Abstract:
Thermoacoustic oscillations can happen in nearly every device which includes a combustion process. The reason therefore is that the combustion and the acoustics of the system interact. This leads to a coupled so-called thermoacoustic system which can either be stable or unstable. A stable system damps out small perturbations. The other possibility is that the system gets unstable and starts to oscillate. At higher sound pressure levels this can lead to a failure of the system. In order to describe thermoacoustic systems with a laminar premixed flame the Level-Set method is used, coupled with a low-order network model. This combination enables to simulate thermoacoustic oscillations with lower computational effort than a standard Computational Fluids Dynamics (CFD) simulation would need. Furthermore, such a simplistic setup allows to carry out some very fundamental investigations where all system parameters are known. First the Level-Set solver was verified, by comparing the flame contours at
different angles of a forcing cycle and by computing the Flame-Describing-Function (FDF). The results of the flame contour were as expected but the FDF showed an atypical phase behaviour. Then two different thermoacoustic coupled systems from literature were recalculated. One of them has a conical flame, the other a slit flame type. Both systems have a geometric bifurcation parameter which was used to vary the acoustics of the systems. The results were analysed with bifurcation plots and phase portraits. At several configurations a limit cycle behaviour was found for both systems.

Übersetzter Abstract:
Thermoacoustic oscillations can happen in nearly every device which includes a combustion process. The reason therefore is that the combustion and the acoustics of the system interact. This leads to a coupled so-called thermoacoustic system which can either be stable or unstable. A stable system dampens out small perturbations. The other possibility is that the system gets unstable and starts to oscillate. At higher sound pressure levels this can lead to a failure of the system. In order to describe thermoacoustic systems with a laminar premixed flame the Level-Set method is used, coupled with a low-order network model. This combination enables to simulate thermoacoustic oscillations with lower computational effort than a standard Computational Fluids Dynamics (CFD) simulation would need. Furthermore, such a simplistic setup allows to carry out some very fundamental investigations where all system parameters are known. First the Level-Set solver was verified, by comparing the flame contour at different angles of a forcing cycle and by computing the Flame-Describing-Function (FDF). The results of the flame contour were as expected but the FDF showed an atypical phase behaviour. Then two different thermoacoustic coupled systems from literature were recalculated. One of them has a conical flame, the other a slit flame type. Both systems have a geometric bifurcation parameter which was used to vary the acoustics of the systems. The results were analysed with bifurcation plots and phase portraits. At several configurations a limit cycle behaviour was found for both systems.

Stichworte:
Level-Set, Thermoacoustic, Limit Cycle, Flame Describing Function

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