EFFECT OF N_2/CO_2 DILUTION ON LAMINAR BURNING VELOCITY OF H_2-CO-O_2 OXY-FUEL PREMIXED FLAME

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Introduction

Synthetic gas (syngas) attracts lots of research interests in the combustion field, recently. Usually, syngas includes primary combustible contents like H_2 and CO as well as inert components like N_2, CO_2 and H_2O [1, 2]. With different fuel sources and gasification methods, the fractions of the above mentioned components are varied widely. Because of this variation, the design of burners and combustion chambers becomes a big challenge for ultra-lean low NO_x combustion technology. Therefore, it is necessary to understand the effects of variation of components on the fundamental combustion properties, such as laminar burning velocity.

In this paper, laminar burning velocity of H_2-CO-O_2-N_2 (or CO_2) mixtures with varying diluent fraction and H_2/CO ratio (including pure hydrogen) was accurately measured with Heat flux method and OH-PLIF based Bunsen flame method. The measurement was carried out under atmospheric condition with equivalence ratio changing from 0.6 to 2.0. The laminar burning velocity less than 60 cm/s was measured with Heat flux method and the one larger than 60 cm/s was measured with OH-PLIF based Bunsen flame method, due to the measurement limitation of Heat flux burner. The PREMIX model in CHEMKIN 4.1 [3] was used in laminar burning velocity calculation. After validation with present experimental data, Davis H_2-CO mechanism [4] was selected to study the reaction mechanism. The effects of N_2/CO_2 dilution on the laminar burning velocity of H_2-CO-O_2 mixtures with varying H_2/CO ratio were discussed thoroughly and the correlations between dilution rate and laminar burning velocity reduction rate were obtained and analyzed.

Conclusions

The laminar burning velocity of H_2-CO-O_2-N_2 (CO_2) mixtures was investigated with Heat flux method and OH-PLIF based Bunsen flame method. Mixture-diluent approach was used to avoid the effect of equivalence ratio on the dilution fraction. H_2 proportion in fuels varied from 5% to 100% and diluent N_2 (CO_2) proportion in unburnt mixture varied from 0% to 70% (50%). The alteration of equivalence ratio was from fuel lean to fuel rich conditions, i.e. from ϕ=0.6 to ϕ=2.0.

The diluent N_2 (CO_2) could reduce the laminar burning velocity significantly and H_2 component could increase it notably. With a given diluent proportion, the laminar burning velocity reduction rate showed to be almost independent from the components of H_2-CO fuels and equivalence ratios. The reduction rates as the function of diluent fraction in the mixture were presented with experimental results and fitted with polynomial functions for five typical H_2-CO fuels. With the correlation between diluent fraction rate and laminar burning velocity reduction rate, the laminar burning velocities of H_2-CO-O_2 mixtures diluted by N_2 and CO_2 could be predicted accordingly. The prediction results were validated by amount of published data and showed a good agreement between each other.

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