Novel catalyst systems for deNO$_x$

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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 European Waste Incineration Directive (WID) 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

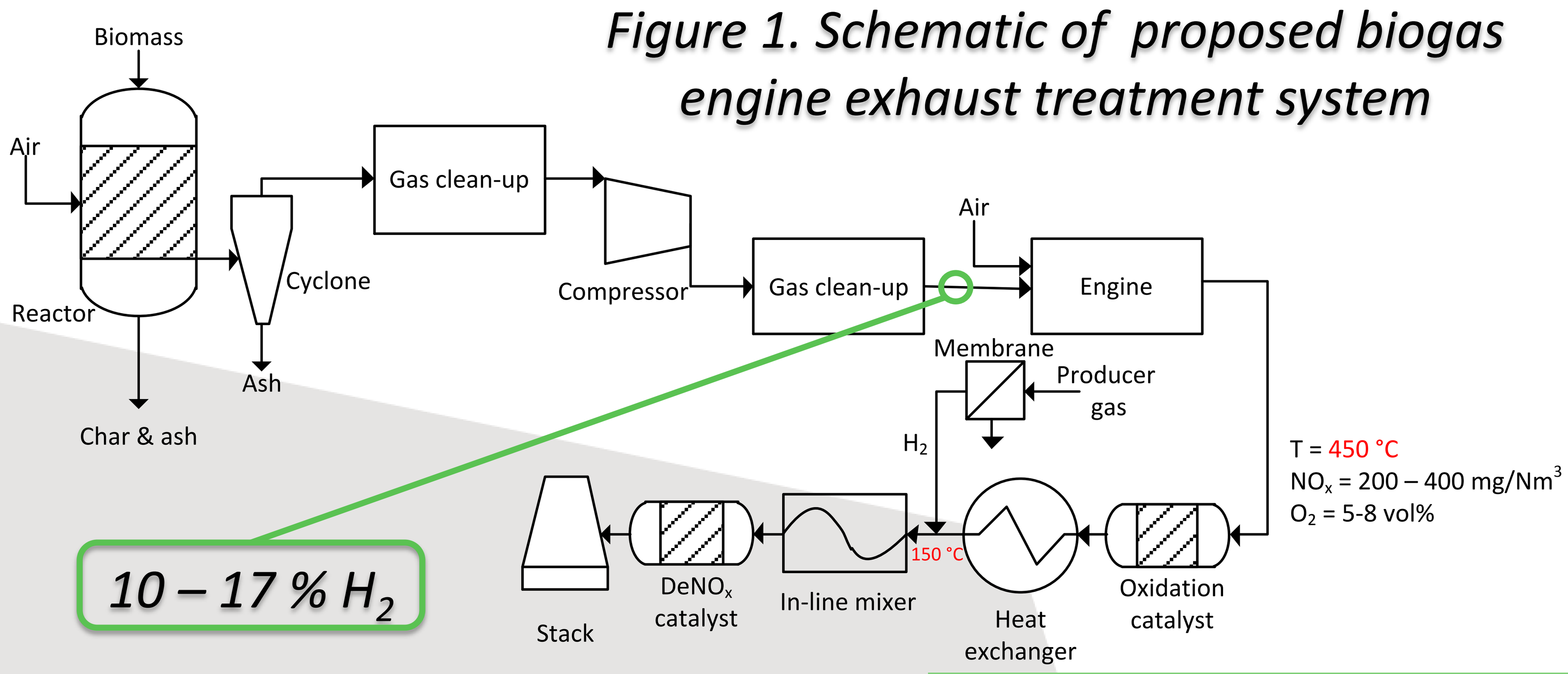

Figure 1. Schematic of proposed biogas engine exhaust treatment system

H_2 for deNO$_x$

Measurements made on an operational gasification plant (Figure 2), using a mass spectrometer (Figure 5), identified the 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) can save on the associated costs of using additional chemicals, as in the current processes (*i.e.* NH_3 – selective catalytic reduction (SCR))

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

Target chemistry : **$2NO + 2H_2 \rightarrow 2H_2O + N_2$** **$2NO_2 + 4H_2 \rightarrow 4H_2O + N_2$**

Figure 2. Refgas gasification plant

Catalysts

Catalysts prepared using impregnation techniques (Table 1)

Supported on honeycomb monoliths (Figure 3)

Outer diameter = 14 mm

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

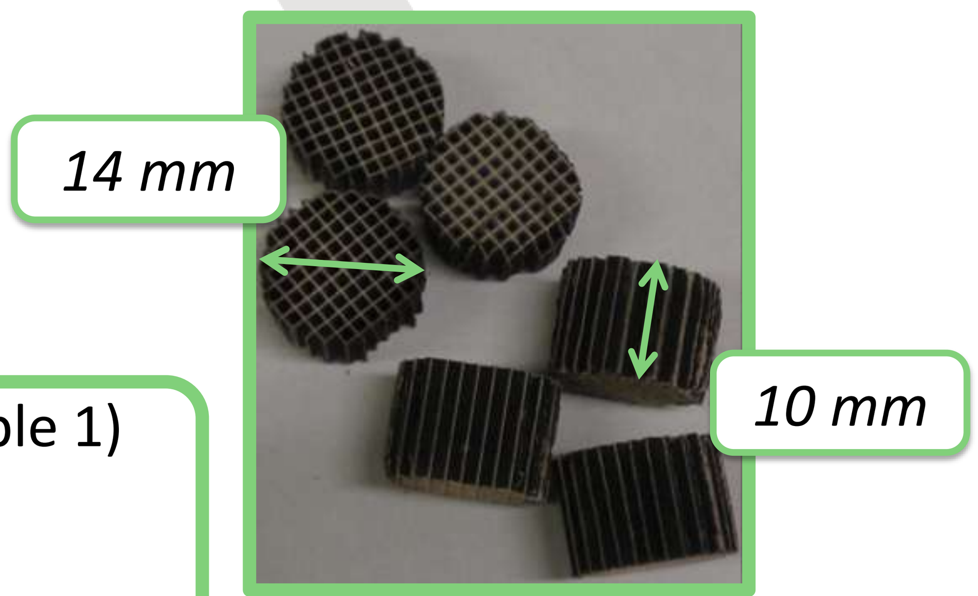

Figure 3. Pt/Al_2O_3 monoliths

Experimental set-up

A rig for investigating catalyst performance in the different processes has been designed, built and commissioned (Figure 4)

A method for identifying the products of the catalytic reactions, using an online mass spectrometer (Figure 5), has been developed and tested

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

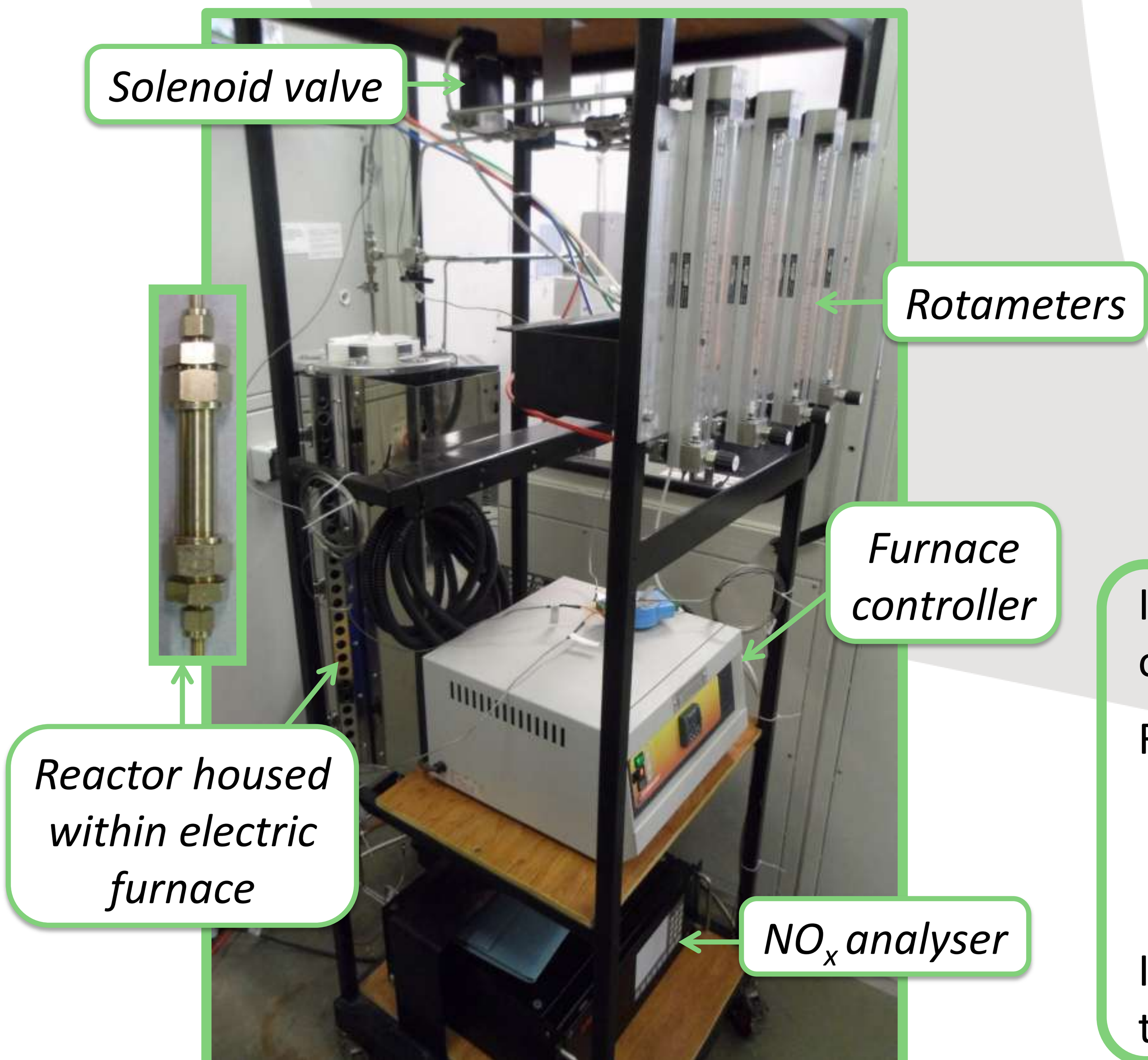

Figure 4. Experimental set-up

Figure 5. Hiden mass spectrometer

Future work

Investigate prepared catalysts performance in their relevant processes and identify optimum conditions/limitations with relevance to the final application

Further characterize catalysts through temperature-programmed studies:

- Temperature-programmed desorption
- Temperature-programmed surface reactions

Investigate hybrid design; combination of both NSR and SCR processes, using H_2 as the reductant

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