Catalyst System Design for the Control of NO_x Using Hydrogen

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1. What is NO_x?

- Nitric Oxides - highly reactive gases; primarily NO (>90 %) and NO_2
- Pollutants, involved in many atmospheric processes e.g. formation of smog
- Produced as a result of the high temperatures during combustion of fossil fuels
- Legislation is in place to reduce NO_x emissions

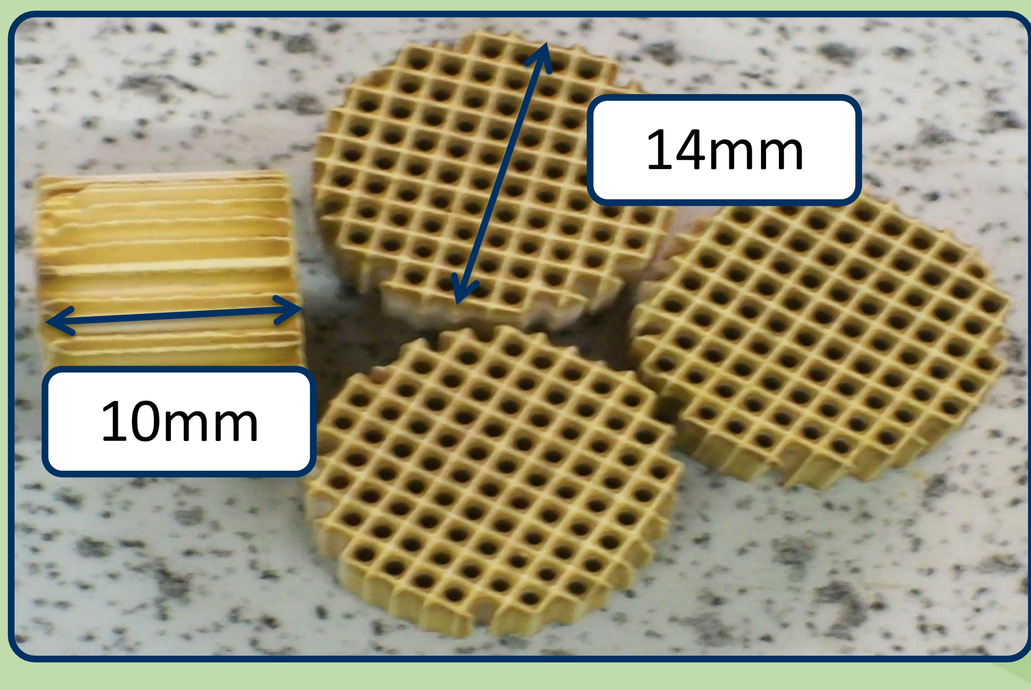


Figure 1 – Pd/Al_2O_3 monoliths

Figure 2 – 1 wt% Pd/Al_2O_3 pellets

3. H_2-SCR

- H_2 is already present in many systems e.g. diesel engines, biomass gasification combined heat and power (CHP) plants
- Could replace NH_3/urea processes:

<u>Target Chemistry</u>

$$2NO + 2H_2 \rightarrow 2H_2O + N_2$$

$$2NO_2 + 4H_2 \rightarrow 4H_2O + N_2$$

- Removes the need for additional chemicals and their associated costs

2. Current De-NOx Processes

- NH_3/urea-Selective Catalytic Reduction (SCR) is an efficient, established method

$$4NH_3 + 4NO + O_2 \rightarrow 6H_2O + 4N_2$$

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

BUT it requires additional toxic chemicals:

- Intrinsic safety issues
- Extra system costs
- NH_3/urea infrastructure necessary

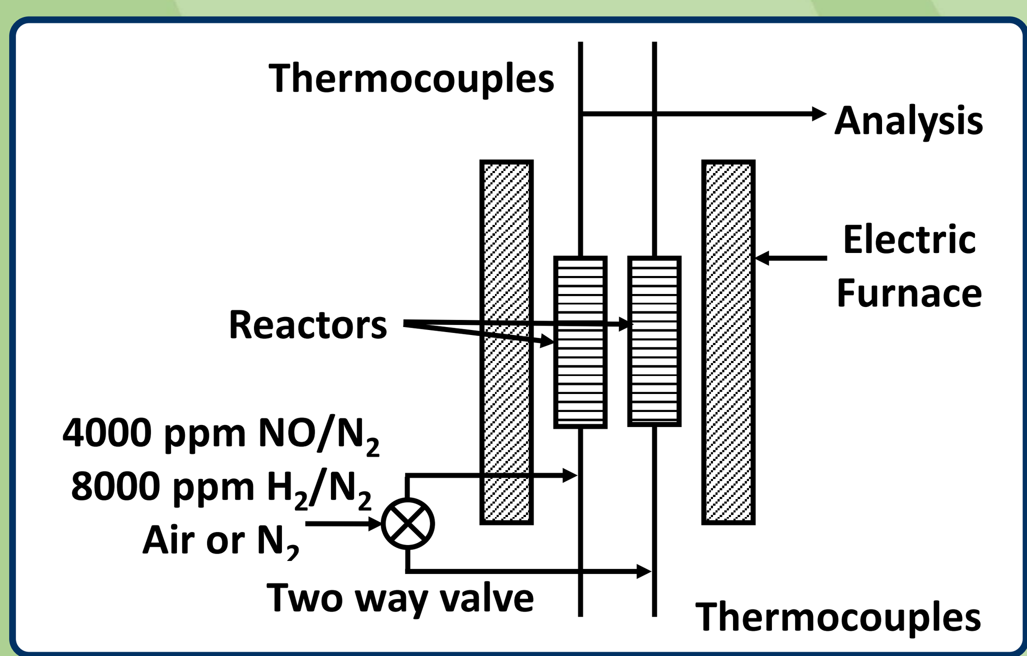


Figure 3 – Experimental set-up

4. Catalyst

- Pd/Al_2O_3 catalyst prepared using an incipient wetness impregnation technique
- Supported on honeycomb monoliths (**Figure 1**)
  - Outer diameter = 14 mm
  - Channel size = 1 mm x 1 mm (x 80)
- Compared to commercially available 1 wt% Pd/Al_2O_3 pellets (**Figure 2**)
  - Diameter = 3 mm

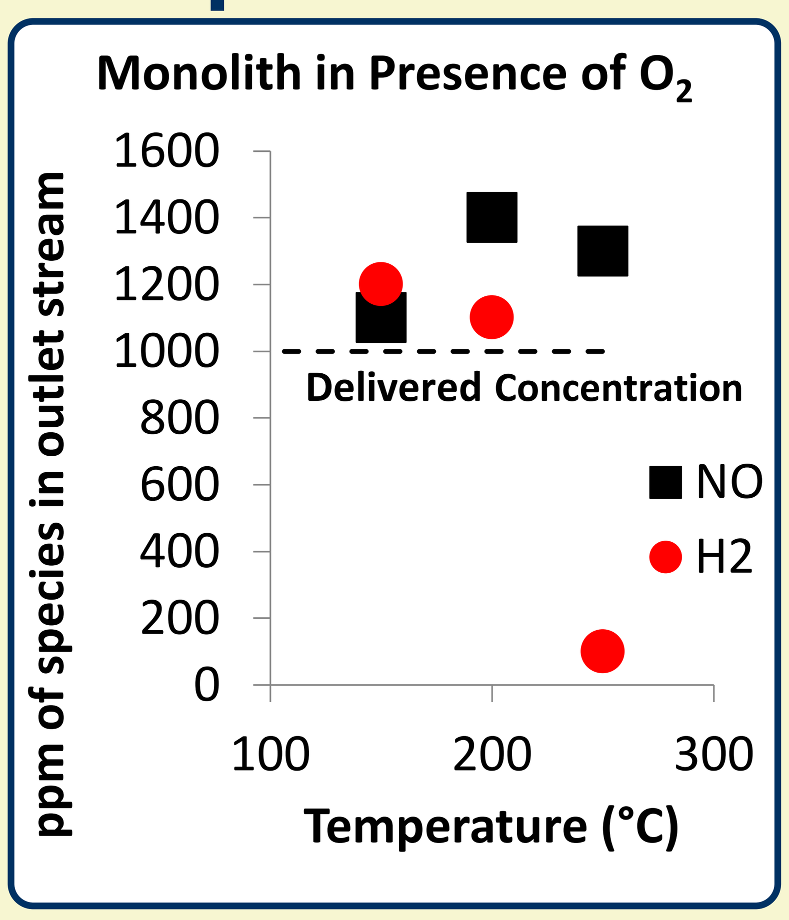
5. Experimental Conditions

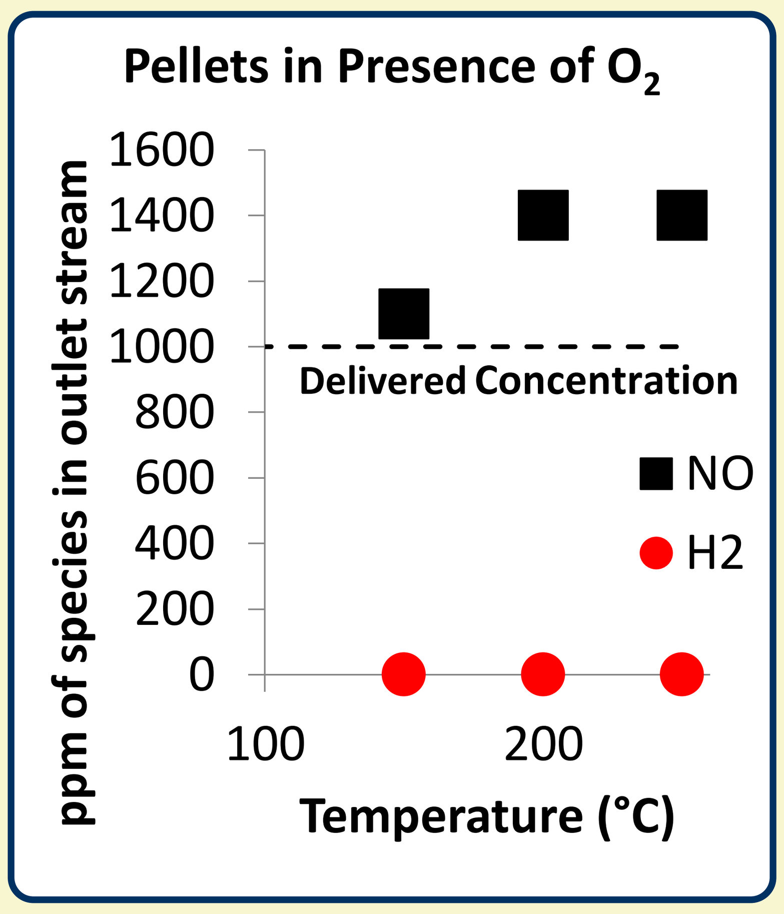
- Gas composition supplied to catalysts:
  - 1000 ppm NO
  - 1000 ppm H_2
  - Air (12.5 % O_2) or N_2
- Temperature varied from 50-250 °C (**Figure 3**)

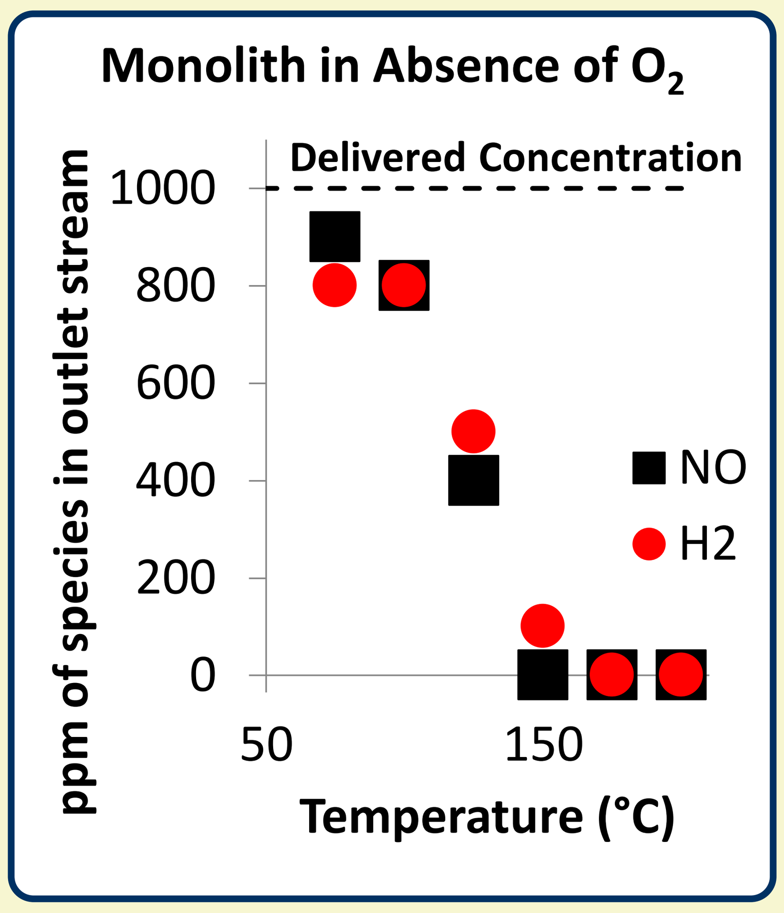
7. Conclusions

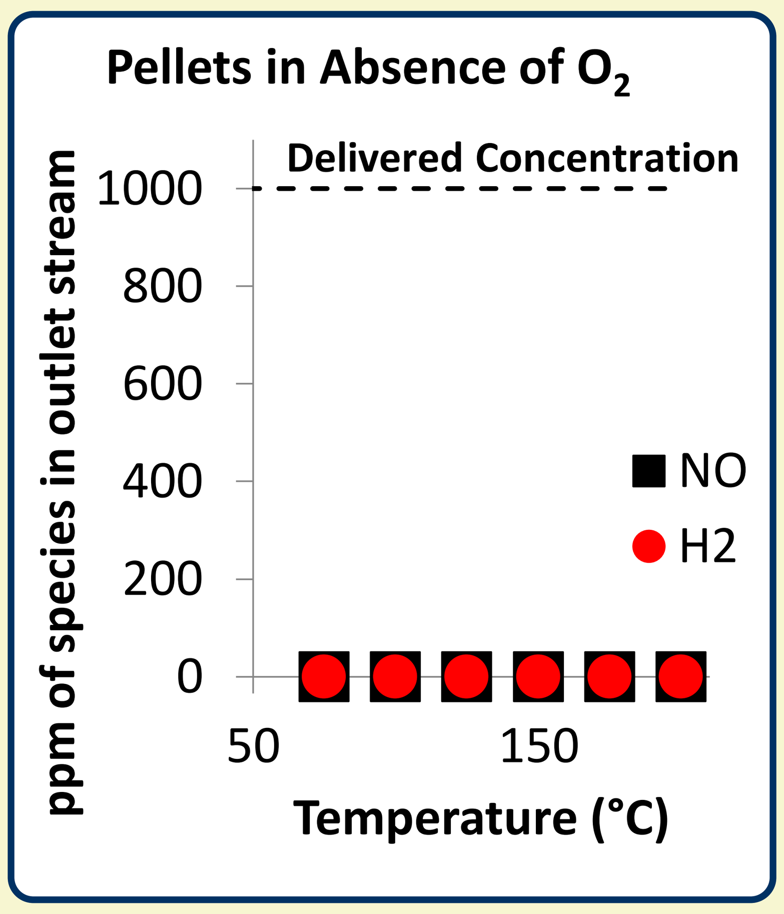
- In the absence of O_2, Pd/Al_2O_3 catalysts can effectively reduce NO_x using H_2
- However, Pd/Al_2O_3 strongly promotes the reaction between H_2 and O_2, even at low temperatures
- Conditioning of the catalyst may be necessary to achieve maximum activity
- Some selectivity of products was seen at varying temperatures

6. Experimental Results









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