

Experimental Measurement of Laminar Flame Velocity of n-Butanol-Air Premixed Flame at High Pressure and Temperature

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The accelerated demand of global energy consumption and the rapid exploitation of fossil fuels making the researchers nowadays more focused on searching suitable alternatives to conventional fuels. Concomitantly, the issues regarding environment and system efficiencies are also major facts to be taken into account. In recent years due to the usability of alcohol fuels (methanol, ethanol, butanol) both as blending agents and pure fuels, more focus has been given into determining the fuel properties of alcohols. High efficiency and low pollutants emission of alcohols have been found by researches on alcohol-gasoline blended fuels [1-2]. High flame speed, high octane number and wide flammability range have made research on alcohol much appealing.

This work mainly focused on determination of laminar flame speed of n-butanol at high pressure and temperature with a wide range of equivalence ratio.

The experimental setup (Fig. 1) consists of constant volume combustion chamber, high-speed imaging system, air heating system, temperature and pressure measurement and controlling system, data acquisition system. The combustion chamber is cylinder type (internal diameter 70mm, length 70mm, total inside volume about 302cm³) placed horizontally. Ignition is initiated at the center of the chamber by two

spark pin. Quartz windows are placed at both sides of the chamber to provide optical access. The chamber is capable of withstanding up to 9atm absolute pressure at 450 K temperature without leaking. ± 0.02 atm pressure is allowed to deviate for this experimental purpose. Temperature inside the chamber is controlled by electric voltage. ± 2 K is considered as acceptable temperature deviation.

Schlieren technique is used to observe the flame front propagation similar to Bradley et al. [3] used in their work. The flame front radius obtained from the experiments at 450 K are confined in between 9 mm to 24 mm for later analytical use in order to avoid the ignition startup disturbance and to satisfy the consideration of constant pressure phenomena.

The experimental results show that the laminar flame speed is around 30cm/s at equivalence ratio $\Phi = 0.8$. It gradually increases as the mixture go toward stoichiometric condition. The value peaks near $\Phi = 1.1$ then again gradually go down. The results with trend line are presented in Fig 2. The trend lien of this result is found consistent with other previously done experimental and numerical results which were performed with butanol isomers [4-5]. The trend is in good agreement between our experiment and numerical results calculated with the short mechanism[6].

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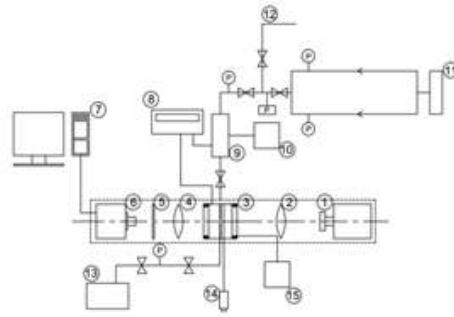


Fig. 1. Schematic diagram of the experimental setup.

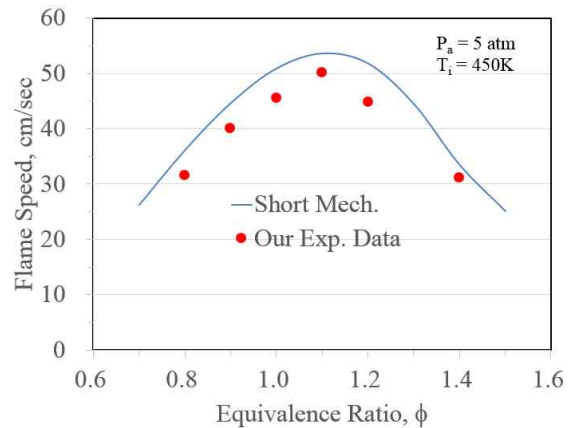


Fig. 2. Flame speeds for n-Butanol/Air premixed flames at $P_a=5\text{atm}$ and $T=450\text{K}$.