Abstract Submitted
for the DFD19 Meeting of
The American Physical Society

Effect of compressibility on laminar flame speed and its influence on the Darrieus-Landau instability of a planar front of premixed flame[1]

YASUHIDE FUKUMOTO, Institute of Mathematics for Industry, Kyushu University, KEIGO WADA, Center of Coevolutionary Research for Sustainable Communities, Kyushu University, SNEZHANA ABARZHI, The University of Western Australia — The effect of compressibility on a premixed flame front is investigated by use of the method of M^2 expansions for small Mach numbers. We study the inner structure of the reaction layer, by applying the method of matched asymptotic expansions to an overall one-step irreversible chemical reaction expressed by the Arrhenius law. We figure out the structure of freely propagating deflagration wave from the perspective of the temperature distribution and the laminar flame speed. The temperature distribution is greatly influenced by the compressibility effect which originates from the material derivative of the pressure in the source term of the heat-conduction equation. This effect naturally embodies the volumetric heat loss, without having to include any artificial sink term, by decreasing the temperature, with the Mach number, on the burned side of the reaction zone, accompanied by the overshoot of the temperature in the midway of the reaction layer. We then seek the laminar flame speed through calculation of the burning-rate eigenvalue and find that it sensitively drops down by the compressibility effect. This implies that the compressibility acts to reduce the growth rate of the Darrieus-Landau instability.

[1]This work was supported in part by a Grant-in-Aid for Scientific Research from the Japan Society for the Promotion of Science (Grant No. 19K03672).

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Date submitted: 01 Aug 2019 Electronic form version 1.4