Copper Exchanged Zeolites for Ammonia Reduction of NO\textsubscript{x} from Biogas Gas Engines

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1. What is NO\textsubscript{x}?

- Nitric oxides are highly reactive gases; primarily NO (>90%) and NO\textsubscript{2}.
- Pollutants, they are involved in many atmospheric processes e.g. formation of photochemical smog and acid rain.
- They are produced as a result of high temperatures during the combustion of fuels.
- Legislation is in place to reduce NO\textsubscript{x} emissions i.e. the European Waste Incineration Directive (WID) regulates activities that involve burning or gasification of waste (Figure 1).

2. DeNO\textsubscript{x} Process

- NH\textsubscript{2}-Selective Catalytic Reduction (SCR) is an efficient, established method for NO\textsubscript{x} removal. The desired reactions are:
  
  \[4\text{NH}_3 + 4\text{NO} + \text{O}_2 \rightarrow 6\text{H}_2\text{O} + 4\text{N}_2\]
  \[8\text{NH}_3 + 6\text{NO}_2 \rightarrow 12\text{H}_2\text{O} + 7\text{N}_2\]
- BUT there are some disadvantages including:
  - Ammonia slip
  - Size of the installation
  - Thermal deactivation
- Structured reactors based on metallic short channel structures (Figure 2) demonstrate improved mass and heat transfer properties [1] and can remedy these issues.

3. Catalyst

- Copper-exchanged zeolites are well known for their NO\textsubscript{x} reduction [2] and direct NO decomposition activity [3].
- Cu-Y and Cu-LZY 82 zeolites were prepared through three-fold ion exchange of the steamed form of LZY-82.

4. Experimental

- Gas composition supplied to catalysts:
  - 2000 ppm NO
  - 2000 ppm NH\textsubscript{3}
  - 3% O\textsubscript{2}
- Temperature varied from 50-500 °C.
- Prepared zeolites compared to Cu-ZSM 5 standard.

5. Conclusions

- The copper exchanged zeolites retain the structure of the initial LZY-82 zeolite.
- Both prepared zeolite-Y catalysts demonstrate comparable DeNO\textsubscript{x} activity to the Cu-ZSM 5 standard.
- The production of unwanted side-products is negligible over the measured temperature range.

6. Future Work

- Prepare zeolite coated metallic sheets.
- Fully characterise both zeolite powders and the supported catalysts through techniques including SEM, Atomic Force Microscopy (AFM) and Raman spectroscopy.
- Repeat catalytic testing to obtain quantitative data for kinetic modelling.

REFERENCES

\textsuperscript{1}Kolodziej, A. & Łojewska, J. 2009. Catalysis Today, 147, S120-S124