2013 CLEERS Workshop Panel Discussion on Low Temperature Aftertreatment

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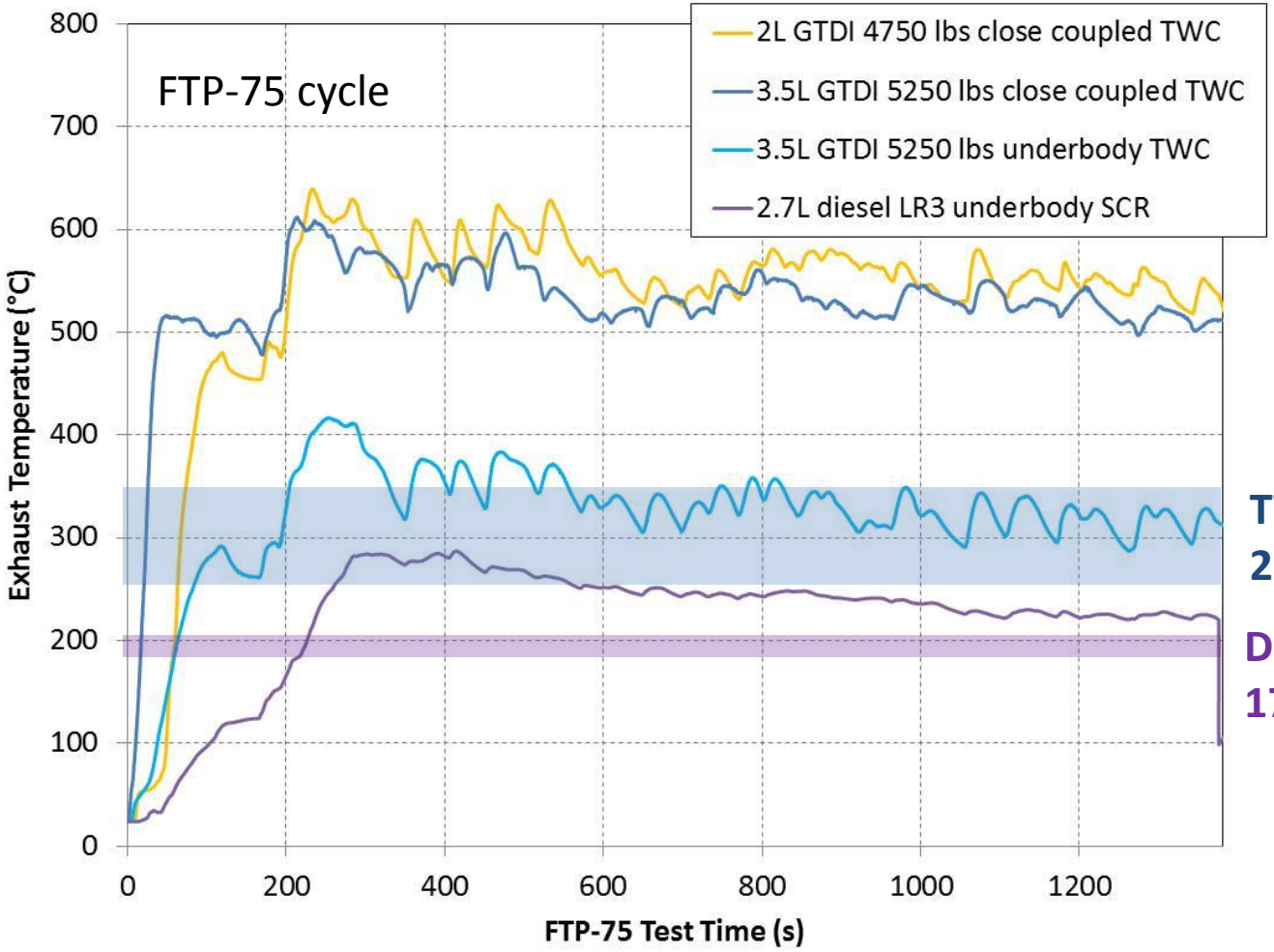
Light Duty Exhaust Gas Temperatures

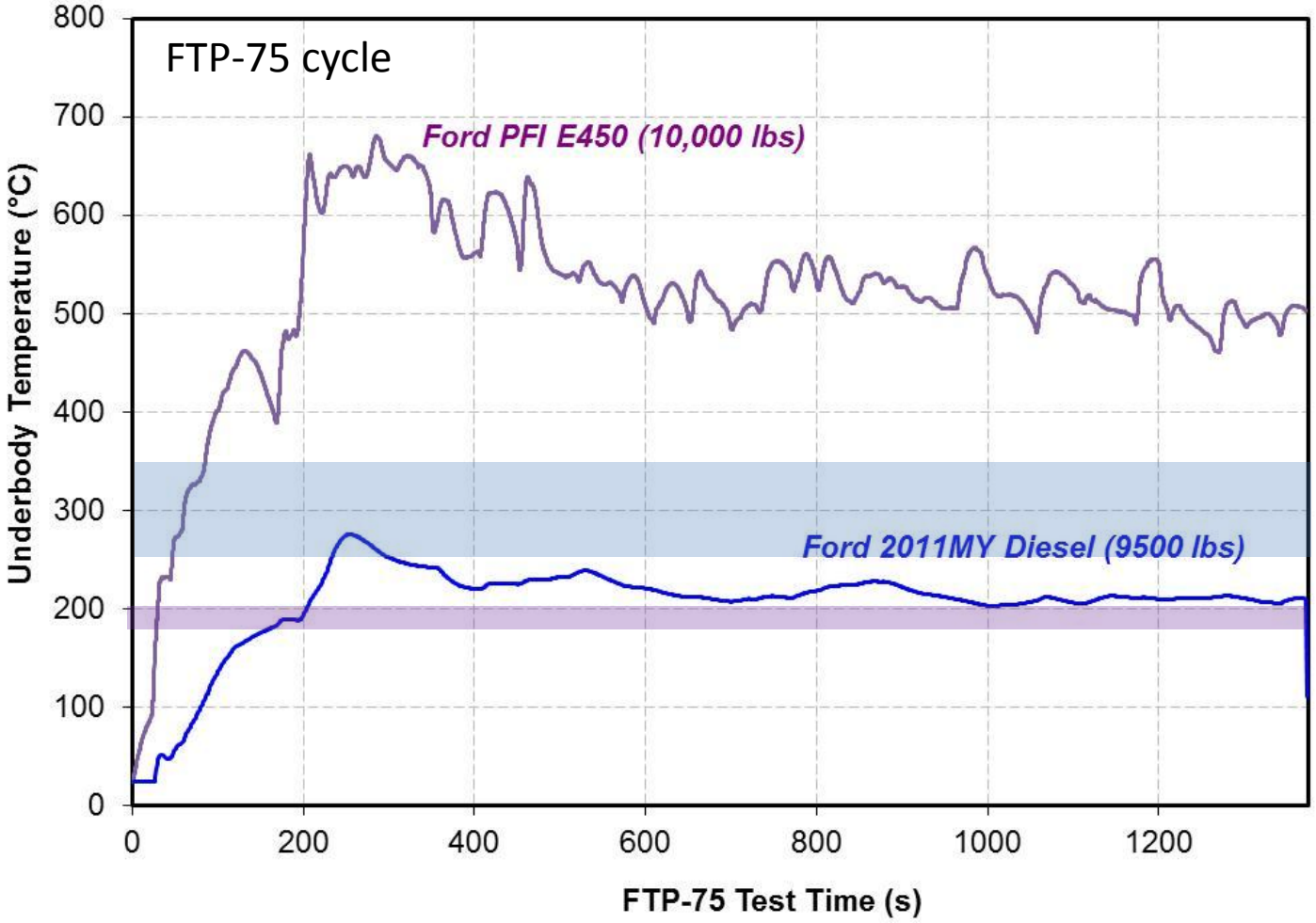


TWC LO
250-350°C

DOC/SCR LO
175-200°C

Courtesy of Carolyn Hubbard, James Pakko, and Kevin Guo

Medium Duty Exhaust Gas Temperatures



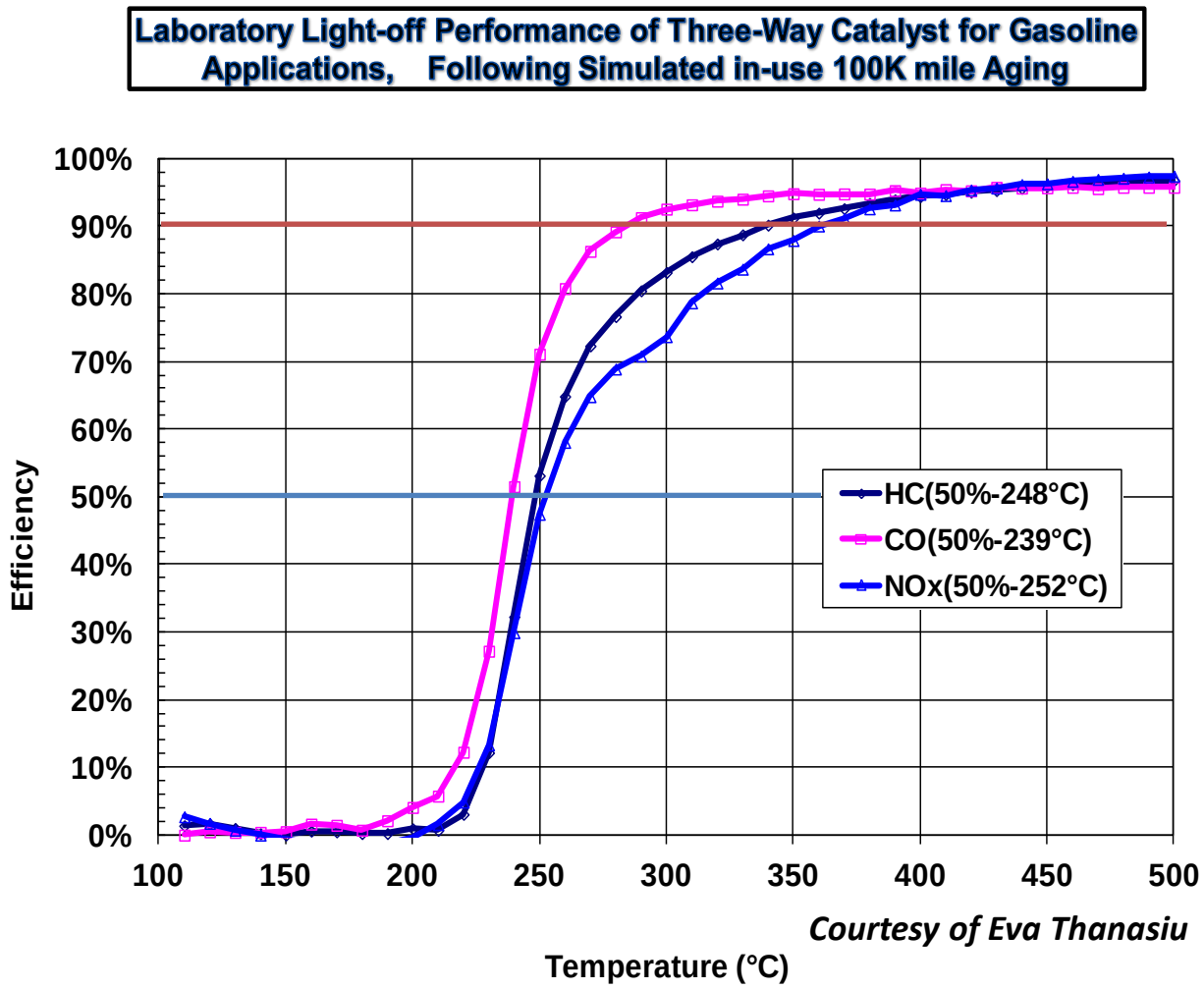
TWC LO 250-350°C

DOC/SCR LO 175-200°C

Courtesy of Carolyn Hubbard and Kevin Guo

Aged TWC Performance

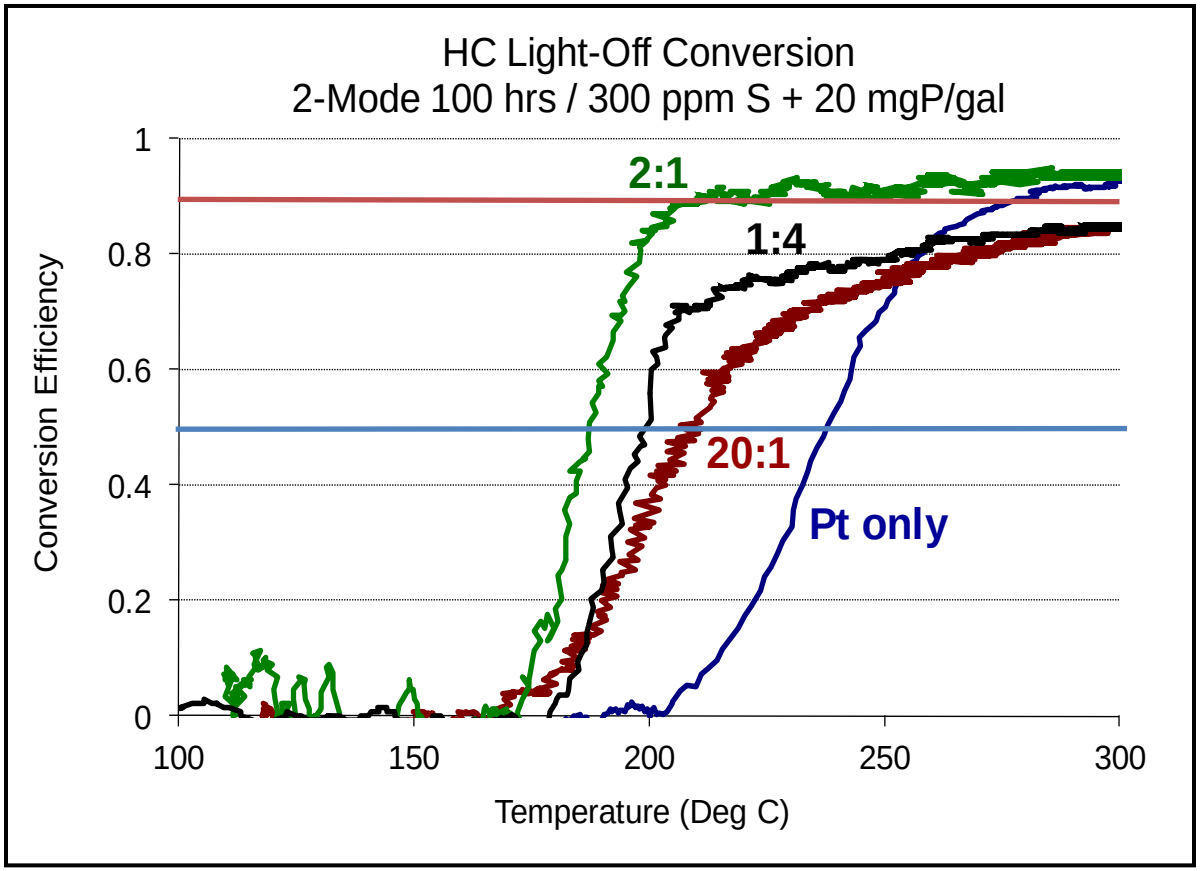
T_{50} = 250°C, T_{90} = 300-350°C



- Current Pd/Rh stoichiometric TWC catalysts lightoff at 250 to 350°C
- Poisoning will shift lightoff to even higher temperatures

Aged DOC Performance

T_{50} = 175°C; T_{90} = 200°C

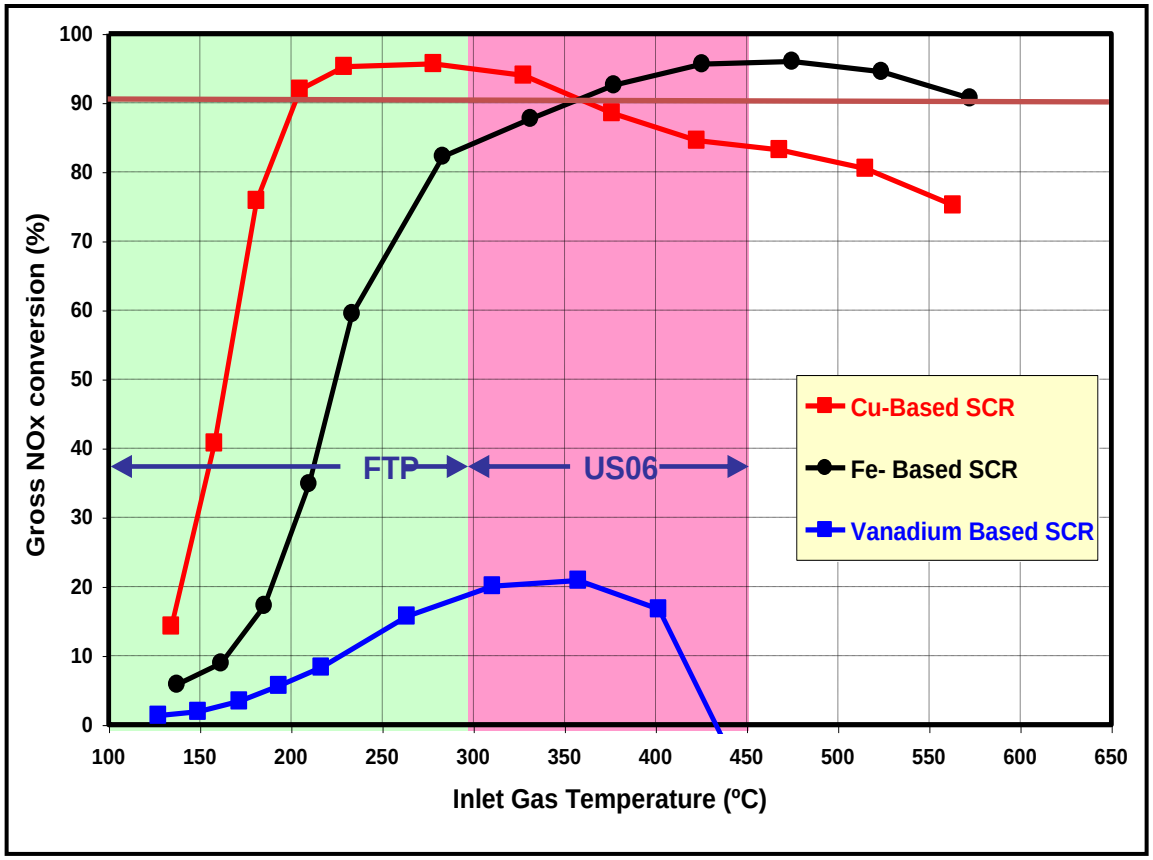


Courtesy of Douglas Dobson

- Pt only DOCs suffer from poor hydrothermal stability
- Addition of Pd stabilizes HC lightoff, esp. at 2:1 Pt:Pd ratio
- Further addition of Pd (1:4) resulted in higher, but still good enough, lightoff for MDD

Aged SCR Performance

T_{90} of Cu/Z = 200°C



Courtesy of Giovanni Cavataio

- After 670°C aging for 64h, V/TiO2 catalysts are not durable
- Fe/zeolite is good for high temperatures > 350°C
- Cu/zeolite is preferred for lower temps
- Reductant choice also determines ability to convert NOx at low temp

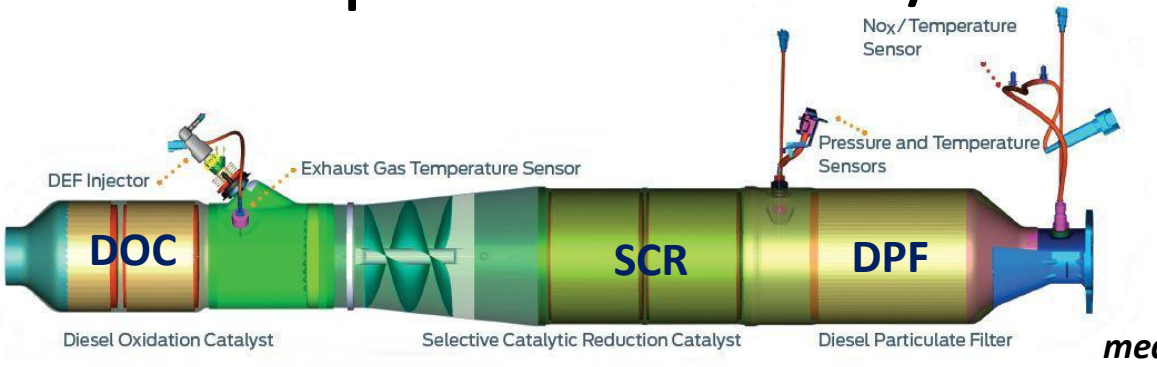
Current Strategies for Low Exhaust Temperature Aftertreatment

- Locate catalyst close to engine
- Fast lightoff fueling procedures
- Heat maintenance fueling strategies
- Dual wall manifold/piping & insulation

Potential Future Strategies for Low Exhaust Temperature Aftertreatment

- What is probably not going to work:
  - More active heating with fuel
  - More precious metal loading
- What might work:
  - Manifold/pre-turbo catalysts
  - Lower overall thermal mass
  - New catalyst materials with lower lightoff
  - Passive adsorption during cold-start (HC, NO)
  - Lower thermal durability requirements

Example of Potential Light-off with Lower Thermal Requirements: Cu/CHA SCR



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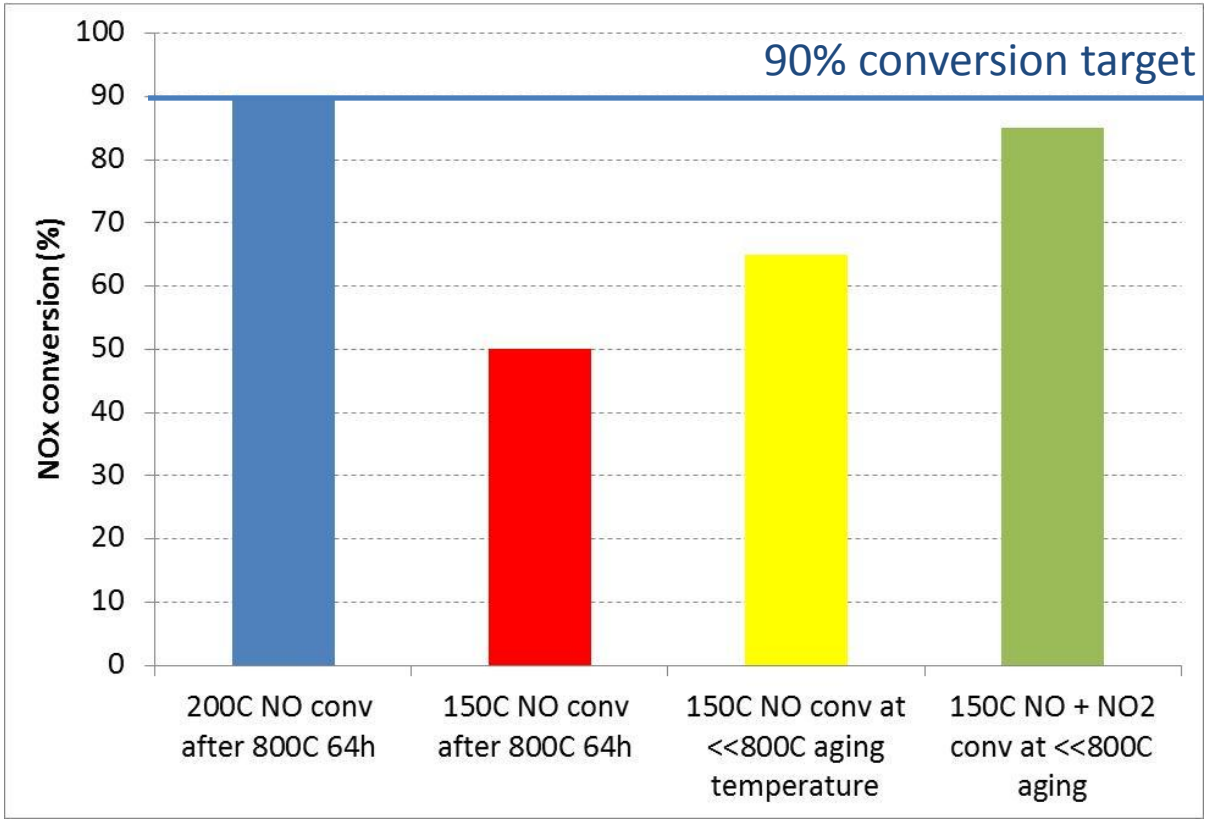
- Actively regenerating filter, DOC exotherm through SCR
- SCR aging predominantly per k=Ae(-E/RT)
- LEV III 150k mi durability ~ 800°C for 80 h
- E/R ~ 32000 K for 200°C NOx conv
- Aging T < 800°C would greatly extend catalyst lifetime
- Some operation > 600°C is needed to remove poisons like S

T deg C	time (h)
920	4
808	64
800	**80**
700	1700
650	10000
600	74000

derived from SAE 2009-01-1282

Cu/CHA SCR Example Approaching 90% NOx Conversion at 150°C



- Higher activity greatly depends on system design/operation

derived from SAE 2009-01-1282