RICH PREMIXED HYDROGEN/AIR OSCILLATORY FLAMES: DETAILED MODELLING AND MODEL REDUCTION*

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The appearance of different dissipative structures emerging as a result of oscillatory diffusive-thermal instabilities are observed in experiments for various fuel-air mixtures mostly with Lewis numbers greater than one (see e.g., [1]), which include pulsating axial, radial, drumhead modes, spirals, target, mixed mode and chaotic pulsations. Theoretical study and quantitative modelling of such complex spatio-temporal regimes with the detailed reaction and diffusion mechanisms is a challenging task [2]. We have recently shown [3] that even for a one-dimensional model characteristics of pulsating regimes predicted by using different reaction mechanisms are sensitive to the choice of mechanism and may differ significantly especially for elevated pressures. This makes the phenomenon as extremely important which can be considered for further development and validation of detailed and reduced reaction models. The latter can be efficiently applied for numerical computational studies. Therefore, one dimensional models to describe the onset of pulsating instabilities and influence of detailed kinetic models are in the focus of the current study.

Mechanism	Ref.	Comment	symbol/Fig. 1
O'Conaire	[4]	no change needed	+
ELTE	[4]	OH($h\nu$) is eliminated	*
Keromnes	[4]	C-.., OH($h\nu$) removed	◇
San Diego	[4]	no change needed	△
Warnatz	[4]	no change needed	□
GRI	[4]	C-.. are eliminated	○

Table 1: Considered mechanisms with references and information regarding the implementation for the considered combustion regime.

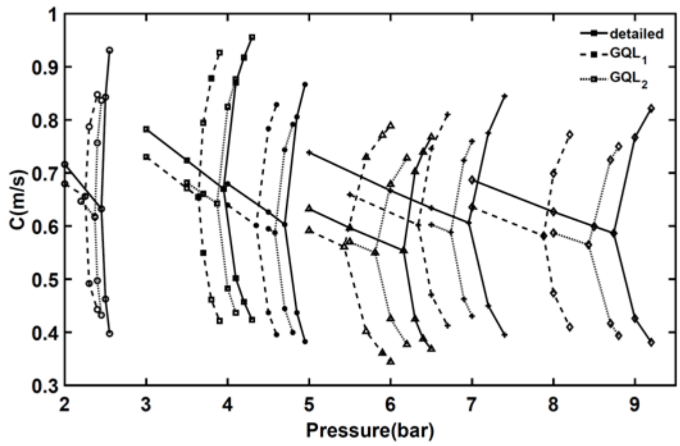

Fig.1. Bifurcation diagram [3] of H_2 / O_2 / N_2 combustion system in the pressure and flame velocity C plane with all detailed and reduced models for the onset of flame pulsations. Symbols correspond to different mechanisms and are provided in Tab. 1.

Figure 1 illustrates and summarizes the main results, where different detailed (Tab. 1) and reduced (e.g. 4D Global Quasi-Linearization (GQL) reduced chemistry, see e.g., [4] for GQL_1 and GQL_2) are considered to address onset of pulsations in the rich hydrogen/air flames. The figure shows how a number of well-established and validated hydrogen combustion mechanisms performs to reproduce the onset (bifurcation) of oscillations. Although the flame velocity is reproduced relatively good, the scatter for the critical pressure of about 7 bar is observed and reported. However, the accuracy of the GQL reduced models, which is much less than the differences between detailed mechanisms, signifies that the GQL reduced chemistry is capable of accurately predicting near limit behavior in rich hydrogen/air systems in a wide range of system parameters.

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