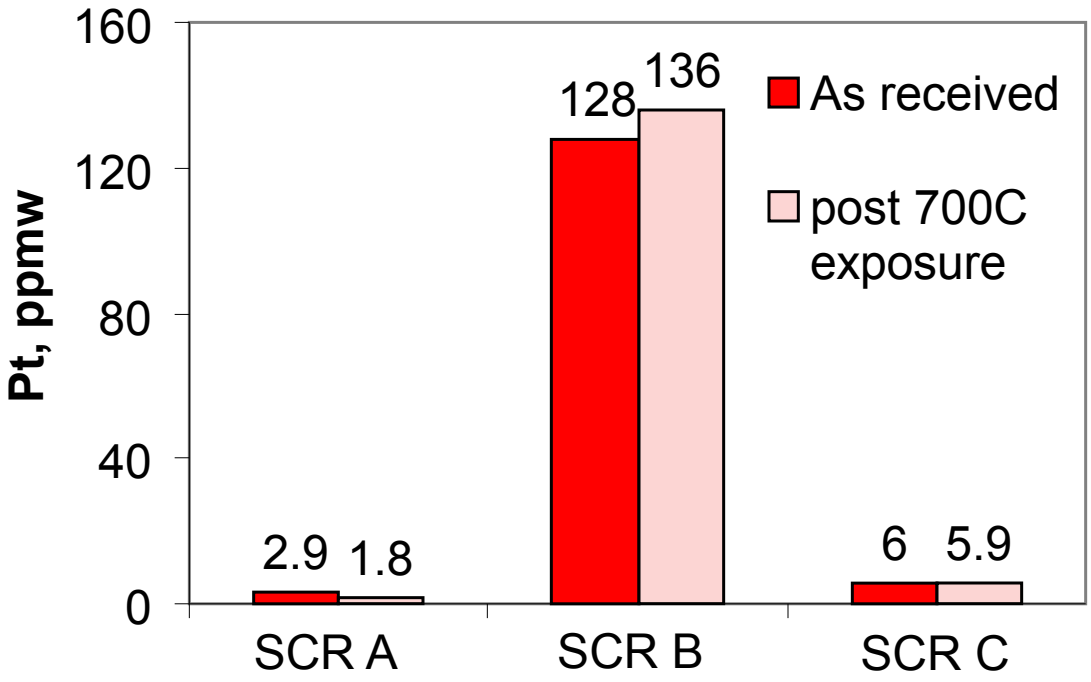
Impact of progressive heat treatment on N_2O formation in SCR condition

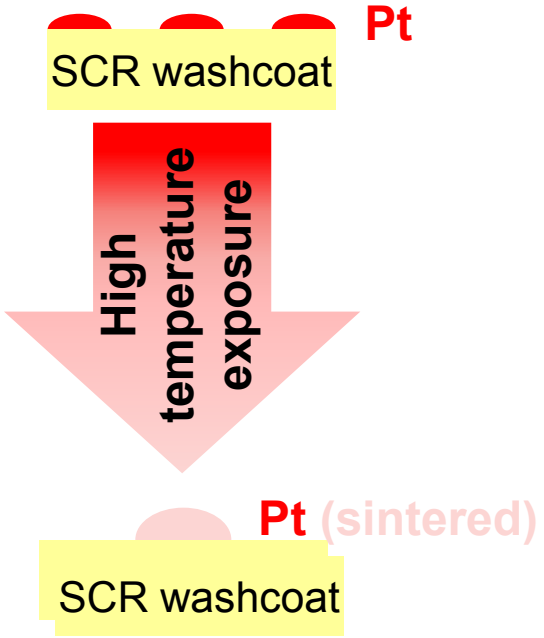


- N_2O formation in SCR conditions was suppressed substantially after high temperature exposure

Mechanism of Pt contamination mitigation: sintering effect

Samples from the inlet face of 3 field returned SCR bricks having DPF melting events





- High temperature treatment did not change Pt level on catalyst but suppressed NH_3 oxidation activity
- Above observations indicate, high temperature treatment caused Pt sintering rather than migration

Summary

- Pt contamination on Cu-Z SCR catalyst may
  - Decrease NOx conversion performance due to NH_3 oxidation
  - Increase N_2O formation in SCR condition
- Pt contamination largely occurred on SCR inlet face
- Impact of Pt contamination on Cu-Z SCR performance can be suppressed by heat treatment above 600 ^oC
  - High temperature treatment caused Pt sintering rather than its migration
  - The effectiveness of heat treatment method is ensured by the outstanding thermal stability of the state of the art Cu-Z SCR catalyst

Acknowledgement

- Jason L Ferguson, CMI, for experimental support
- Tamas Szailer, CMI, for useful discussions