**What is NO\textsubscript{x}?**

Nitric oxides are highly reactive gases; primarily NO (>90 %) and NO\textsubscript{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\textsubscript{x} emissions, forming harmless N\textsubscript{2} and H\textsubscript{2}O. Development of a material and process to treat NO\textsubscript{x} emissions using H\textsubscript{2} is the aim of this project.

**H\textsubscript{2} for deNO\textsubscript{x}\textsuperscript{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\textsubscript{2} content depending on the conditions in the gasifier.

Utilising H\textsubscript{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\textsubscript{3} – selective catalytic reduction (SCR)).

H\textsubscript{2} can also be used in NO\textsubscript{x} storage and reduction (NSR) processes where NO\textsubscript{x} species are ‘trapped’ before they are subsequently reduced through alternate lean and rich-burn cycles.

Target chemistry: \[ 2\text{NO} + 2\text{H}_2 \rightarrow 2\text{H}_2\text{O} + \text{N}_2 \quad \text{and} \quad 2\text{NO}_2 + 4\text{H}_2 \rightarrow 4\text{H}_2\text{O} + 2\text{N}_2 \]

**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)

**Table 1. Summary of prepared H\textsubscript{2}-deNO\textsubscript{x} catalysts and associated processes**

<table>
<thead>
<tr>
<th>H\textsubscript{2}-SCR</th>
<th>H\textsubscript{2}-NSR</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pt/Al\textsubscript{2}O\textsubscript{3}</td>
<td>Pt/Ba/Al\textsubscript{2}O\textsubscript{3}</td>
</tr>
<tr>
<td>Ag/Al\textsubscript{2}O\textsubscript{3}</td>
<td>Pt/K/Al\textsubscript{2}O\textsubscript{3}</td>
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<tr>
<td>Ag/Ba/Al\textsubscript{2}O\textsubscript{3}</td>
<td>Ag/K/Al\textsubscript{2}O\textsubscript{3}</td>
</tr>
</tbody>
</table>

**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.

**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\textsubscript{2} as the reductant.