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# Catalyst System Design for the Control of NO<sub>x</sub> Using Hydrogen

David W. J. McClymont<sup>a</sup>, Stan T. Kolaczowski<sup>b</sup>, Kieran C. Molloy<sup>c</sup>

<sup>a</sup>Doctoral Training Centre <sup>b</sup>Department of Chemical Engineering <sup>c</sup>Department of Chemistry  
Centre for Sustainable Chemical Technologies, University of Bath, BA2 2AY, UK.

E-mail: D.W.J.McClymont@bath.ac.uk: URL: <http://www.bath.ac.uk/csct>

## 1. What is NO<sub>x</sub>?

- Nitric Oxides - highly reactive gases; primarily NO (>90 %) and NO<sub>2</sub>
- 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<sub>x</sub> emissions

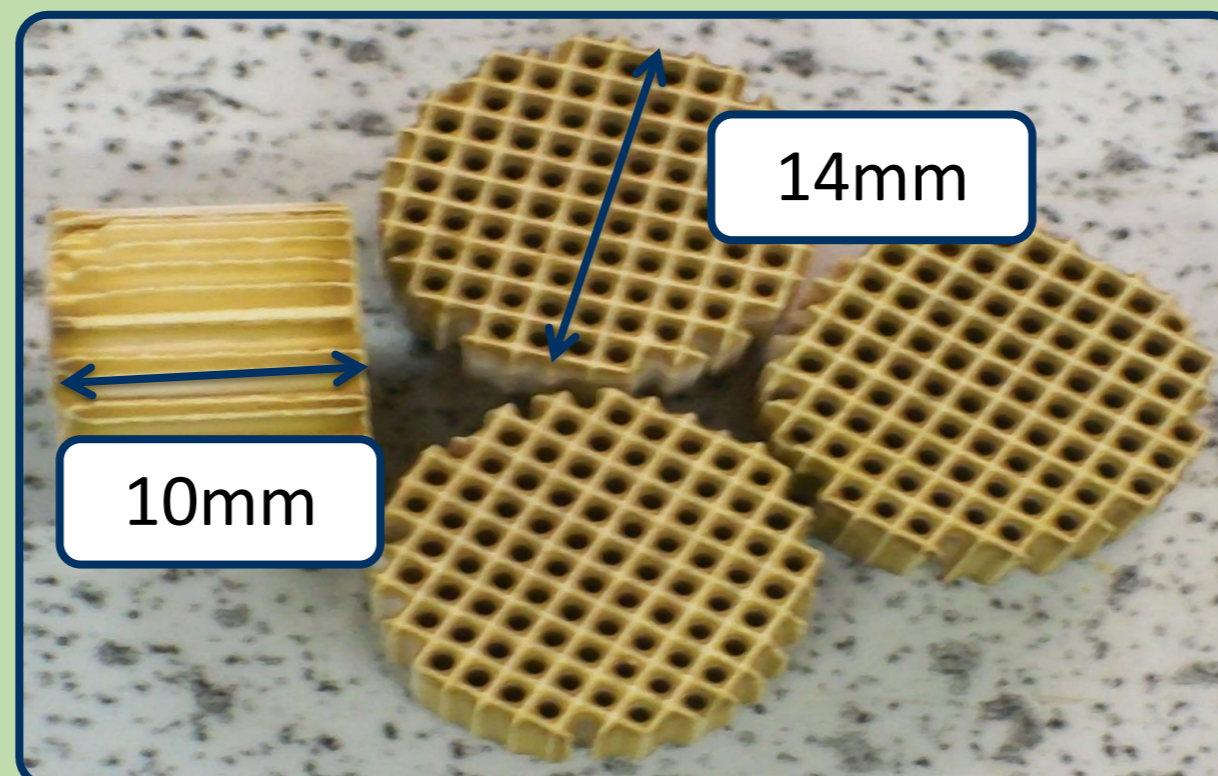


Figure 1 – Pd/Al<sub>2</sub>O<sub>3</sub> monoliths

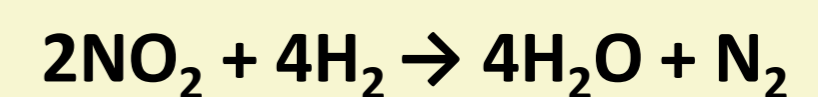
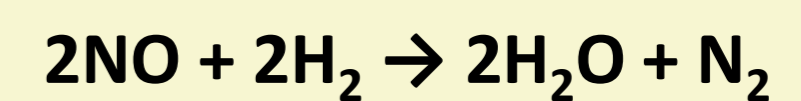


Figure 2 – 1 wt% Pd/Al<sub>2</sub>O<sub>3</sub> pellets

## 3. H<sub>2</sub>-SCR

- H<sub>2</sub> is already present in many systems e.g. diesel engines, biomass gasification combined heat and power (CHP) plants
- Could replace NH<sub>3</sub>/urea processes:

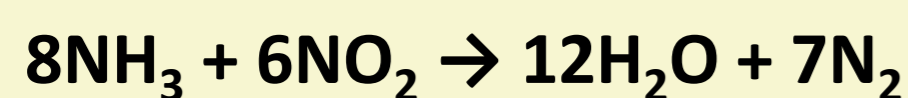
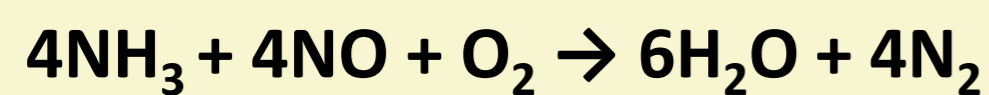
Target Chemistry



- Removes the need for additional chemicals and their associated costs

## 2. Current De-NO<sub>x</sub> Processes

- NH<sub>3</sub>/urea-Selective Catalytic Reduction (SCR) is an efficient, established method



BUT it requires additional toxic chemicals:

- Intrinsic safety issues
- Extra system costs
- NH<sub>3</sub>/urea infrastructure necessary

## 4. Catalyst

- Pd/Al<sub>2</sub>O<sub>3</sub> 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<sub>2</sub>O<sub>3</sub> pellets (Figure 2)
  - Diameter = 3 mm

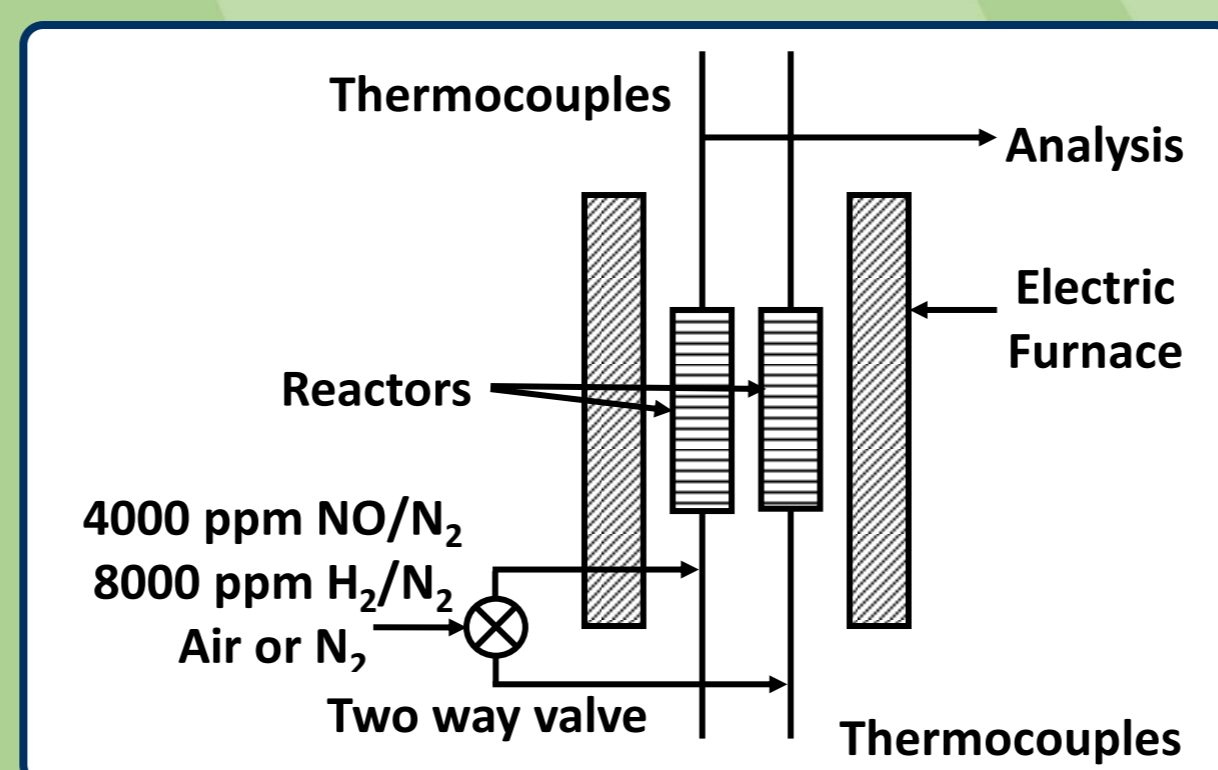


Figure 3 – Experimental set-up

## 5. Experimental Conditions

- Gas composition supplied to catalysts:
  - 1000 ppm NO
  - 1000 ppm H<sub>2</sub>
  - Air (12.5 % O<sub>2</sub>) or N<sub>2</sub>
- Temperature varied from 50-250 °C (Figure 3)

## 7. Conclusions

- In the absence of O<sub>2</sub>, Pd/Al<sub>2</sub>O<sub>3</sub> catalysts can effectively reduce NO<sub>x</sub> using H<sub>2</sub>
- However, Pd/Al<sub>2</sub>O<sub>3</sub> strongly promotes the reaction between H<sub>2</sub> and O<sub>2</sub>, 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

