Alternative Combustion Technology for High Hydrogen Content Fuel

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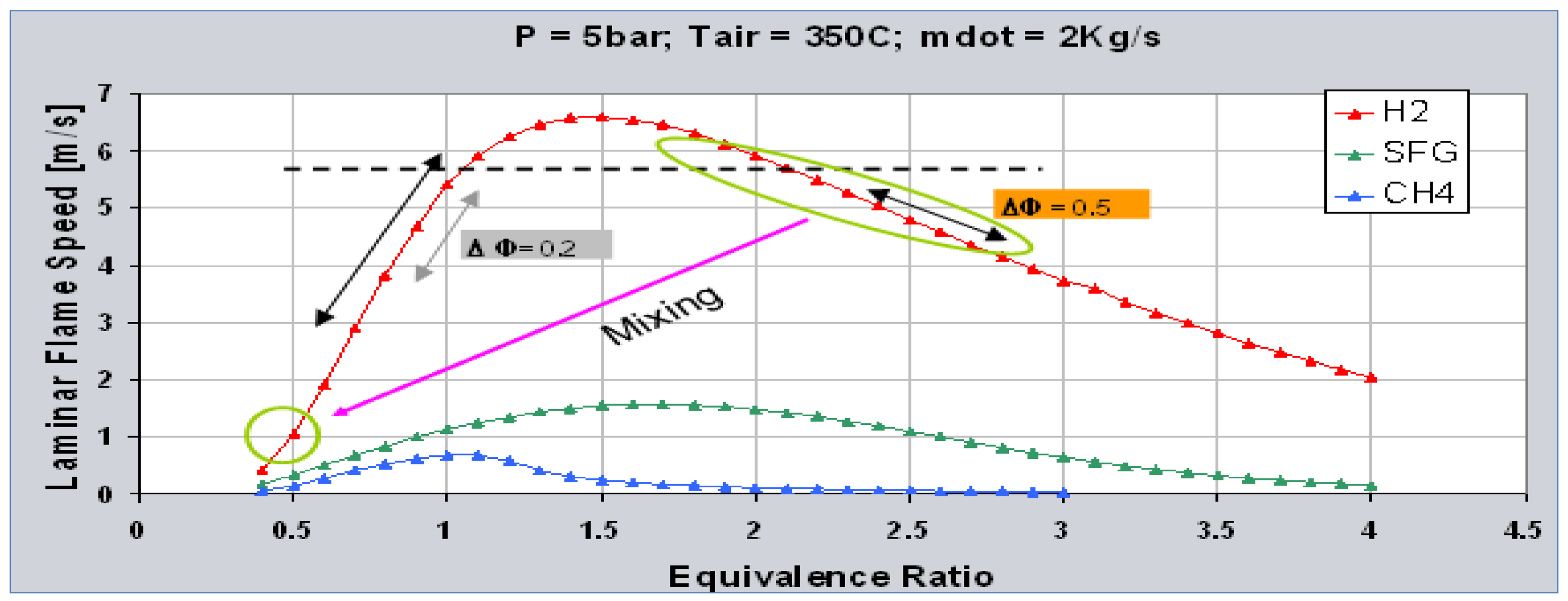
Introduction:

- Future generation gas turbine combustors using high hydrogen content fuel requires an improvement in efficiency and reduction in emissions without sacrificing operational advantages.
- Premixed RQL (Rich-Burn, Quench, Lean-Burn) combustion is a promising technology for potentially mitigating flame flashback while ensuring operation in the low NOx emission regime.
- In RQL, combustion occurs first under fuel-rich conditions before quenching by rapid mixing with air. Combustion occurs again and completes in a fuel-lean condition.

Motivation:

- It is hypothesized that operating in the rich regime will minimize local regions of high flame speed caused by unmixed air-fuel mixtures in the combustor.



- For a fixed level of unmixed gas, a lean combustor will have larger flame speed fluctuation than a rich combustor leading to greater likelihood of flashback.

Objectives:

- Perform kinetic and emission calculation for different fuel compositions using GENE-AC network reactor model
- Parametric modeling of the RQL combustion method for different hydrogen content fuel compositions.

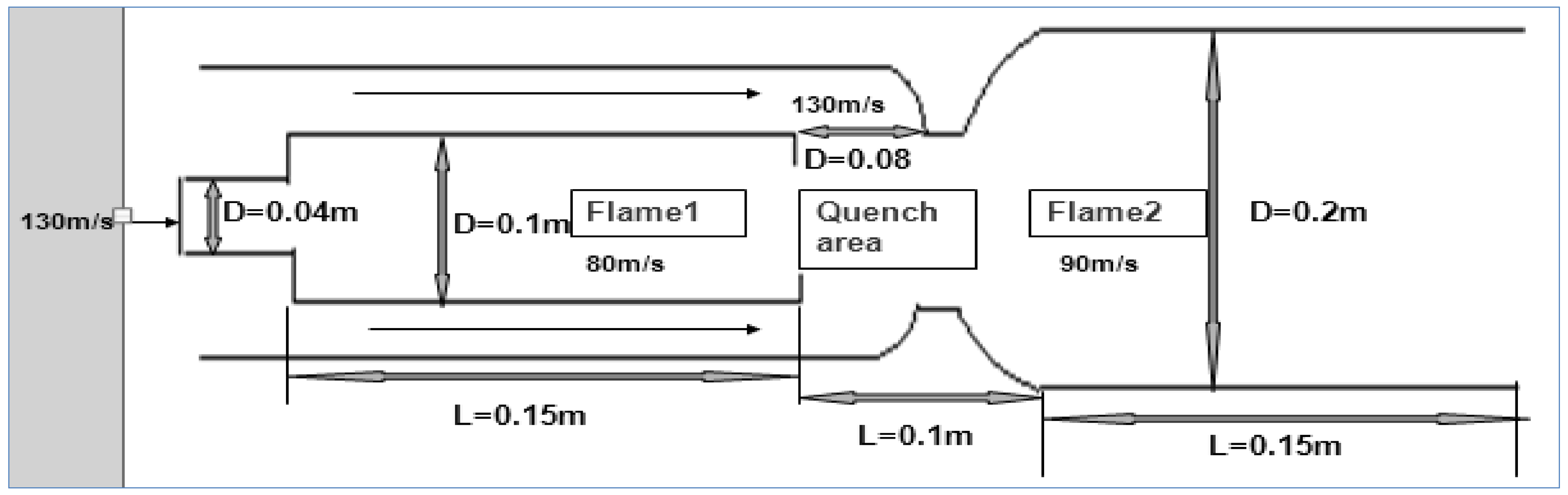


Fig 1: Baseline Geometry of RQL combustor

Technical Approach:

The mixing and emission behavior associated with the rich-burn effluent and dilution jets in the RQL combustor has been studied using Holdeman correlation based aero design and chemical reactor network modeling, respectively.

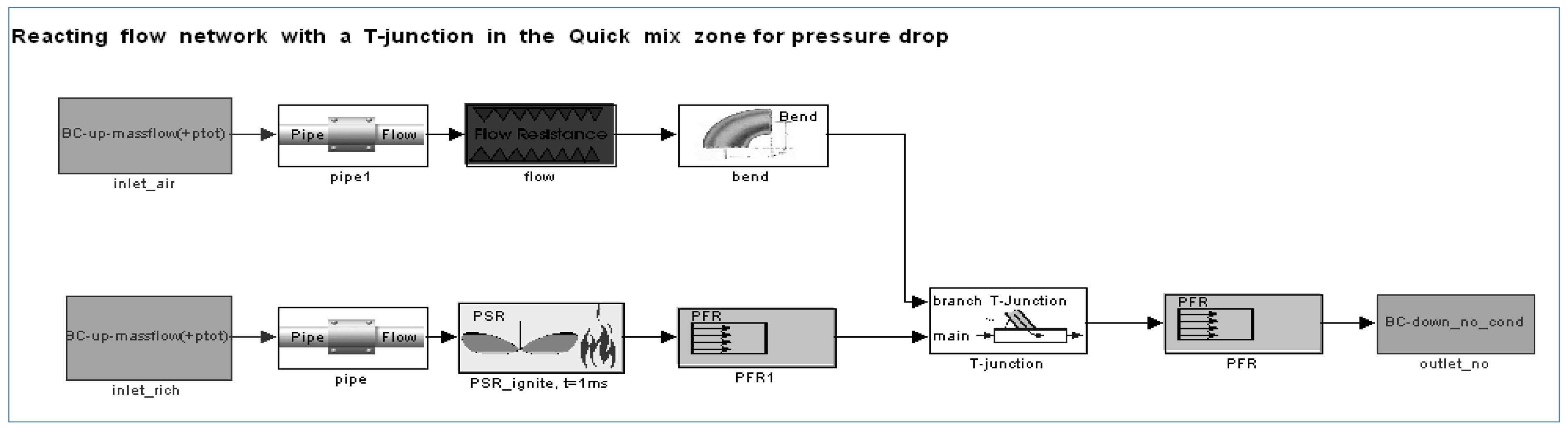


Fig 2: Network reactor model for pressure drop calculation

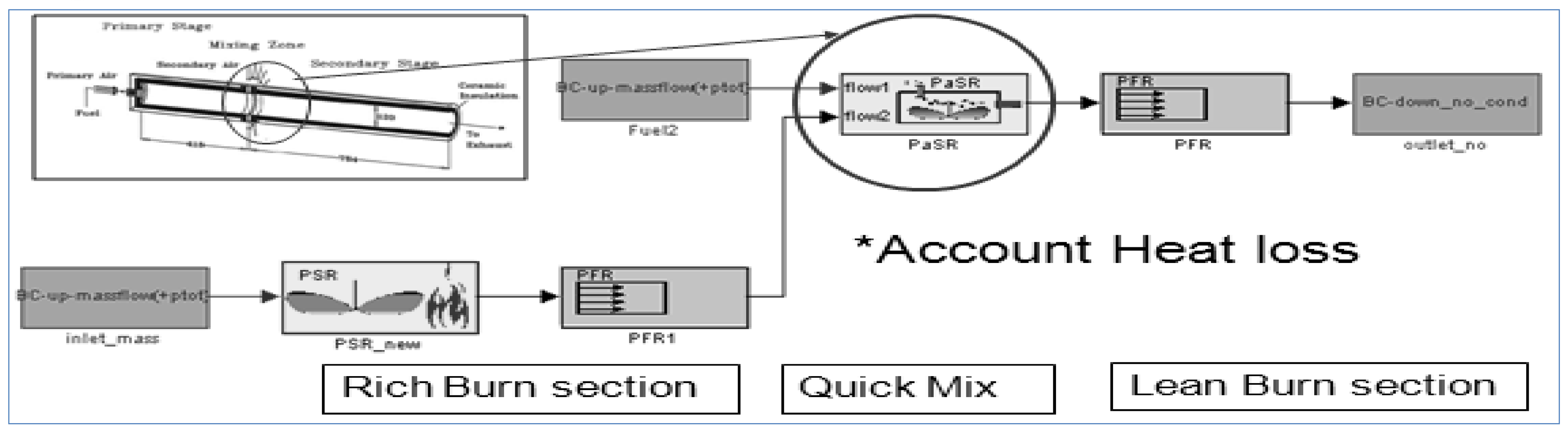


Fig 3: Network reactor model validation by Emission calculation

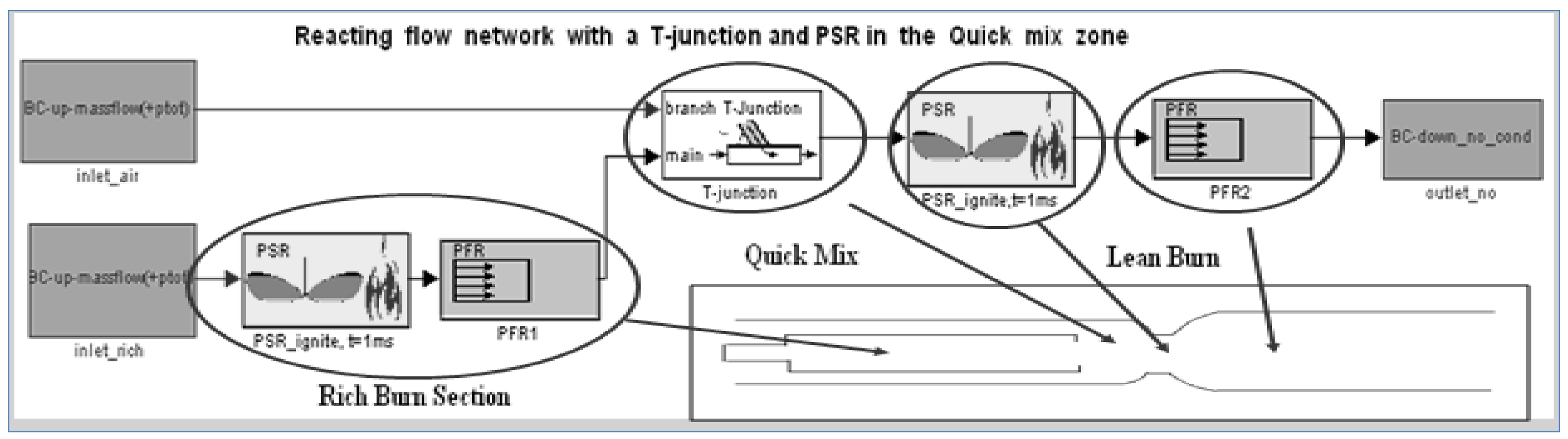


Fig 4: Network reactor model for Emission calculation

Results:

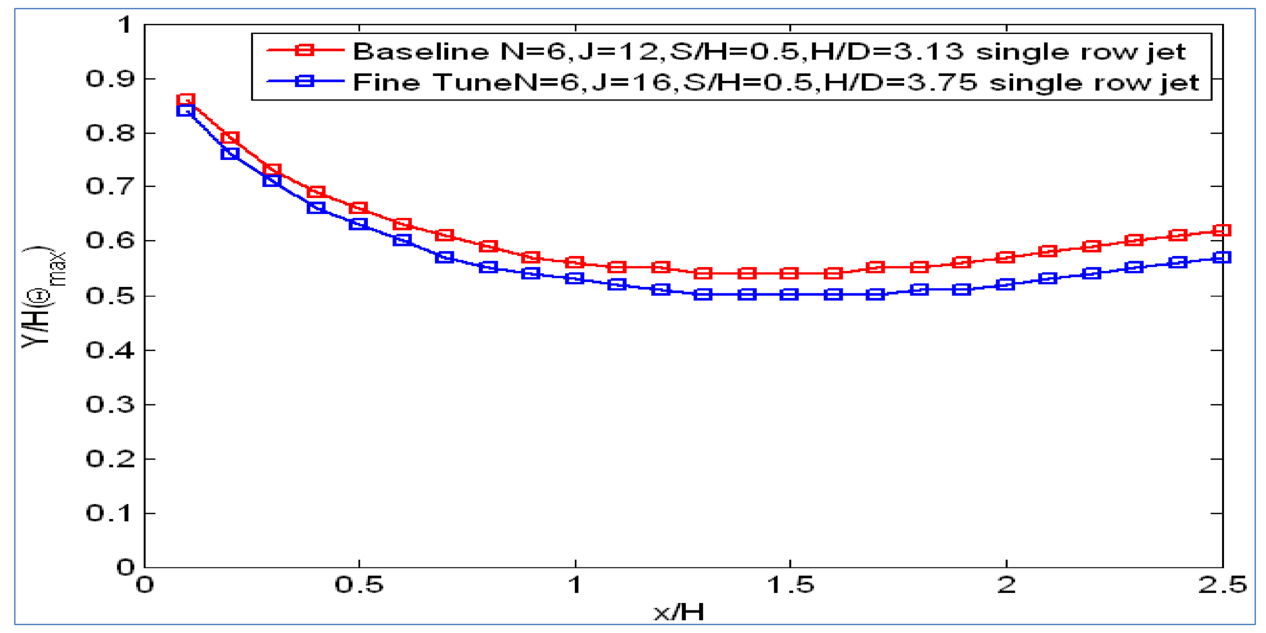


Fig 5: Jet to cross flow mixing profile

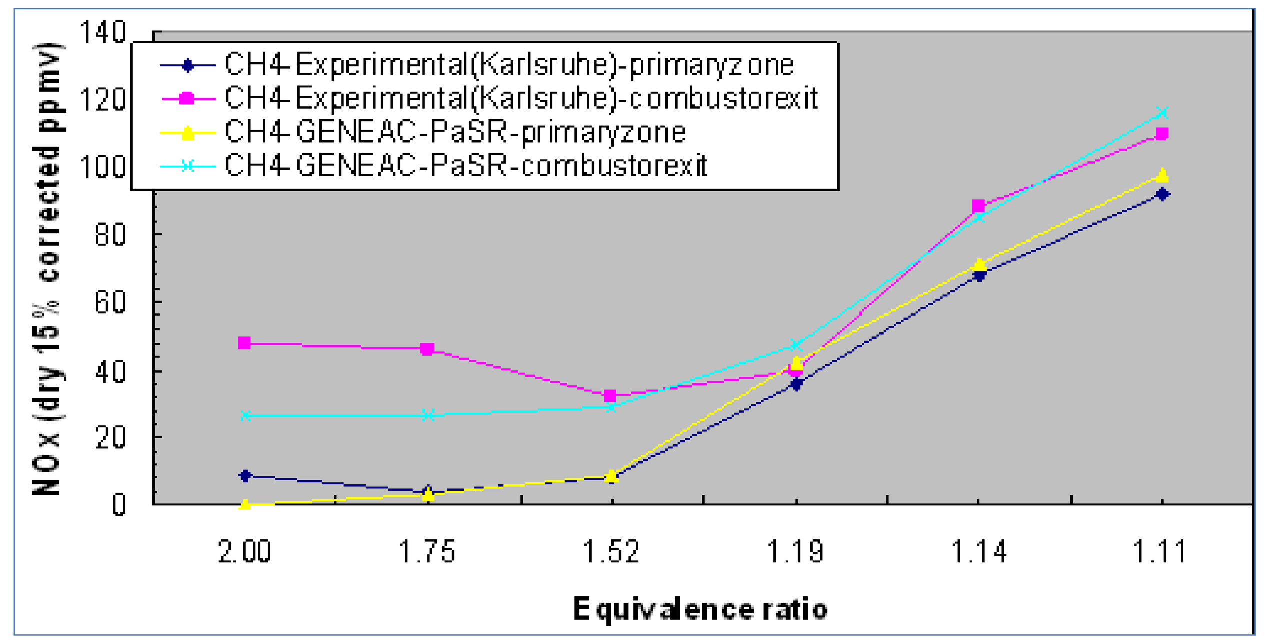


Fig 6: Network Reactor Model validation

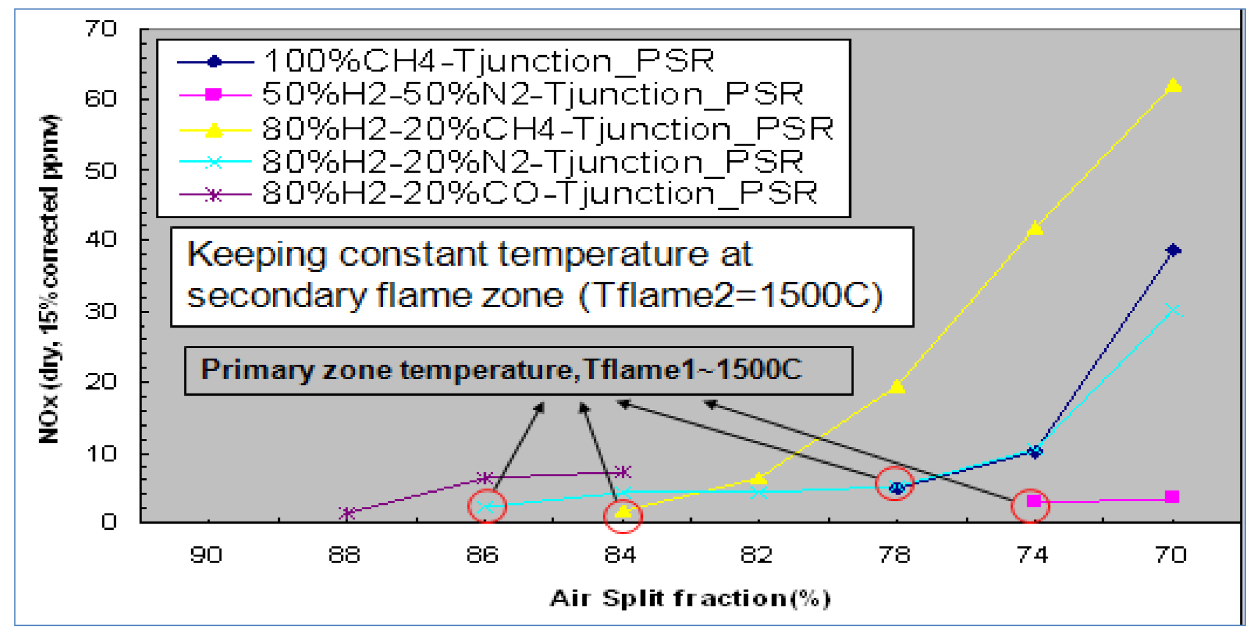


Fig 7: NOx Emission Trend using the model

Conclusion:

- Aero design looks promising in terms of pressure drop
- Maintaining air split fraction can control NOx emission
- Mixing would be major challenge to ensure the feasibility of the RQL combustor.

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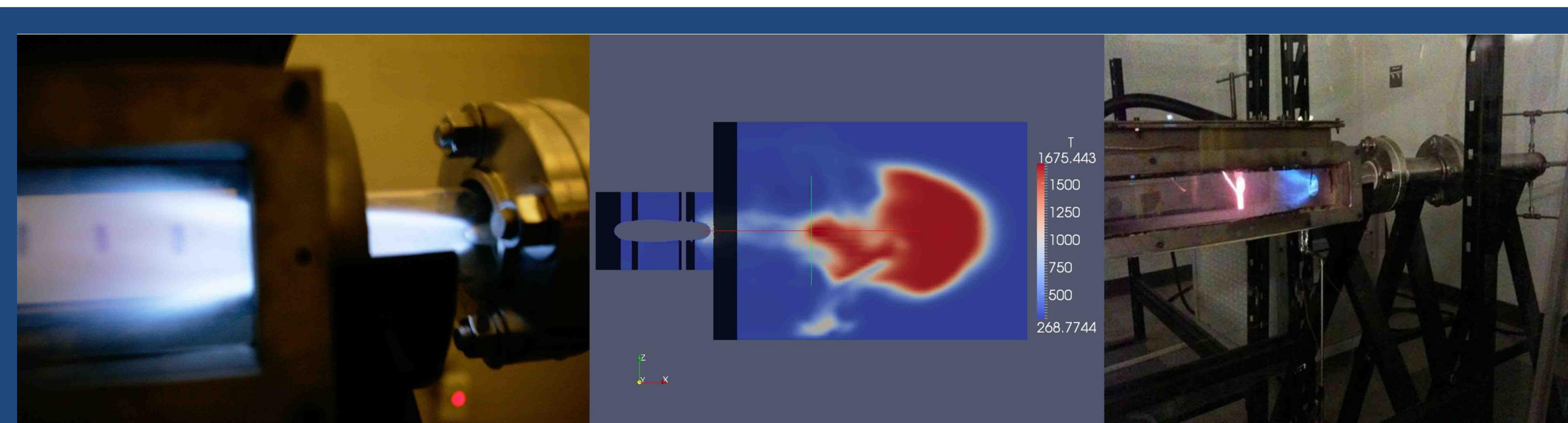

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