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# Development of an SGS model for thermodiffusive instabilities

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Climate change is the root cause of many disasters in today's world. The burning of fossil fuels drives it. The global energy demand makes it impossible to stop burning these fuels; hence, burning environment-friendly fuels is one of the best options [1]. Hydrogen ($H_2$), among all other carbon-neutral fuels, has attracted the most attention. When $H_2$ is burnt in lean conditions, the emission of nitrogen oxides reduces [1]. So, burning $H_2$ in lean conditions is one of the emerging ideas. However, lean $H_2$ flames are subject to thermodiffusive instability, resulting in different flame dynamics [2, 3].

Thermodiffusive instability arises due to the difference between molecular and thermal diffusivity [1-3]. Thermodiffusively (TD) unstable flames show different characteristics–higher propagation speed, thinner and cellular flame surface–compared to conventional hydrocarbon flames [2]. Most of the turbulent combustion models fall short of considering the effect of this instability, leading to erroneous predictions. Howarth *et al.* [2] proposed local flame speed enhancement relations for TD unstable flames. Using these relations and fractal properties of TD unstable flames, Ramirez *et al.* [3] developed a model that considers the effect of this instability on flame propagation. These latest developments are based on the thickened flame approach.

The aim of this study is to simulate large-scale industrial safety scenarios. To do so, we employ the flame surface density (FSD) approach, which evaluates FSD algebraically or by solving a transport equation. We evaluate the thermodiffusive model by Ramirez *et al.* [3] against a medium-scale, well-instrumented deflagration experiment. A specific experiment was chosen where thermodiffusive instability plays a crucial role. We compare different ways of computing growth rate ($\omega_2$) and stretch factor ($I_0$) to that of Howarth *et al.*, and analyse the model's sensitivity towards these computations.

**References**

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