Instituto Universitario de Investigación de Ingeniería de Aragón
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Study of the Thermal Decomposition of Ammonia in a Stainless Steel Reactor: Ammonia Production and Sustainable Prospects

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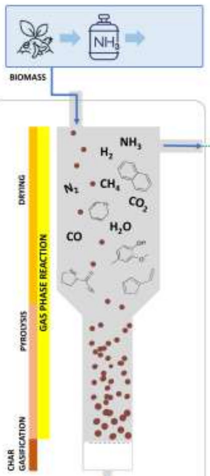
INTRODUCTION



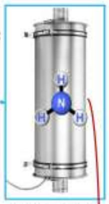
• **Secondary reactions:** influence the final distribution of fuel-N [1]

Decomposition reaction

$$NH_{3\,(g)} \rightleftharpoons \frac{1}{2} N_2\,(g) + \frac{3}{2} H_{2\,(g)}$$

Pressure
Reaction atmosphere
Temperature
Reactor characteristics

Corrosion resistant
High durability



Stainless steel reactor

Material Group	Catalytic Effect	NH_3 Decomp. (%) T = 823 K	% NH_3 Decomp. (%) T = 1173 K	Source
Stainless steel reactor (with catalytic effect)	Yes	89.5	100	This work
Quartz/alumina reactor (no catalytic effect)	No	-	0.8	[2]
Catalysts used for NH_3 decomposition	Yes	Fe 4 Co 9 Ru 14 Ni 33	-	[3]

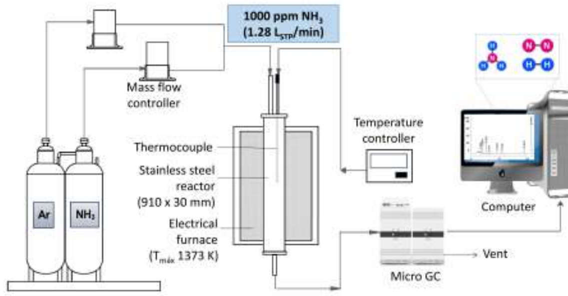
Behavior of NH_3 conv. at T's between 773 and 1173 K ?

OBJECTIVE

Evaluate the conversion of ammonia in steady-state conditions in a stainless-steel reactor under different temperatures (773-1173 K). Explore its application in the recovery of NH_3 from nitrogen-rich waste by gasification.

METHODOLOGY

Analysis of the influence of Temperature on NH_3 conversion



Experimental conditions utilized

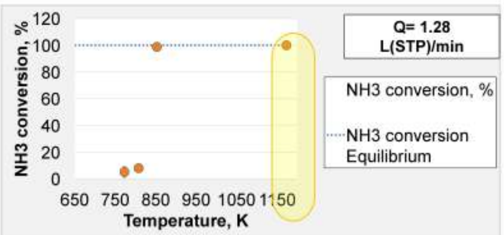
T (K)	773	808	853	1173
t_{res} (s)	10.7	10.2	9.7	7.0

- Holding each set point constant until the product's concentration attained a steady-state condition.

RESULTS

Influence of temperature on NH_3 conversion (%) in a stainless steel AISI 310 plug-flow reactor

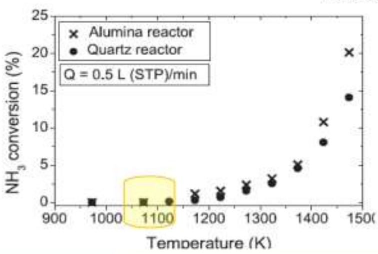
Stainless Steel reactor



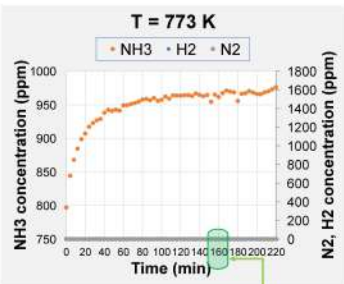
vs

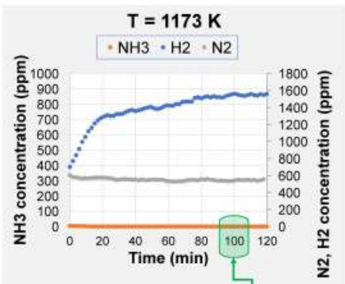
Quartz/Alumina reactor

Source: [1]



✓The higher conversion of ammonia (100%) compared to the result obtained in a plug-flow quartz reactor for the non-catalytic thermal decomposition (~1.5%) at the same temperature (1173 K) and residence time (7.0 s) evidences a potential catalytic effect of stainless steel.





Transient (non-stationary) times

CONCLUSION

The reactor material, specifically **stainless steel**, plays a crucial role in ammonia decomposition based on temperature. At **above 853 K**, the reactor surface **promotes H_2 production**, enhancing decomposition. Conversely, at **below 808K**, the reactor material stabilizes conditions favoring **NH_3 formation**. This demonstrates how the reactor composition directly impacts gas-phase reactions and overall process efficiency.

References

[1] Gil-Lalaguna, N., Afailal, Z., Aznar, M. & Fonts, I. Exploring the sustainable production of ammonia by recycling N and H in biological residues: Evolution of fuel-N during glutamic acid gasification. *J Clean Prod* **282**, (2021).

[2] Benés, M. *et al.* Experimental study of the pyrolysis of NH_3 under flow reactor conditions. *Energy and Fuels* **35**, 7193–7200 (2021).

[3] Lucentini, I., Garcia, X., Vendrell, X. & Llorca, J. Review of the Decomposition of Ammonia to Generate Hydrogen. *Ind Eng Chem Res* **60**, 18560–18611 (2021).

Acknowledgements

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