NH$_3$-Selective Catalytic Reduction over Ag/Al$_2$O$_3$ Catalysts

Stefanie Tamm$^a$, Sebastian Fogel$^b$, Magnus Skoglundh$^a$, Pär Gabrielsson$^b$ and Louise Olsson$^a$

$^a$Competence Center for Catalysis, Chalmers University of Technology
$^b$Haldor Topsøe A/S
HC-SCR over Ag/Al₂O₃

- H₂ lowers the temperature, where Ag/Al₂O₃ is active for HC-SCR
- Ag/Al₂O₃ is not active for H₂-SCR
- H₂ is a co-reductant

- Conditions: 500 ppm NO, 375 ppm C₈H₁₈, 1 vol% H₂, 6 vol% O₂, 10 vol% CO₂, 350 ppm CO, 12 vol% H₂O in He.
**NH₃-SCR over Ag/Al₂O₃**

- High activity at low temperature
- H₂ is needed for NH₃-SCR

Concitions: 1000 ppm NO, 1000 ppm NH₃, 1 vol% H₂, 6 vol% O₂, 7 vol% H₂O. GHSV = 30000 h⁻¹

H\textsubscript{2}-assisted NH\textsubscript{3}-SCR - own results

- 6 wt% Ag on Al\textsubscript{2}O\textsubscript{3}
- Presulfated monolith catalyst
- 250 ppm NO
- 250 ppm NH\textsubscript{3}
- 750 ppm H\textsubscript{2}
- 10% O\textsubscript{2}
- 5% H\textsubscript{2}O
- in Ar
- GHSV = 33 100 h\textsuperscript{-1}

• The hydrogen concentration is divided by 3.
• NO\textsubscript{x} conversion decreases with increasing NO concentration.

- 125 – 375 ppm NO
- 250 ppm NH\textsubscript{3}
- 750 ppm H\textsubscript{2}
- 10% O\textsubscript{2}
- 5% H\textsubscript{2}O
- in Ar
- GHSV =33 100 h\textsuperscript{-1}
- NO\textsubscript{x} conversion increases with increasing NH\textsubscript{3} concentration to a ratio of 1:1.

**NH\textsubscript{3} variation**

- 250 ppm NO
- 125 – 375 ppm NH\textsubscript{3}
- 750 ppm H\textsubscript{2}
- 10% O\textsubscript{2}
- 5% H\textsubscript{2}O
- in Ar
- GHSV = 33 100 h\textsuperscript{-1}

![NH\textsubscript{3} variation graph](image)
The ratio between NO and NH$_3$ conversion was in all experiments 1:1.
Variation of H₂

- Higher NOₓ conversion with higher H₂ concentration
- Above 300°C all H₂ is converted
- H₂ conversion is independent on NO : H₂ ratio

- 250 ppm NO
- 250 ppm NH₃
- 0-1500 ppm H₂
- 10% O₂
- 5% H₂O in Ar
- GHSV = 33 100 h⁻¹
NO\textsubscript{x} conversion levels out at 250 and 300 °C but increases constantly at 150, 200 and 400 °C.
• The ratio between NO and H₂ conversion was in all experiments 1:2 without unselective H₂ oxidation.
Role of $\text{H}_2$

From own experiments
- Limit in $\text{NO}_x$ conversion due to $\text{H}_2$
- Defined ratio of $\text{NO}:\text{H}_2 = 1:2$

Proposals in the literature
- Increase of the number of small silver clusters
- Reduction of silver species
- Increase of the amount of surface nitrates
- Hydrogen reduces or removes nitrates from the catalyst
**H₂ reduces nitrates?**

- Step – response DRIFT experiment at 250°C
- NH₃, NO and H₂ are switched in and out
- Step length: 1 h
- Nitrates increase from step 3
**H₂ assists nitrite conversion**

- Step – response DRIFT experiment at 250°C
- 5 min nitrate/nitrite formation from NO + O₂ → 1 min 10% O₂ → 2 min 1000 ppm H₂ + 10% O₂
Summary

• Ratio between NO : NH₃ : H₂ = 1 : 1 : 2

• Increasing the H₂ concentration => NOₓ conversion levels out at 250 and 300°C but increases constantly at 150, 200 and 400°C.

• H₂ concentration can limit the NOₓ conversion although NH₃ is available in excess.

• H₂ assists the conversion of nitrites to nitrates
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