LARGE-EDDY SIMULATION EMPLOYING FLAMELET APPROACH OF A TRANSCRITICAL O_2/H_2 JET FLAME

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The validity of Large-eddy simulation (LES) employing a flamelet/progress variable approach [1], which takes the real gas effects into account, is investigated for a transcritical oxygen/hydrogen coaxial jet flame. The LES is performed using an in-house thermal flow analysis code FK^3 [e.g. 2, 3]. The flamelet library is created using the one-dimensional analysis version of FK^3, namely FK^3/1d, employing a chemical reaction mechanism of 8 species and 21 reactions at the pressure of 10 MPa. The computational domain and conditions are set based on the experiment in Mayer and Tamura [4]. In order to take the real gas effects into account, the Soave-Redlich-Kwong equation of state is applied as equation of state, and the TRAPP method is used for transport properties [5]. The LES is performed on a collocated Cartesian grid consisting of 1152 × 320 × 320 grid points in the x-, y- and z-directions, respectively. The CPU time required is approximately 8 million core hours by parallel computation using 24576 cores on a Fujitsu supercomputer PRIMEHPC FX100 at Nagoya University (the actual time required for the computation is approximately 320 hours). The results show that the predicted breakup position of liquid oxygen core is in good agreement with the experiment [4]. It is also found that in this condition, oxygen and hydrogen, which are injected into the chamber in the liquid and supercritical states, respectively, react in the gas state and that oxygen experiences the supercritical state before reaching the gas state.

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