Implementation/adaptation of a Total Variation Diminishing (TVD) scheme to a non-linear 1D finite volume method for engine gas-exchange modelling
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Abstract

Modelling is becoming an increasingly important tool in the design of internal combustion engines, therefore, more accurate and complex numerical methods have been appearing that are able to solve the hyperbolic partial differential equations. Among these, non-linear time-domain 1D finite volume methods have a wide acceptance and are used in most commercial codes. However, they are subject to spurious oscillations unless corrective measures are taken.

An attractive possibility in this sense is based on the concept of the Total Variation Diminishing (TVD), introduced by Harten [1] in 1983 as a property of certain discretization schemes, which states that the total variation of any physically admissible solution does not increase in time. Harten also proved that a TVD scheme is monotonicity preserving, which would avoid numerical oscillations, whence the interest for the present problem.

This paper shows the development of a TVD scheme for a time domain non-linear 1D finite volume method based on the distinction of two different mesh elements in which the equations are solved (staggered mesh). This distinction offers the additional possibility of using the proposed scheme as a non-linear quasi-3D model able to solve more complex problems involving 3D phenomena. Other alternative techniques for avoiding overshoots at discontinuities will be discussed and their respective merits compared to those of the proposed solution.