NO ABSORBENTS AS MASS TRANSFER VECTORS FOR BIOLOGICAL TREATMENTS

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Environmental problem targeted

TRANSPORTATION

50% NO\textsubscript{x} emissions

ENERGETIC INDUSTRY

22% NO\textsubscript{x} emissions

95% NO
5% NO\textsubscript{2}

HEALTH AND ENVIRONMENTAL EFFECTS

LUNG DISEASES
HEART DISEASES
HEADACHES
DIZZINESS
GLOBAL WARMING
ENVIRONMENTAL DAMAGE

8.8 million causes of deaths per year worldwide can be attributed to polluted air.
Objective

Nitric oxide (NO) is slightly soluble to be treated with conventional technologies. To develop an innovative technology for the treatment of nitric oxide (NO) from combustion process gases and based on two stages: a chemical absorption stage with a mass transfer vector and a biological process stage, in which the nitric oxide (NO) and regenerates from the mass transfer vector, minimizing the environmental impact of the treatment.

Our solution: NOx to N2

Combustion processes Flue gases

- Chemical absorption
- Biological reduction

Low energy consumption, No secondary pollutants, Low capital and operational cost

Patent pending
Research steps

- **120 ml vials**
- **500 ml bottles**
Experimental methodology of absorption test

1. 120 mL vials or 500 mL bottles filled with N₂ gas.
2. The volume of NO (10%) needed to prepare the mixture of the desired concentration was injected.
3. The volume of absorbent was injected while maintaining a slight overpressure inside the vial to prevent air from entering.

Mass transfer vectors:

Non-aqueous phase solvents
NAPs
Experimental methodology of biocompatibility test

SBR
Enriched denitrifying bacteria

Anaerobic respirometry

WWTP Manresa (Catalunya)

Aerobic respirometry (Ultimate DBO - OxiDirect®)
Results (absorption test)

- 120 mL vials
- Different amounts (moles) of NAP
- Gas phase (NO) and NAP
Results absorption test (NAPs-aqueous phase - water)
Results absorption test (NAPs-aqueous phase - buffer)

- GAS PHASE (NO-NO₂)
- NAP + PHOSPHATE BUFFER
### Results of biocompatibility studies

<table>
<thead>
<tr>
<th>NAP</th>
<th>Toxicity</th>
<th>Biodegradability (Anaerobic)</th>
<th>%Biodegradability (Aerobic)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hexadecane</td>
<td>No</td>
<td>No</td>
<td>8</td>
</tr>
<tr>
<td>Diethyl Sebacate</td>
<td>No</td>
<td>Yes</td>
<td>100</td>
</tr>
<tr>
<td>Heptamethyl nonane</td>
<td>No</td>
<td>No</td>
<td>1</td>
</tr>
<tr>
<td>Heptamethyl trisiloxane</td>
<td>No</td>
<td>No</td>
<td>7</td>
</tr>
<tr>
<td>Silicone oil</td>
<td>No</td>
<td>No</td>
<td>0</td>
</tr>
</tbody>
</table>

\[
\% \text{Biodegradability} = \frac{\text{COD}_{\text{experimental}}}{\text{COD}_{\text{Theoretical}}} \times 100\%
\]
Results of integration CABR systems

1. 2.5 mL NAP’s – Enriched biomass

2. 2.5 mL NAP’s – Enriched biomass X2

<table>
<thead>
<tr>
<th>Gas phase (NO-NO2)</th>
</tr>
</thead>
<tbody>
<tr>
<td>NAP, mineral medium and biomass</td>
</tr>
</tbody>
</table>
Results of integration CABR systems
Microbial community analysis and qPCR
Conclusions

The results of this work showed that all the NAPs (HEX, HNO, HTX, DSE, SO) could be used as mass transfer vectors for chemical absorption - biological reduction systems of NO, with heptamethyl trisiloxane being the compound that showed the greatest absorption capacity both in its pure state and in contact with an aqueous phase. In the CABR tests, it was shown that NO elimination improves in a short time (30 minutes) when the three mass transfer vectors (HEX, HTX, HNO) and enriched denitrifying bacteria are added.

None of the NAPs studied turned out to be toxic for denitrifying bacteria. However, diethyl sebacate resulted to be biodegradable, which, to be used in biological processes, would generate high operational costs because NAP could not be reused in the process.
Future challenges

✓ Increasing the TRL of the technology scaling up to bench scale in which each of the stages can be studied.

✓ Maintain a NO removal efficiency greater than 80% at bench scale.

✓ To optimize the recirculation of the mass transfer vector in order to reduce operating costs.

✓ Study the effect that other gases such as CO₂, SO₂ and O₂ have on microbial activity and the absorption process.

✓ Adapt the technology to the diversity of combustion processes such as power plants or incinerators, taking into account legal requirements, NO concentration and gas flow conditions.
Thank you!

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