Novel catalyst systems for deNO$_x$

David W. J. McClymont,[a,b] Stan T. Kolaczkowski,[b] Kieran C. Molloy,[c] Serpil Awdry[b]
[a]Centre for Sustainable Chemical Technologies, University of Bath, BA2 7AY, UK.
[b]Department of Chemical Engineering, University of Bath, BA2 7AY, UK.
[c]Department of Chemistry, University of Bath, BA2 7AY, UK.
E-mail: D.W.J.McClymont@bath.ac.uk URL: http://www.bath.ac.uk/csct

1. What is NO$_x$?

Nitric oxides are highly reactive gases; primarily NO (>90 %) and NO_2, 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$_x$ emissions, forming harmless N_2 and H_2O. Development of a material and process to treat NO$_x$ emissions using H_2 is the aim of this project

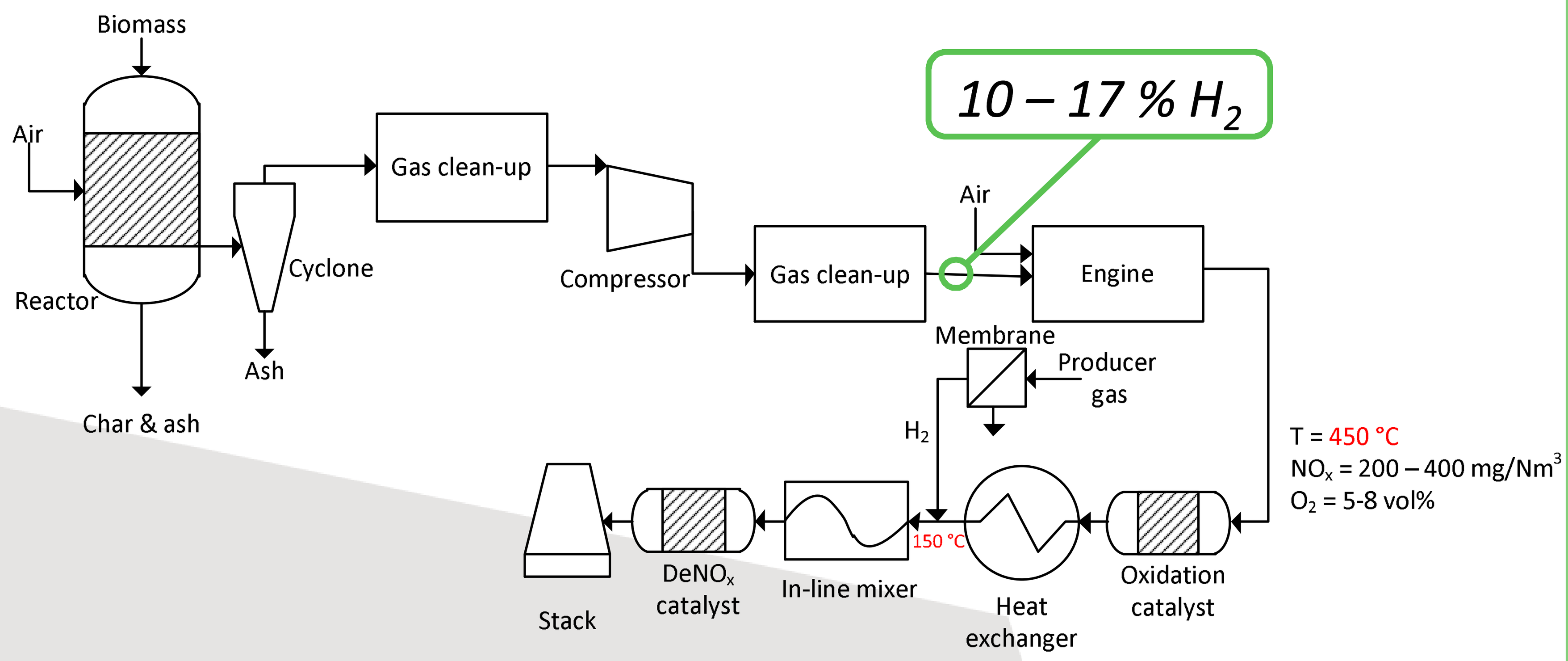

Figure 1. Schematic of proposed biogas engine exhaust treatment system

Figure 2. Refgas gasification plant, Chester, UK

2. H_2 for deNO$_x$

Measurements made on an operational gasification plant (Figure 2), identified the gaseous fuel produced as having a 10-17 % H_2 content depending on the conditions in the gasifier

Utilising H_2 already present in the system (Figure 1) could provide a reductant which does not have to be specially manufactured (e.g. NH_3, urea), and hence would be a cleaner approach

H_2 can also be used in NO$_x$ storage and reduction (NSR) processes where NO$_x$ species are 'trapped' and subsequently reduced through alternate lean and rich-burn cycles (Figure 4)

3. Catalysts

Catalysts prepared using impregnation techniques (Table 1)

Supported on honeycomb monoliths (Figure 3)

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

Table 1. Summary of prepared H_2-deNO$_x$ catalysts and associated processes

H_2-SCR	H_2-NSR
Pt/Al_2O_3	$Pt/Ba/Al_2O_3$
Ag/Al_2O_3	$Pt/K/Al_2O_3$
	$Ag/Ba/Al_2O_3$
	$Ag/K/Al_2O_3$

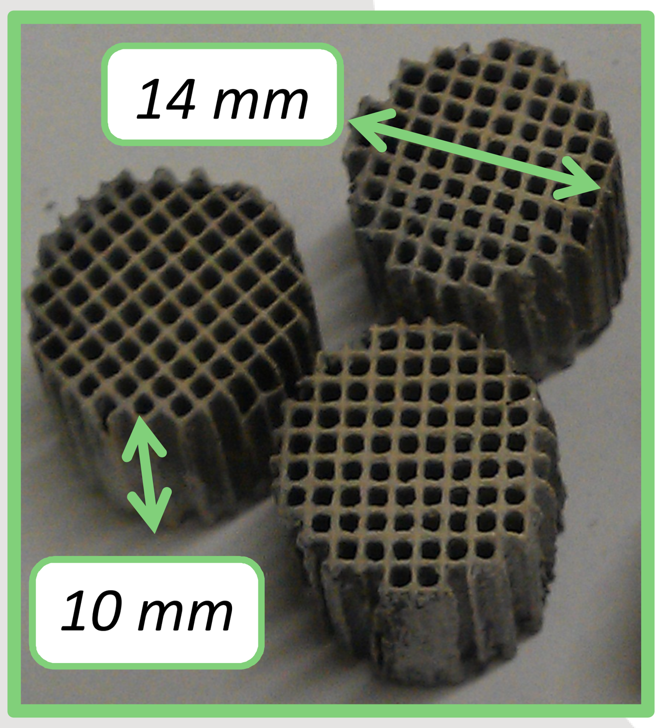

Figure 3. $Pt/Ba/Al_2O_3$ monoliths

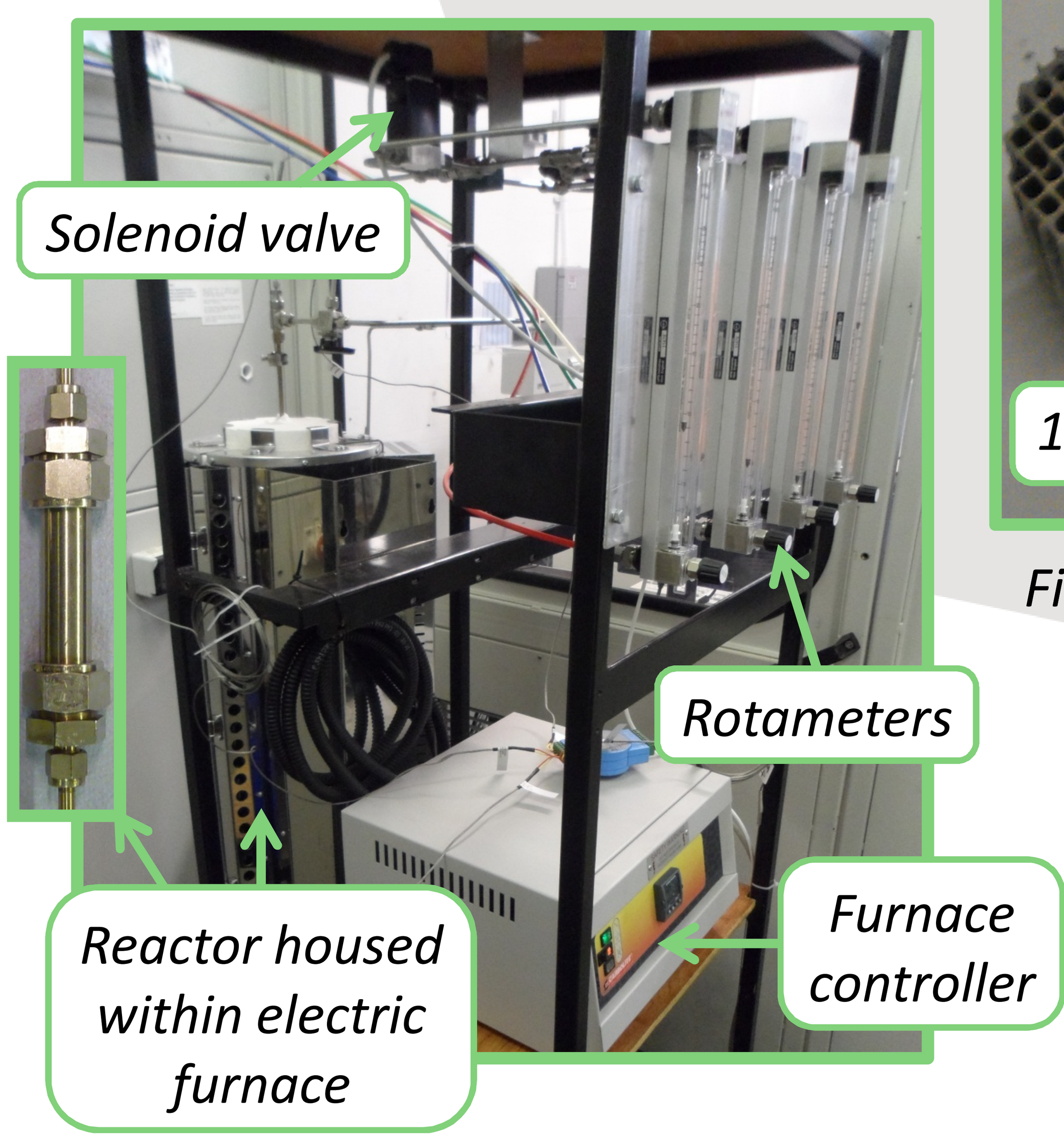

Figure 5. Experimental set-up

4. Experimental Results

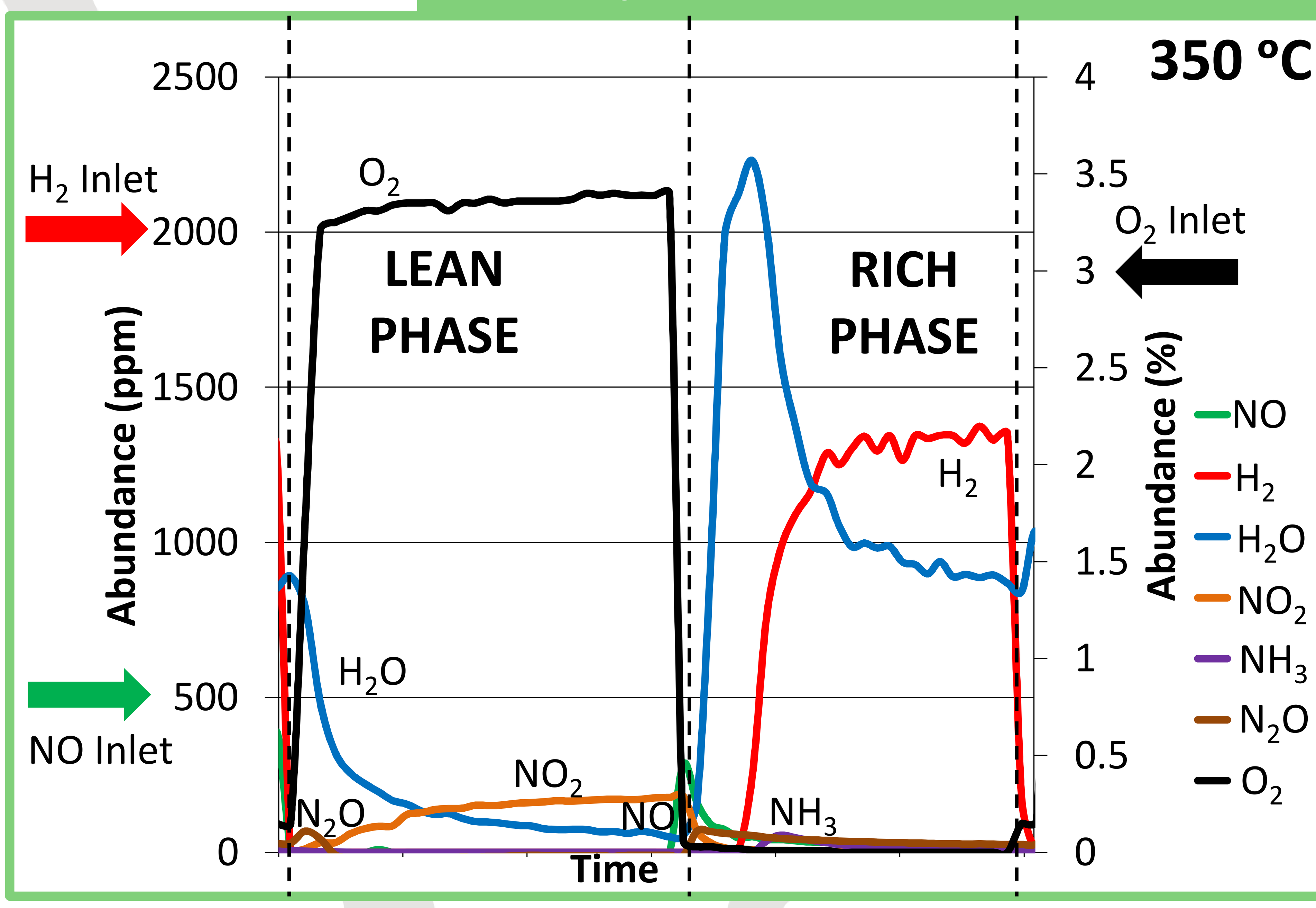

Figure 4. Example of data obtained from H_2-NSR over $Pt/Ba/Al_2O_3$ catalyst. Reaction conditions: Lean Phase - 500 ppm NO, 3 % O_2, balance N_2. Rich Phase - 2000 ppm H_2, balance N_2.

5. Initial Conclusions and Future work

Initial results (Figure 4) suggest that catalysts demonstrate some deNO$_x$ activity and there is some competition between desired NO$_x$ storage and the formation of NO_2

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)

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