Autoignition of Hydrogen/Natural Gas/Nitrogen Mixtures at Reheat Combustor Operating Conditions

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**Abstract**

This study investigates the influence of fuel jet composition on autoignition, ignition kernel propagation, and subsequent flame stabilization at conditions that are relevant for the practical operation of gas turbine reheat combustors (p = 15 bar, Tinlet > 1000 K, hot flue gas, appropriate residence times). The experimental investigation was carried out in a generic, optically accessible reheat combustor. Autoignition of H2/natural gas (NG)/N2 jets in cross flow were recorded by a high-speed camera at frame rates of up to 30,000 fps. The autoignition behaviour was investigated as the H2 volume fraction was increased (decreasing NG) in different fuel mixtures for two different jet penetration depths. Additionally, the subsequent flame stabilization phenomena and the structure of the stabilized flame are discussed. The results reveal that autoignition kernels occurred even for the lowest H2 fuel fraction, but they did not initiate a stable flame in the mixing zone. Increasing the H2 volume fraction decreased the distance between the initial position of the autoignition kernels and the fuel injector, finally leading to flame stabilization. The occurrence of autoignition kernels at lower H2 volume fractions (H2/(H2+NG) < 85%) was not found to be significantly influenced by the fluid dynamic and mixing field differences related to the different jet penetration depths. In contrast, autoignition leading to flame stabilization was found to depend on jet penetration; flame stabilization occurred at lower H2 fractions for the higher jet penetration depth (H2/(H2+NG) ≈ 89 compared to H2/(H2+NG) ≈ 95 vol. %).

# Introduction

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|  |  |
| --- | --- |
|  |  |

Figure 1. Temporal variation of the droplet mean diameter at 50 mm downstream of the nozzle at centerline and 6 mm off-center. Error bars represent 2 standard deviations obtained from repetitive measurements.

Tables

Tables should be numbered consecutively with Arabic numerals. Footnotes to tables should be indicated by superior letters, beginning with “a”. The table caption should be above the table, as shown below:

Table 1. Relative concentrations of species at 4000 K and 56 MPa computed using detailed chemical mechanism assuming identical binary diffusion coefficients and temperature dependent transport properties.

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| Set | H | O | OH | CHa | Nb | S | R |
| 1 | 0.01 | 0.03 | 0.08 | 0.01 | 0.08 | 0.03 | 0.01 |
| 2 | 0.08 | 0.01 | 0.03 | 0.08 | 0.03 | 0.01 | 0.03 |
| 3 | 0.03 | 0.03 | 0.01 | 0.03 | 0.01 | 0.08 | 0.01 |
| 4 | 0.01 | 0.08 | 0.03 | 0.01 | 0.03 | 0.01 | 0.08 |
| 5 | 0.08 | 0.03 | 0.08 | 0.03 | 0.01 | 0.03 | 0.01 |

a Estimated by using reaction 324.

b Obtained from RKM approximation.

# Conclusions/Concluding Remarks (or summary)

* 1. *Units*

Authors are expected to use the SI system of units.

**Acknowledgements**

Any acknowledgement you might wish to include goes here.

**References**

References should be indicated in the text by full-size numbers in brackets, e.g., [1], and should be numbered in the order cited. The numbered reference list should conform to *Sustainable Energy Technologies and Assessments* instructions *except* that full paper titles should be included:

*Journal Papers*:

1. J.R. Doe, J.Q. Public, An Analysis of Interesting Paper Titles, *Combust. Flame* 100 (2005) 60-69.
2. J.R. Smith, A Novel Nano-bio-energy Thing, *Proc. Combust. Inst.* 30 (1986) 1115-1124.

*Thesis*:

1. M.R. Student, Stuff that took me a year too long, MASc. thesis, Institute for Engineering Studies, University of Canada, Iqaluit, NU, Canada, 2010.

*Book*:

1. C. K. Law, *Combustion Physics*, Cambridge University Press, New York, 2006, p.84.

*Paper or Chapter in an Edited book*:

1. H. Burns, I.M. Hot, in: U.R. Pyro (Ed.), Large Scale Fire Dynamics, Taylor and Francis, London, 1988, p.502.

*Conference Proceedings*:

1. M.T. Head, I.M. Done, Another Novel Nano-bio-energy Thing, Proceedings of Combustion Institute Canadian Section Spring Technical Meeting, May 15-17, 2012, pp.3.1-3.6.

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