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REDIM reduced kinetics for Flame-Wall Interactions including Flame Retardants and the investigation of its Sensitivity with respect to the gradient estimation

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In the past few years, combustion processes near walls have been investigated intensively. These processes are strongly influenced by the interaction between the flame, the wall and the surrounding flow field. However, not only the combustion process in e.g. internal combustion engines where cold walls usually can occur but also the avoidance of combustion processes close to boundary layers needs to be investigated. Therefore, flame retardants and their effect on combustion processes close to walls are analysed in more detail.
Besides experimental investigations, simulations of reacting flow systems have become a powerful tool to study and improve combustion processes. The major drawback of numerical simulations is the high computational effort that is required to solve the very stiff problems of high dimensions in complex applications like internal combustion engines [1]. One way to overcome this problem are reduced kinetic models like the Reaction-Diffusion manifold (REDIM) method [2].
In previous works regarding Flame-Wall-Interactions (FWI) with the REDIM-method it was shown that the REDIM method is able to recapture the transient system behaviour of FWI with and without the influence of added flame retardants (see e.g. [3]). For the generation of a REDIM, an initial guess as well as a gradient estimation need to be provided [2]. The initial guess of the manifold serves as starting solution of the REDIM integration procedure while the gradient estimation is comparable to the specification of scalar dissipation rates in the context of flamelet generated manifolds, but it has much less influence.
In order to investigate this influence, the sensitivity of the REDIM with respect to the gradient estimation is investigated in this work for FWI with flame retardants. Therefore, the REDIM is generated and the sensitivity of the REDIM regarding the gradient estimation is calculated simultaneously. In this way it is demonstrated, that the estimation of the gradients necessary for the REDIM generation is sufficient for the generation of REDIM reduced kinetics.

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REFERENCES

[1] C. K. Law, Recent advances in droplet vaporization and combustion, *Prog. Energ. Combust.*, 8(3) (1982) 171-201.
[2] V. Bykov, U. Maas, The extension of the ILDM concept to reaction--diffusion manifolds, *Combust. Theor. Model*., 11 (6) (2007) 839–-862.
[3] C. Strassacker, V. Bykov, U. Maas, REDIM reduced modeling of quenching at a cold wall including heterogeneous wall reactions, *Int. J. Heat Fluid Fl.*, 69 (2018) 185-193.