**D5** Numerical Modelling of Thermoacoustic Stirling Engines & Refrigerators

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Thermoacoustic machines depend on the complex relationship between thermodynamics and acoustics, and thus understanding it is vital in order to analyse the working principles and optimise parameters (i.e. geometrical or operational) to improve their performance. This paper investigates how numerical modelling can be used to explore this relationship and compares the accuracy of the performance predictions for different numerical simulation software. The software used included one designed for modelling Stirling machines called 'Sage' and one designed for modelling thermoacoustic machines called 'DeltaEC'. To compare their results a model of both a thermoacoustic Stirling engine and refrigerator were developed from existing models in published papers, which contained experimental data to validate the numerical models. The results from the thermoacoustic Stirling engine model show that there is good agreement between the predictions from DeltaEC and the experimental data, as well as relatively good agreement between the Sage and DeltaEC predictions. However, due to Sage requiring a different approach to model the boundary conditions for the standing wave type machine (i.e. one end closed) the predictions varied slightly from those by DeltaEC. The results from the thermoacoustic Stirling refrigerator model, however, show improved agreement between the predictions from Sage and DeltaEC – potentially due to Sage and DeltaEC using a similar approach to model the boundary conditions for the travelling wave type (i.e. two open ends). Overall, it was found that although both can accurately model travelling wave thermoacoustic machines, the nature of Sage's solving method makes it more complex to model the standing wave type compared to DeltaEC. A discussion on the use of numerical models as a tool for better understanding thermoacoustic machines, and the importance of the accuracy of the results to allow for optimisation and improvement in their design is presented.

**Keywords**
Thermoacoustics; standing wave; travelling wave; modelling; Sage; DeltaEC; Stirling; stack; regenerator