# Selective Catalytic Reduction In Automotive

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# Selective Catalytic Reduction …in general

- **Wide technique of NOx removal**
  - Used everywhere, where NOx is produced (and undesired)
  - Used mainly for exhaust gases (chimneys, exhausts, …)

- **Selective**
  - We can select which molecule will be reduced (NOx, CO, $CO_2$, $SO_2$)
- **Catalytic**
  - Reaction needs to be catalysed.
- **Reduction**
  - NOx to $N_2$

# SCR in automotive

- Reduction of NOx using reduction agent on a surface of solid catalyst in presence of oxygen

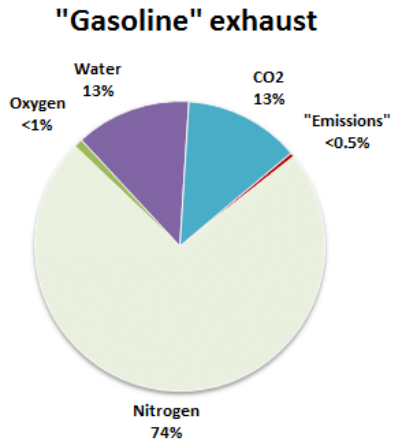
- Summary equation: $\mathbf{4}NO + \mathbf{4}NH_3 + \mathbf{O_2} \rightarrow \mathbf{4}N_2 + 6H_2O$
- Other SCR reactions:

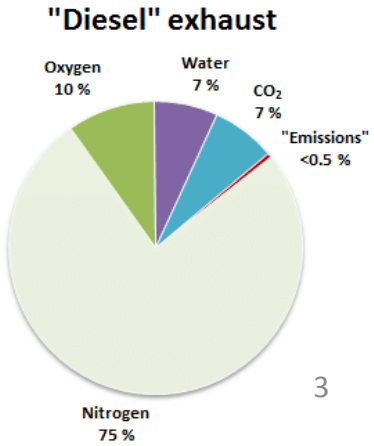
  $8NH_3 + 6\mathbf{NO_2} \rightarrow 7N_2 + 12H_2O$

  … plus many side reactions

  $2NH_3 + \mathbf{NO} + \mathbf{NO_2} \rightarrow 2N_2 + 3H_2O$ „fast SCR“

- Reduction agent
  - Needed for high conversion rates
  - $\mathbf{NH_3}$, HC (hydrocarbons)



# … a bit of History

- SCR was developer for industrial applications
  - 70s - applied in thermal power plants in Japan
  - Since 80s – widespread to Europe and USA

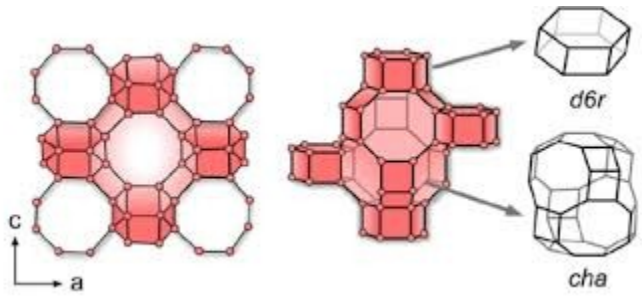
- First mobile aplications (not powerplants)
  - 90s Korean cargo ships (diesel engine = electric generator)
  - Reason for this application - similar application as in powerplants, steady state of engine operation

# How does SCR catalyst look like?

- Ceramics carrier with active substance
  - SiC, Cordierite
- „Mate“
  - Heat resisting dense fibers
  - Spacer for thermal dilatation
- Metal housing
  - Stainless steel

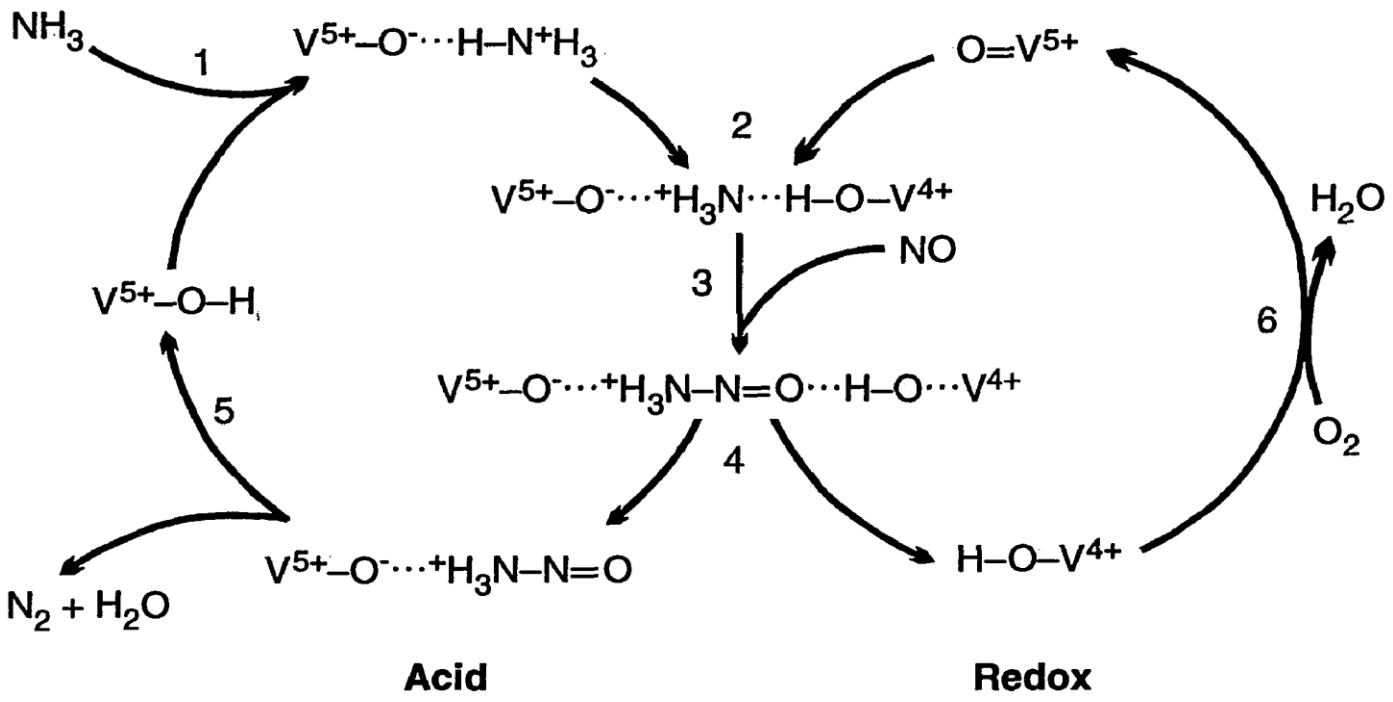
# What is the active substance?

- Several substances are catalytically active enough to be used for SCR
- Cu and Fe zeolites (Cu-SSZ-13, Fe-ZSM5)
- Metal oxides ($V_2O_5$)

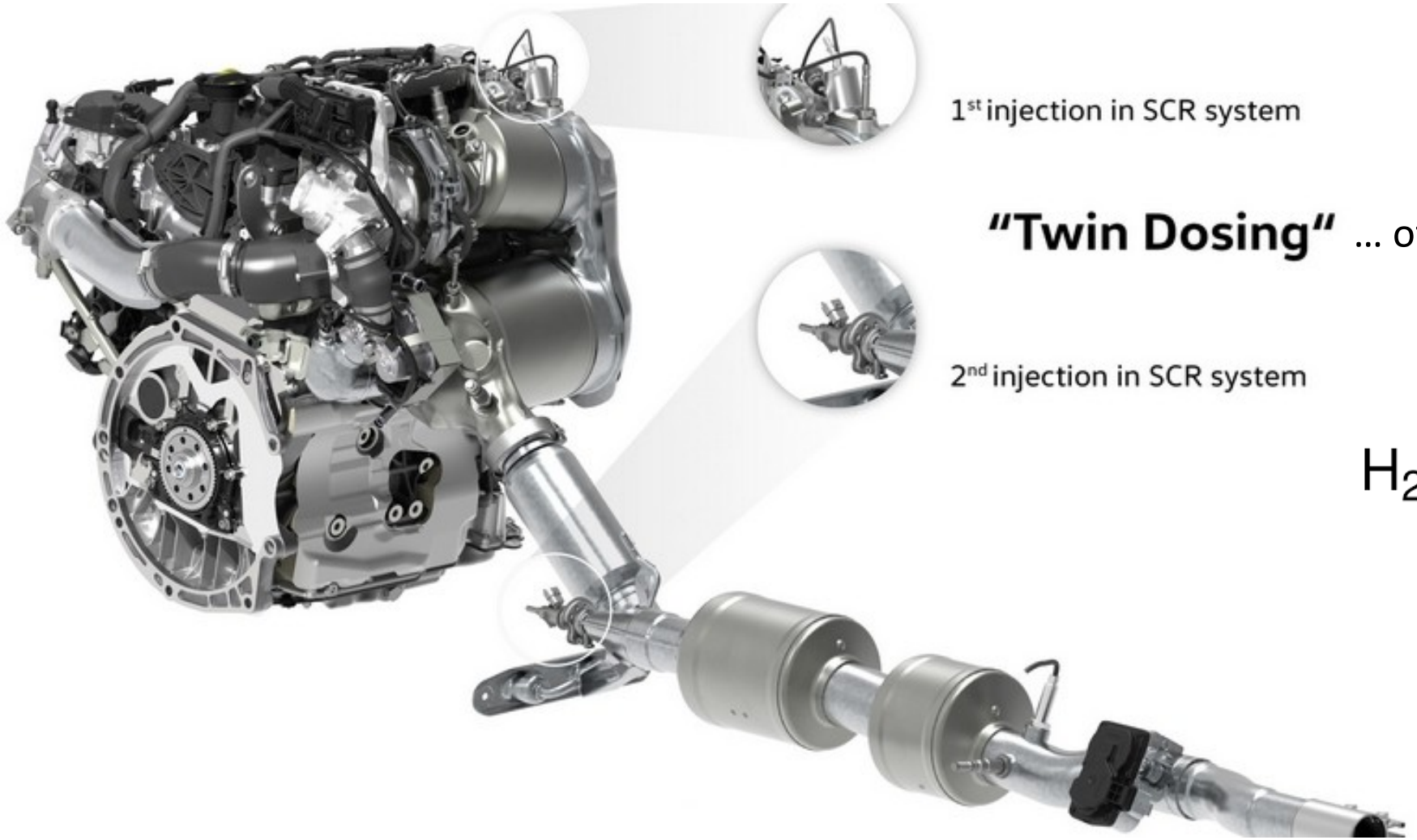



# What is the mechanism?

- Mechanism is strongly dependent on exact composition of the material



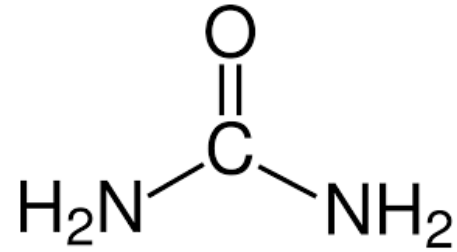

# „State of the Art“



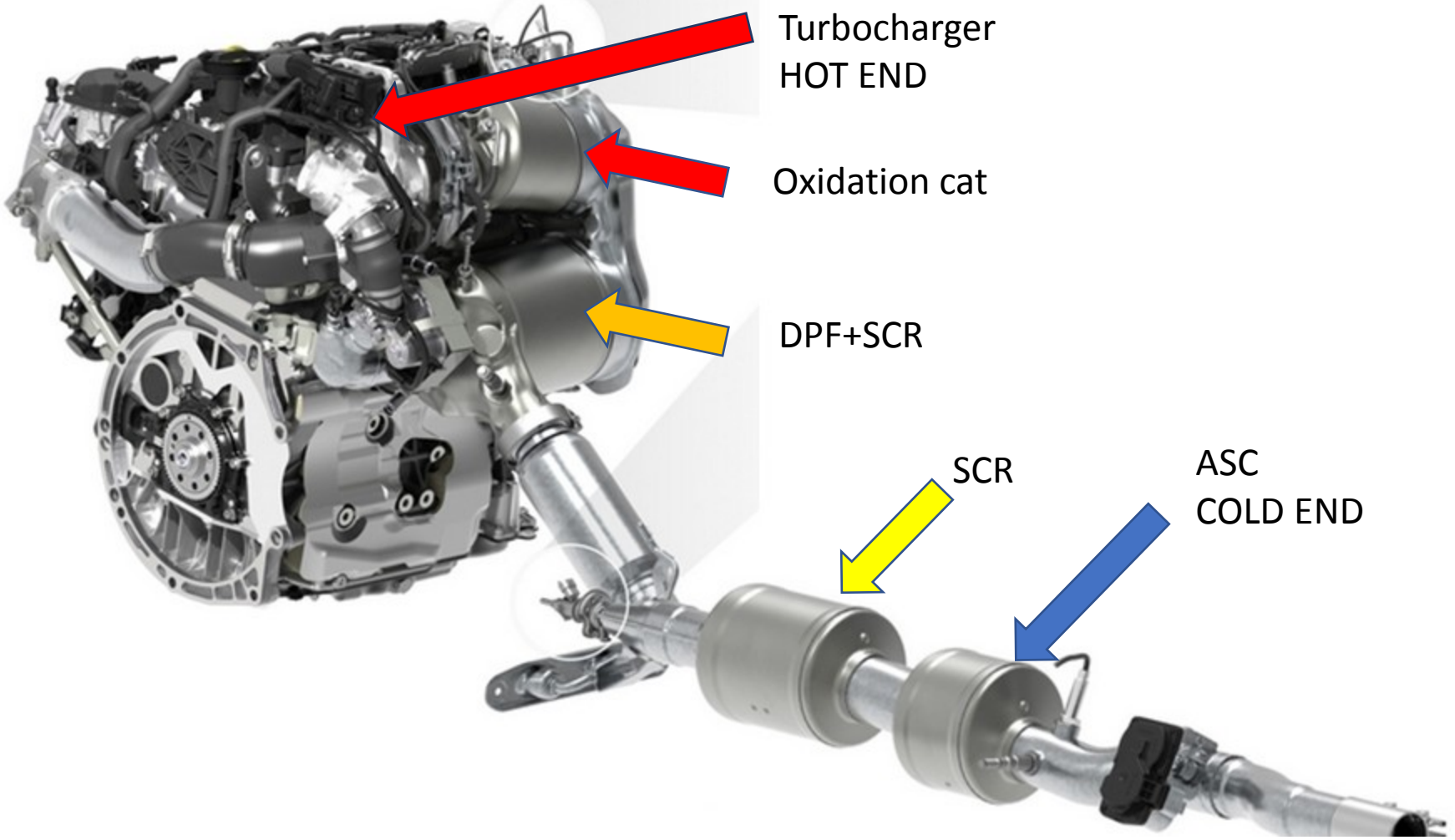
1st injection in SCR system

**“Twin Dosing“** … of urea

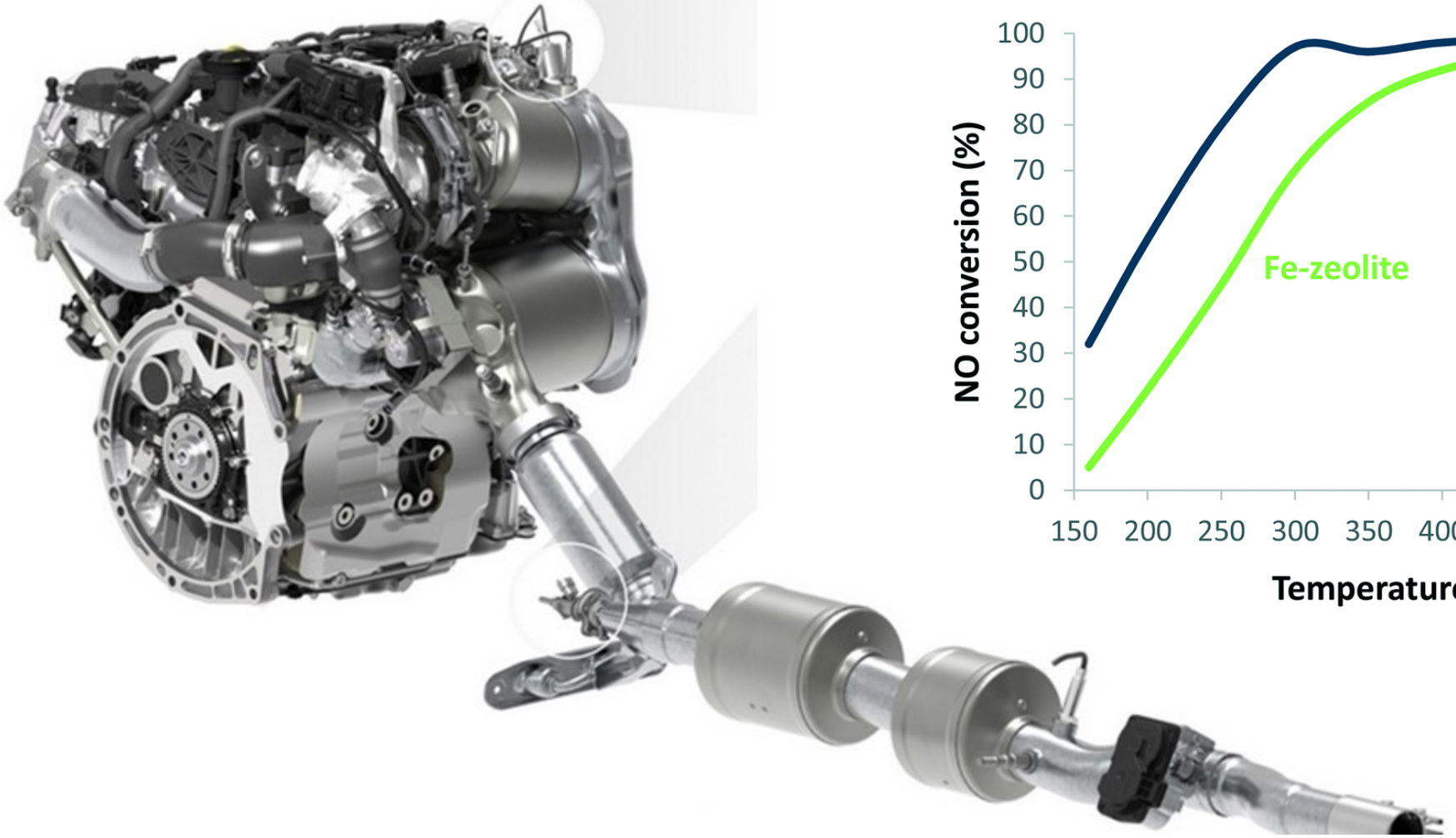
2nd injection in SCR system



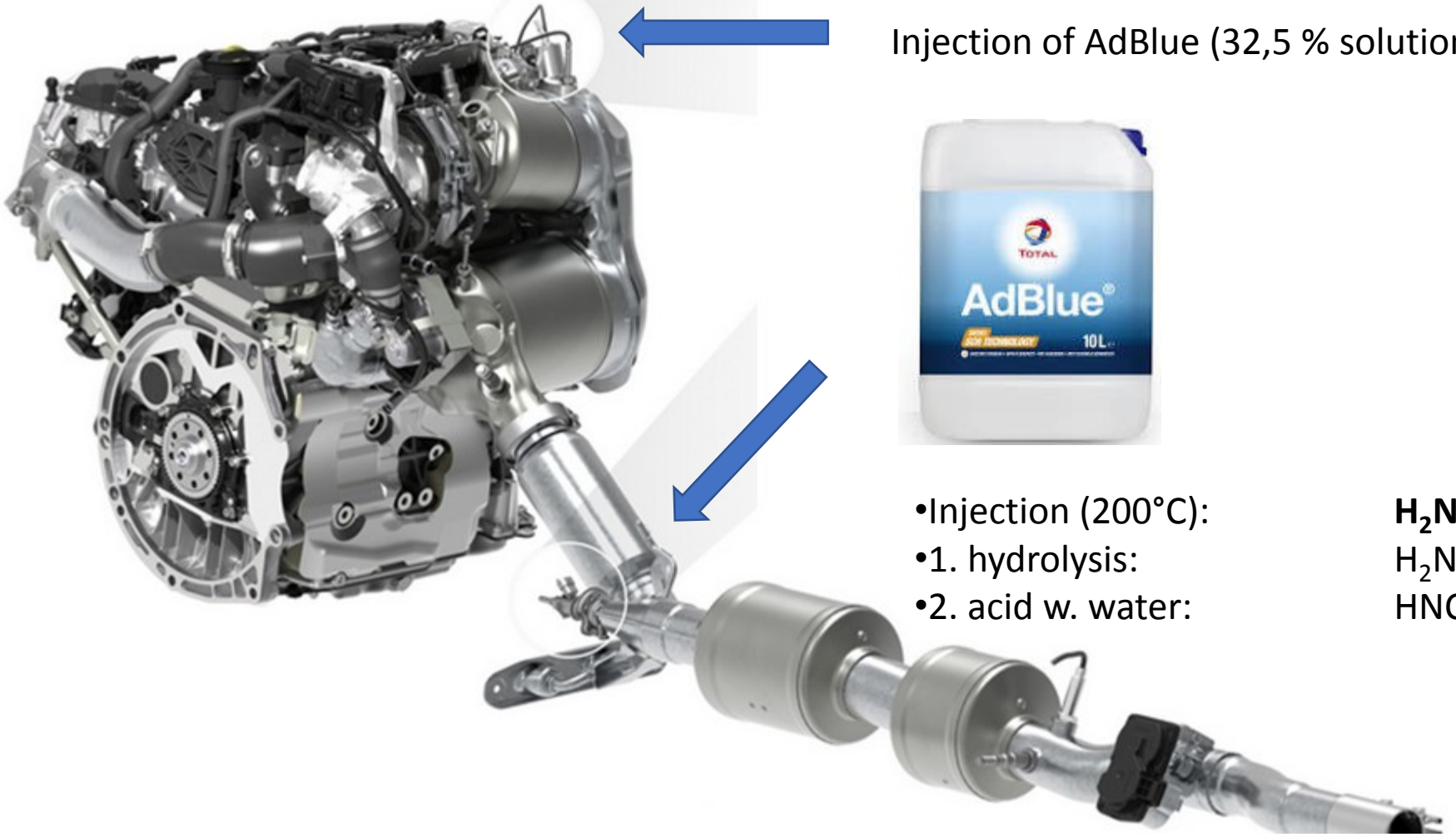
# SCR in Automotive



# SCR in Automotive



# $NH_3$-SCR in Automotive



Injection of AdBlue (32,5 % solution of urea in distilled water)




- Injection (200°C): **$H_2N\text{-}CO\text{-}NH_2 + H_2O \rightarrow 2NH_3 + CO_2$**
- 1. hydrolysis: $H_2N\text{-}CO\text{-}NH_2 + H_2O \rightarrow NH_3 + HNCO$
- 2. acid w. water: $HNCO + H_2O \rightarrow NH_3 + CO_2$