Copper Exchanged Zeolites for Ammonia Reduction of NO_x from Biogas Gas Engines

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1. What is NO_x?

- Nitric oxides are highly reactive gases; primarily NO (>90 %) and NO_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_x emissions i.e. the European Waste Incineration Directive (WID) regulates activities that involve burning or gasification of waste (Figure 1).

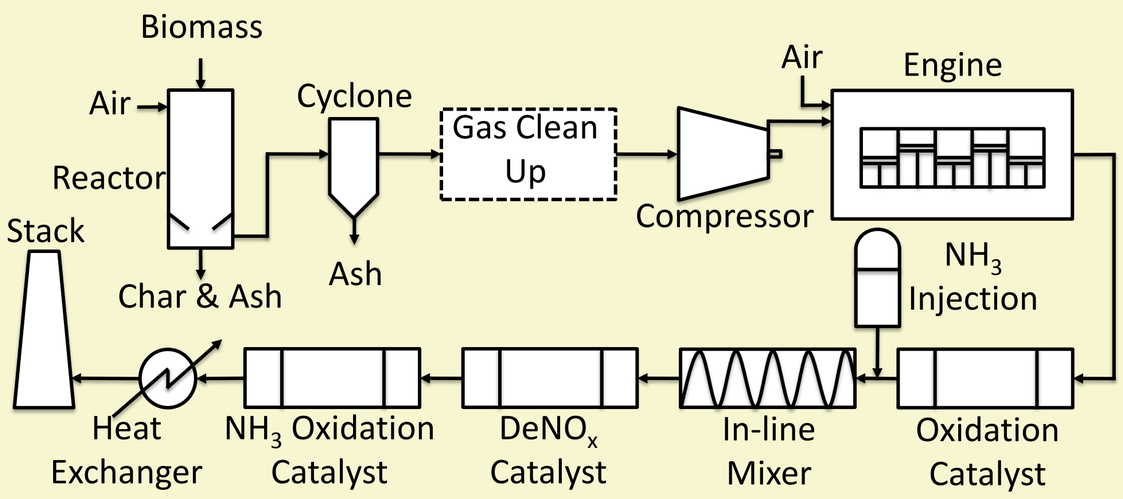

Figure 1. Schematic of proposed biogas engine exhaust treatment system

2. $DeNO_x$ Process

- NH_3-Selective Catalytic Reduction (SCR) is an efficient, established method for NO_x removal. The desired reactions are:

$$4NH_3 + 4NO + O_2 \rightarrow 6H_2O + 4N_2$$
$$8NH_3 + 6NO_2 \rightarrow 12H_2O + 7N_2$$

- 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.

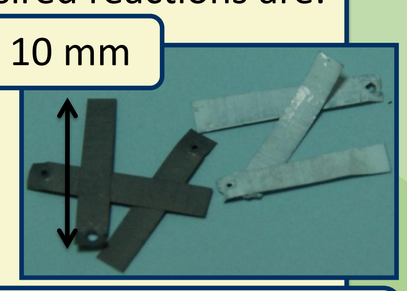

Figure 2. Metal sheet catalyst supports

3. Catalyst

- Copper-exchanged zeolites are well known for their NO_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.

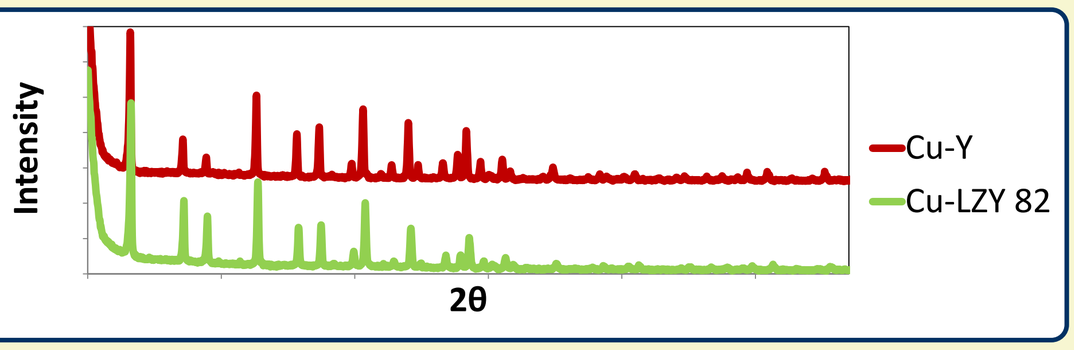

Figure 3. Powder X-ray diffraction patterns of prepared zeolites

4. Experimental

- Gas composition supplied to catalysts:
  - 2000 ppm NO
  - 2000 ppm NH_3
  - 3 % O_2
- Temperature varied from 50-500 °C.
- Prepared zeolites compared to Cu-ZSM 5 standard.

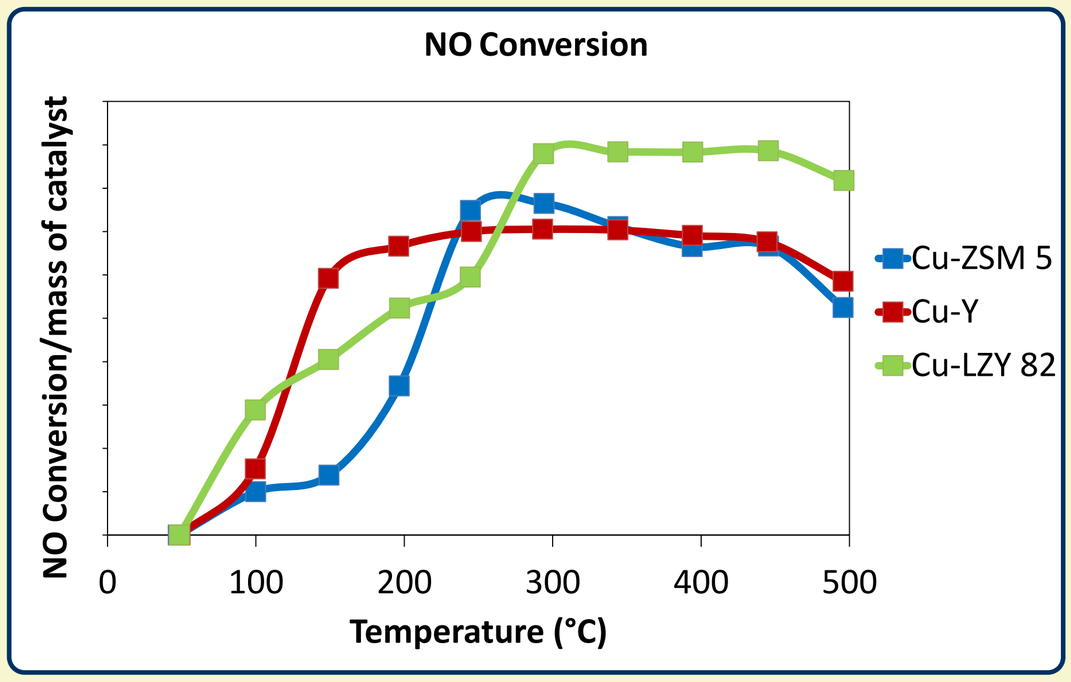

Figure 4. Comparison of NO conversion capabilities of zeolite catalysts

5. Conclusions

- The copper exchanged zeolites retain the structure of the initial LZY-82 zeolite.
- Both prepared zeolite-Y catalysts demonstrate comparable $DeNO_x$ 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
[1]Kołodsiej, A. & Łojewska, J. 2009. *Catalysis Today, 147**, S120-S124***
[2]Sato, S., Yu-U, Y., Yahiro, H., Mizuno, N. & Iwamoto, M. 1991. *Applied Catalysis, 70**, L1-L5.***
[3]Iwamoto, M., Yahiro, H., Tanda, K., Mizuno, N., Mine, Y. & Kagawa, S. 1991 *The Journal of Physical Chemistry, 95**, 3727-3730.***

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