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# Novel catalyst systems for deNO<sub>x</sub>



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

Nitric oxides are highly reactive gases; primarily NO (>90 %) and NO<sub>2</sub>, involved in many pollutant processes e.g. the formation of acid rain

They are produced as a result of high temperatures during the combustion of fuels, and legislation is in place to control emissions i.e. the Industrial Emissions Directive (IED) regulates activities that involve burning or gasification of waste (Figure 1)

Technologies have been developed which react a reductant with NO<sub>x</sub> emissions, forming harmless N<sub>2</sub> and H<sub>2</sub>O. Development of a material and process to treat NO<sub>x</sub> emissions using H<sub>2</sub> is the aim of this project

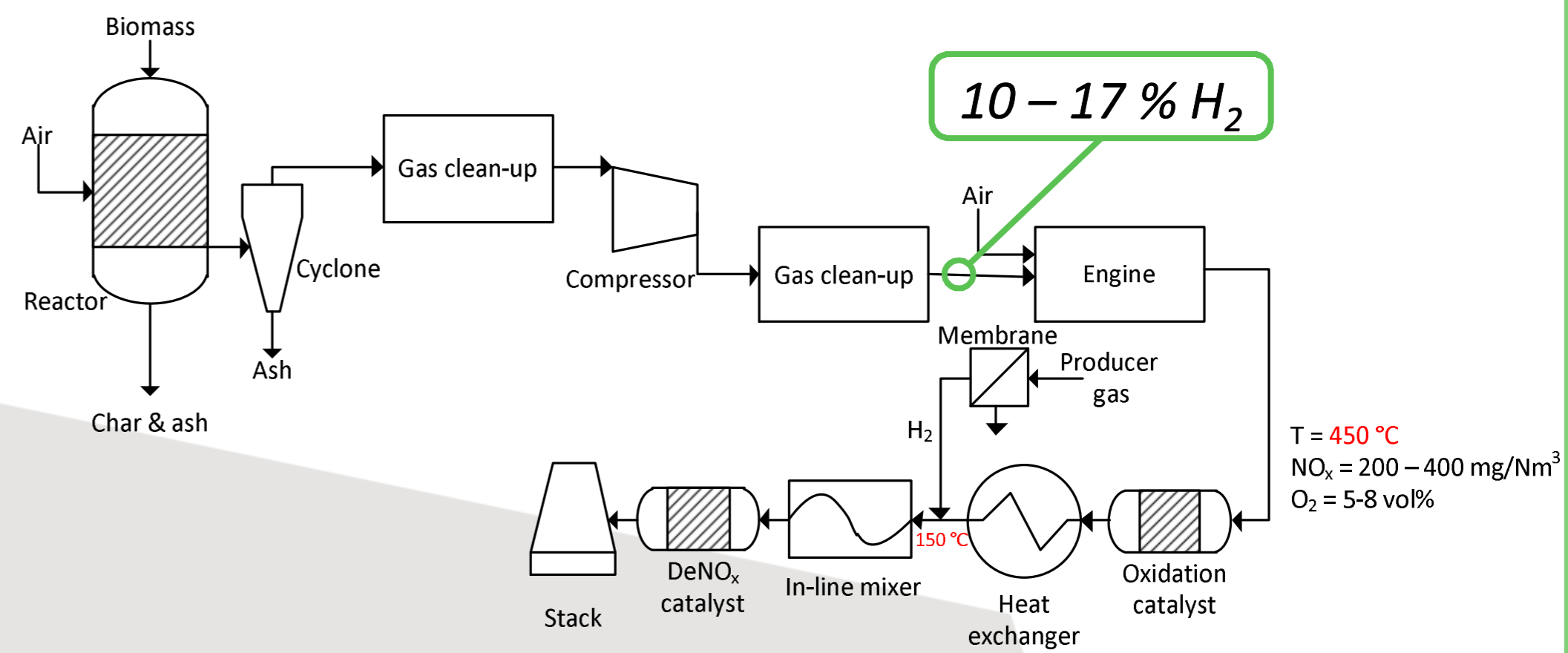


Figure 1. Schematic of proposed biogas engine exhaust treatment system

## 2. H<sub>2</sub> for deNO<sub>x</sub>

Measurements made on an operational gasification plant (Figure 2), identified the gaseous fuel produced as having a 10-17 % H<sub>2</sub> content depending on the conditions in the gasifier

Utilising H<sub>2</sub> already present in the system (Figure 1) could provide a reductant which does not have to be specially manufactured (e.g. NH<sub>3</sub>, urea), and hence would be a cleaner approach

H<sub>2</sub> can also be used in NO<sub>x</sub> storage and reduction (NSR) processes where NO<sub>x</sub> species are 'trapped' and subsequently reduced through alternate lean and rich-burn cycles (Figure 4)



Figure 2. Refgas gasification plant, Chester, UK

## 3. Catalysts

Table 1. Summary of prepared H<sub>2</sub>-deNO<sub>x</sub> catalysts and associated processes

H <sub>2</sub> -SCR	H <sub>2</sub> -NSR
Pt/Al <sub>2</sub> O <sub>3</sub>	Pt/Ba/Al <sub>2</sub> O <sub>3</sub>
Ag/Al <sub>2</sub> O <sub>3</sub>	Pt/K/Al <sub>2</sub> O <sub>3</sub>
	Ag/Ba/Al <sub>2</sub> O <sub>3</sub>
	Ag/K/Al <sub>2</sub> O <sub>3</sub>

Catalysts prepared using impregnation techniques (Table 1)

Supported on honeycomb monoliths (Figure 3)

Channel size = 1 mm x 1 mm (~80 channels per monolith)

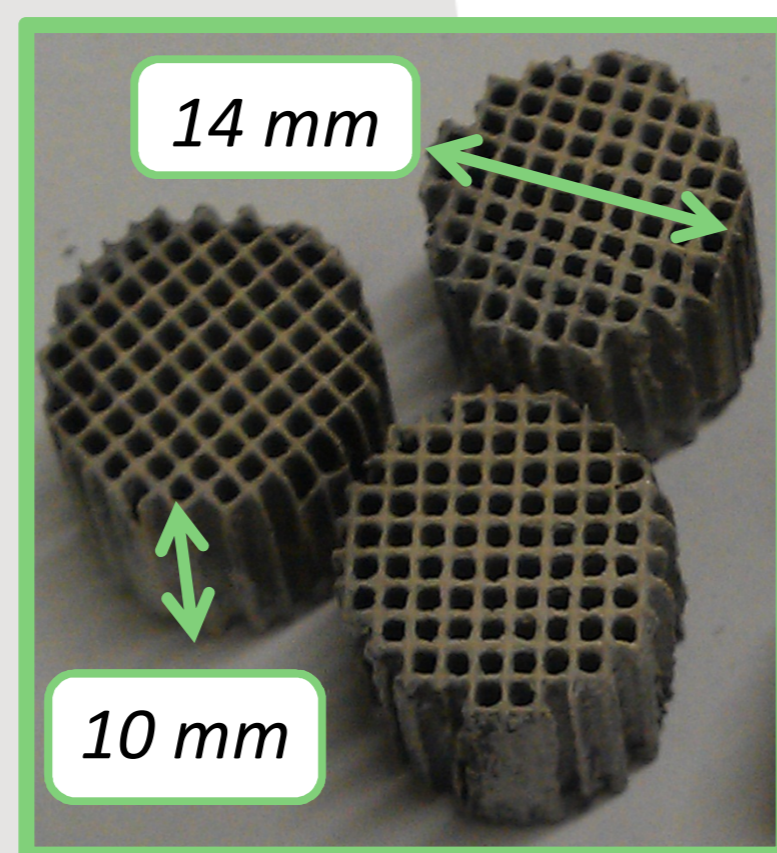


Figure 3. Pt/Ba/Al<sub>2</sub>O<sub>3</sub> monoliths

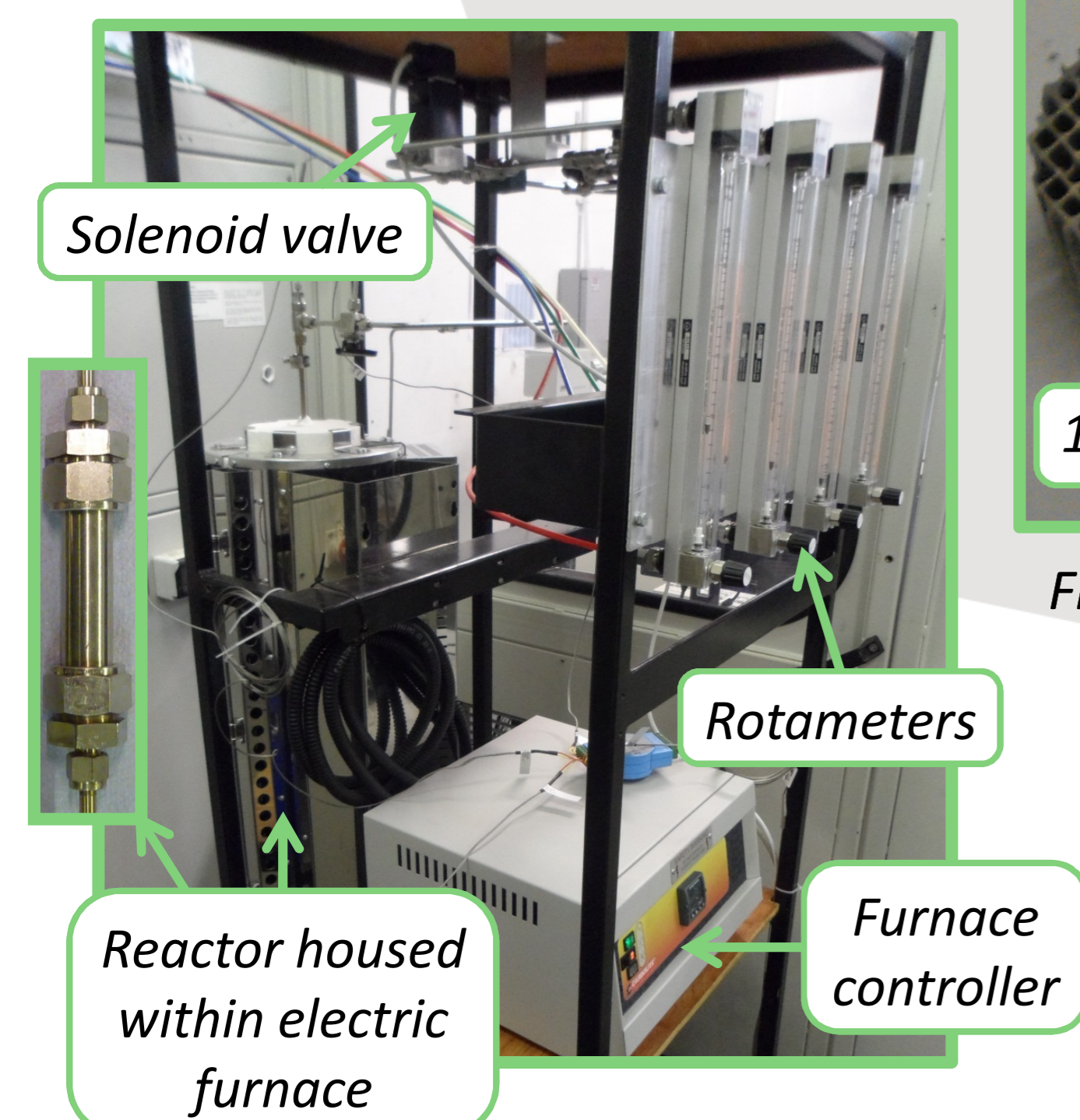


Figure 5. Experimental set-up

## 4. Experimental Results

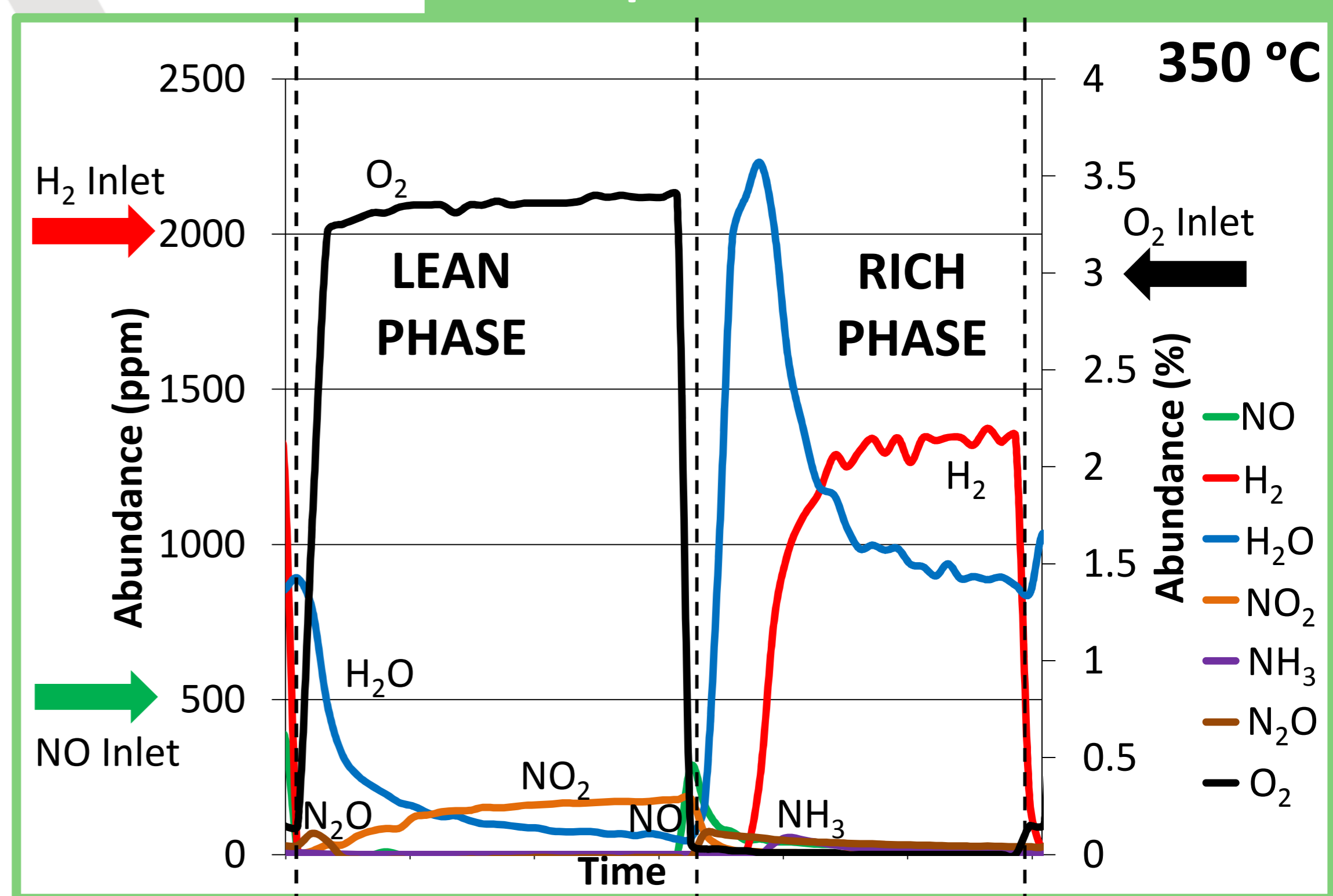


Figure 4. Example of data obtained from H<sub>2</sub>-NSR over Pt/Ba/Al<sub>2</sub>O<sub>3</sub> catalyst. Reaction conditions: Lean Phase - 500 ppm NO, 3 % O<sub>2</sub>, balance N<sub>2</sub>. Rich Phase - 2000 ppm H<sub>2</sub>, balance N<sub>2</sub>.

## 5. Initial Conclusions and Future work

Initial results (Figure 4) suggest that catalysts demonstrate some deNO<sub>x</sub> activity and there is some competition between desired NO<sub>x</sub> storage and the formation of NO<sub>2</sub>

Further work will investigate the performance of the prepared catalysts in their relevant processes (SCR/NSR) and identify optimum conditions/limitations. The catalysts will be characterized through temperature-programmed studies (TPD and TPSR)