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# A Numerical Study on Transient Side-Wall Quenching of Premixed Laminar Ammonia Flames Enriched with Hydrogen

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One of the alternative ways of enhancing the low reactivity of ammonia ($NH_3$) is to enrich it with hydrogen ($H_2$). This enrichment could affect the interactions between ammonia-based flames and walls. Very recently, the effects of the equivalence ratio and the blending ratio (i.e. the molar ratio of hydrogen to ammonia/hydrogen in the mixture) on side-wall quenching (SWQ) characteristics such as the formation of pollutants, quenching distance, and wall heat flux have been explored for ammonia/hydrogen flames in detail [1]. Similar to [1], the SWQ of premixed laminar ammonia/hydrogen flames is explored herein using detailed chemistry and the mixture-averaged transport model. A two-dimensional (2-D) domain which is equipped with a rod for the purpose of stabilization is utilized. In this work, three test cases are designed to assess the SWQ characteristics of ammonia/hydrogen flames by systematically varying the imposed excitation frequency ($f$) at the inlet of the channel from $0$ to $1000\,\mathrm{Hz}$ for a stoichiometric flame under a fixed wall temperature of $500\,\mathrm{K}$ at atmospheric pressure. The blending ratio for all three cases is equal to $0.4$. For the unperturbed test condition ($f = 0\,\mathrm{Hz}$), the results show that the $N_2$ pathway is the dominant mechanism of NO formation in the vicinity of the wall near the quenching region. Within this pathway, the leading reaction converting NO to $N_2$ is $\mathrm{R}76$ ($\mathrm{NH_2 + NO \Leftrightarrow N_2 + H_2O}$). Furthermore, the results reveal that the flame responds strongly to the low excitation frequency of $200\,\mathrm{Hz}$, which is indicated by flame front fluctuations. However, it does not respond to the high excitation frequency of $1000\,\mathrm{Hz}$.

## References

[1] Tamadonfar et al. A numerical study on side-wall quenching of premixed laminar flames: An analysis of ammonia/hydrogen/air mixtures. *Combustion and Flame*. 2025;275.