Towards a Sustainable Decarbonised Future: Aftertreatment for Ammonia Fuelled Engines

MariNH3 — Clean, green ammonia engines for maritime

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Introduction

Unlike other conventional fuels, NH_3 does not produce carbon-based emissions. However, NH_3 presents significant environmental concerns due to the potential for substantial emissions of NH_3, NO_x, and N_2O. The primary cause of NH_3 emissions is incomplete combustion. N_2O emissions arise from intermediate products formed during the incomplete combustion of NH_3. It is well established that N_2O emissions possess a considerably high global warming potential. In combustion strategies, there is a trade-off in controlling NH_3 and N_2O emissions. Consequently, advanced after-treatment systems are critical components in the effort to reduce emissions from NH_3-fueled engines.

NH_3: Strong Irritant odor, highly toxic.

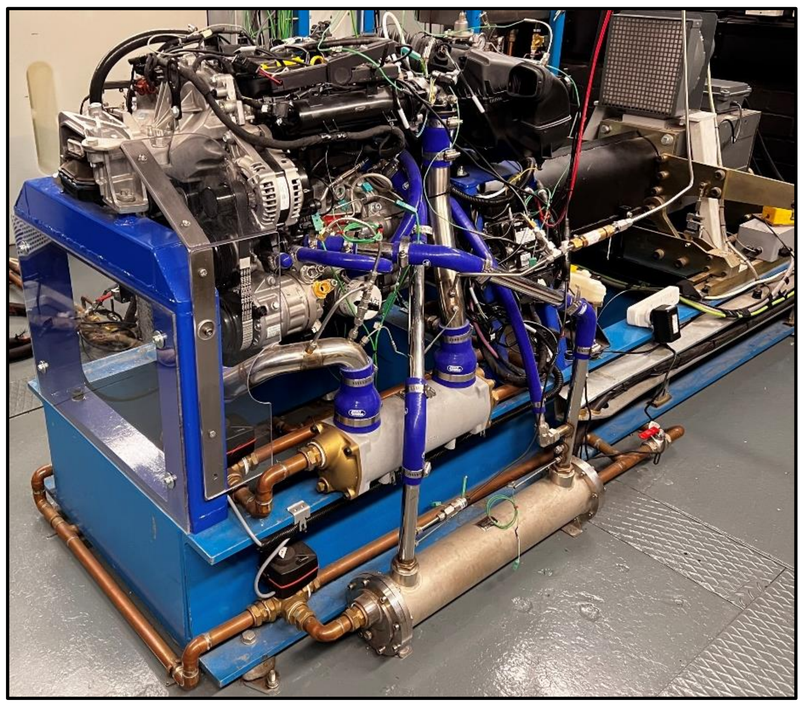
NO_X: Photochemical smog, acid rain, air pollution, highly toxic.

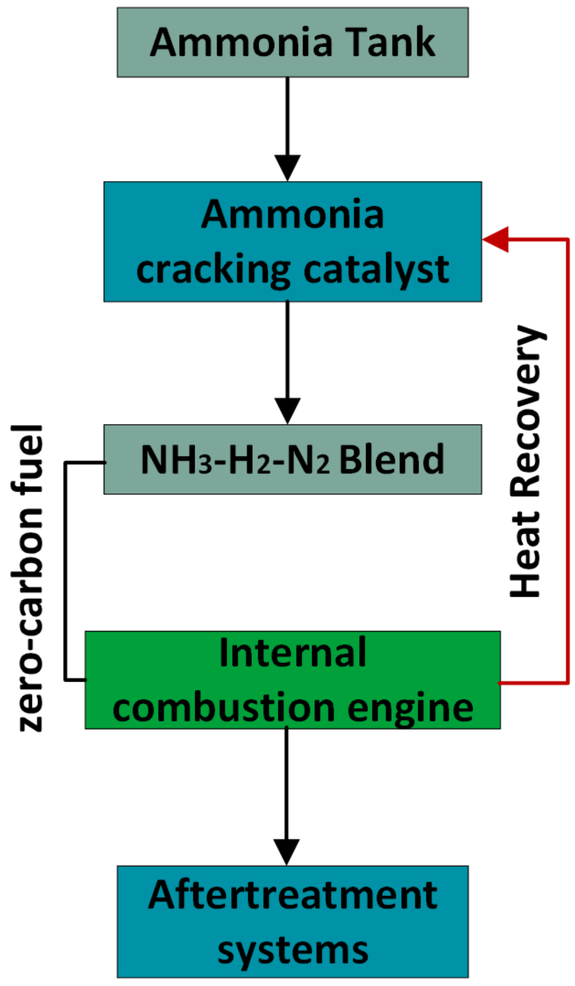
N_2O: A long-lived greenhouse gas. Ozone-depleting substance.

Zero Carbon Fuels (H_2/NH_3)

$CO + THC + NO_X$ → Conventional Fuel

$NH_3 + NO + NO_2 + N_2O$ → Conventional Fuel





Ammonia cracking catalysts

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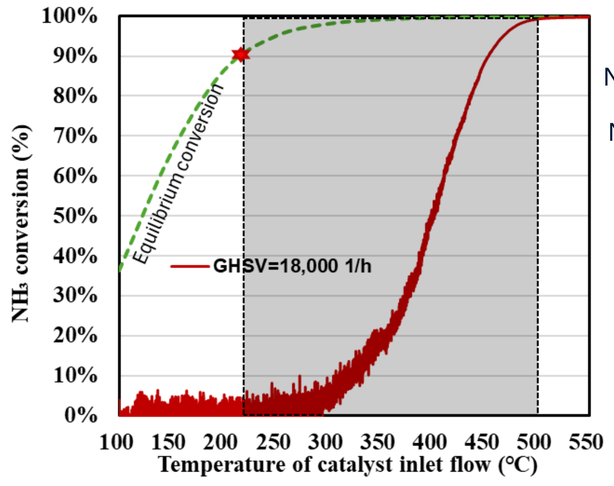


$NH_3 + * \leftrightarrow NH_3(*)$

$NH_3(*) + * \leftrightarrow NH_2(*) + H(*)$

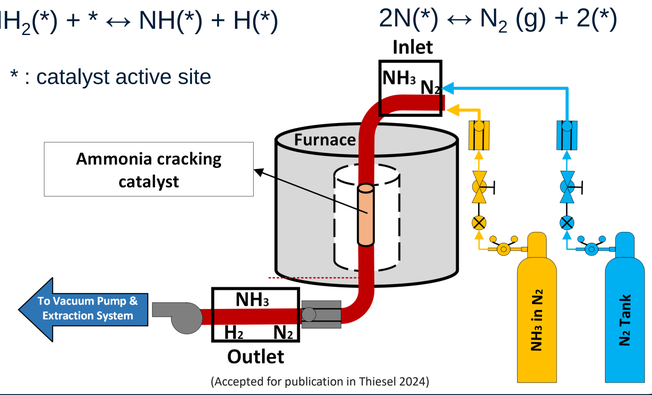
$NH_2(*) + * \leftrightarrow NH(*) + H(*)$

$NH(*) + * \leftrightarrow N(*) + H(*)$

$2H(*) \leftrightarrow H_2(g) + 2(*)$

$2N(*) \leftrightarrow N_2(g) + 2(*)$

* : catalyst active site



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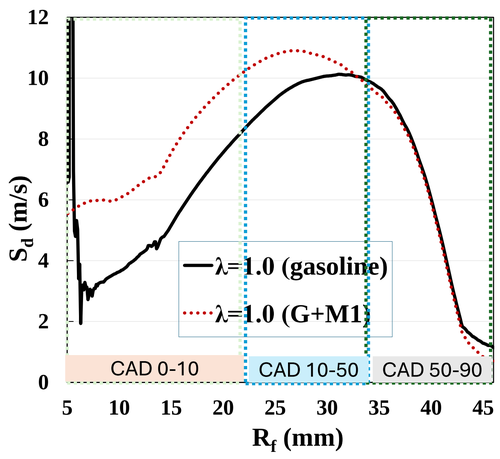
Fundamentals model analysis of combustion speed



Filtering pressure records

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Determination parameters by genetic algorithms

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Diagnostic thermodynamic model

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Geometric model

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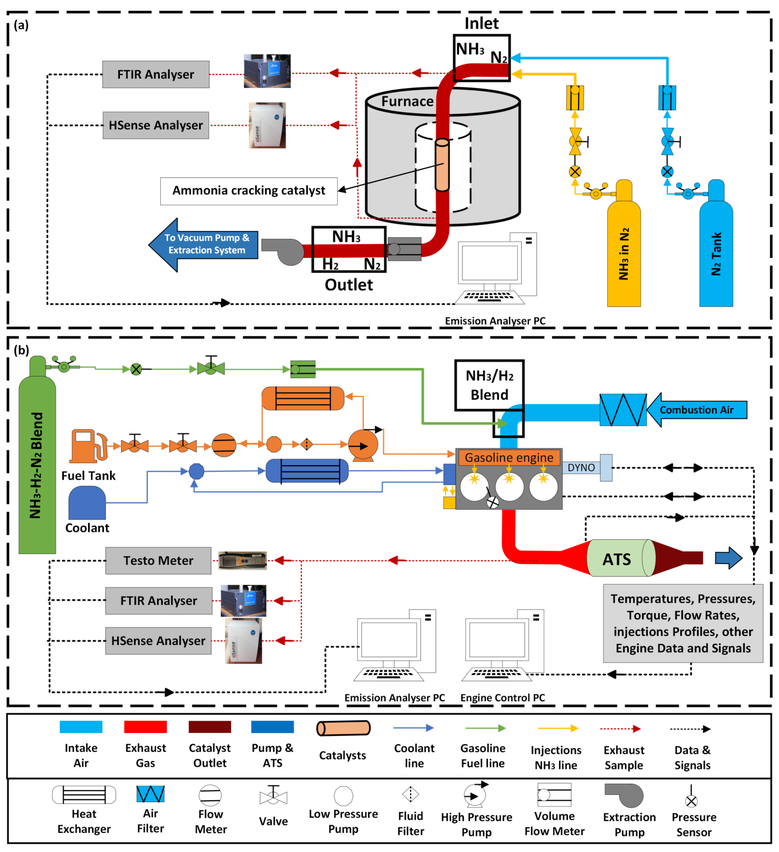
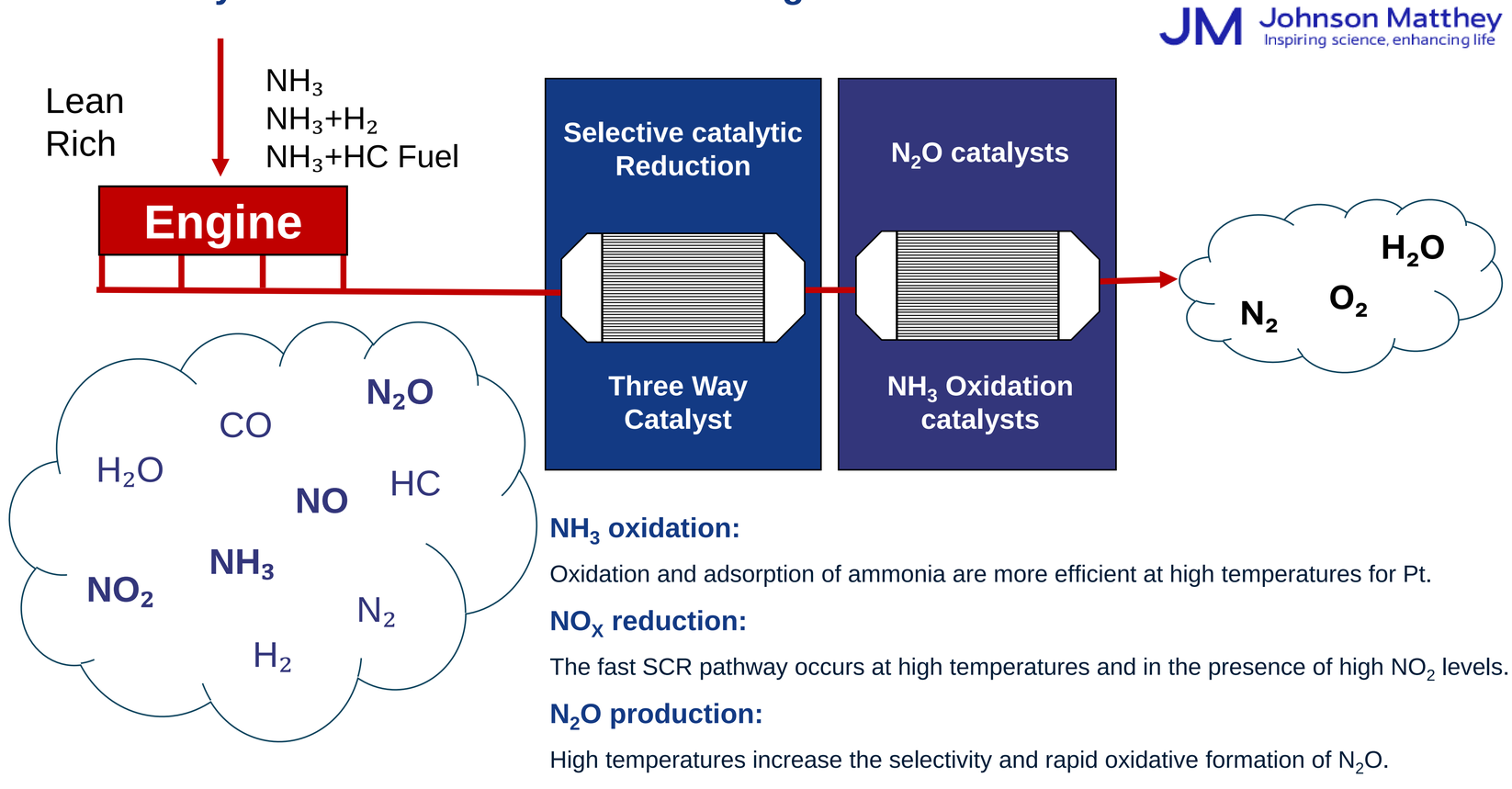
Combustion flame speed (S_d)

After-treatment systems for Ammonia Fueled Engines





NH_3 oxidation:

Oxidation and adsorption of ammonia are more efficient at high temperatures for Pt.

NO_X reduction:

The fast SCR pathway occurs at high temperatures and in the presence of high NO_2 levels.

N_2O production:

High temperatures increase the selectivity and rapid oxidative formation of N_2O.

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