THE MIXING FIELD AND FLAME STRUCTURE NEAR THE
REACTION ZONE OF TURBULENT PLANAR FLAMES AT
DIFFERENT LEVELS OF MIXTURE INHOMOGENEITY

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Abstract

Turbulent flames with compositionally inhomogeneous mixtures are commonly used in many combustion systems. In this work, turbulent planar jet flames issued from a concentric flow slot burner, CFSB, were used to study the impact of mixture inhomogeneity near the flame sheet. The CFSB burner can alter the mixing inhomogeneity by changing the mixing length "L" between the concentric fuel and air slot nozzles. At various levels of mixture inhomogeneity, the mixing field, presented by mixture fraction, Z, distribution, and the flame structure was investigated via simultaneous Rayleigh imaging and OH-PLIF. Our previous study investigated the mixing field immediately downstream of the burner exit in non-reacting conditions. The PDFs of Z showed that the mixing field covered a wide range of mixture fractions, where the high flame stabilization occurred when a large portion of the PDF(Z) was located within the fuel flammability limits. This work showed that further downstream, the highly stabilized flames were also obtained when the range of fluctuations in the mixture fraction was close to the stoichiometric mixture fraction. Moreover, plotting the mixing field using the scatter plot within the mixing regime diagram for various flame conditions showed that the mixing field downstream of the burner exit consistently follows the mixing diagram classification. Moreover, a close inspection of the flame structure showed that the flame sheet varies from thick, and corrugated at a low and high levels of mixing to thin flame sheet but less corrugated and that at a particular mixing normalized length L/D = 7.

Keywords
Mixing Field; Inhomogeneous; Turbulent Planar Flames; Flame Structure; Regime Diagram; Mixture Fraction; Rayleigh; OH-PLIF

This preprint research paper has not been peer reviewed. Electronic copy available at: https://ssrn.com/abstract=4499168
1. Introduction

Combustion technology is one of the most used technologies for converting primary sources of energy to secondary energy, such as heat and power. Combustion is considered the primary technology for fossil fuel energy conversion [1]. Turbulent combustion is complicated where the interaction between turbulence, mixing field, and chemistry is coupled and very intense. The turbulence and mixing field structure influence combustion efficiency and flame stability [2]. The control of the combustion systems (in terms of stability, emissions, and energy density) starts mainly by manipulating the mixing and turbulence levels. The characteristics of inhomogeneous jet flames feature higher stability than those of the premixed and non-premixed flames in either the concentric flow slot burner [3] or the concentric flow conical nozzle burner [2,4]. In addition, the NO\textsubscript{x} and the particulate emissions from flames are significantly controlled by the level of inhomogeneity and the mixing between the air and the fuel. Li et al. [5] studied numerically the application of the partially premixed combustion mode combined with the exhaust gas recirculation in a direct injection diesel engine. They [5] showed that soot and CO emissions could be reduced without altering the NOx emissions and thermal efficiency under a certain degree of partial premixing of fuel. The same observations were pointed out by Rashwan et al. [6], where they showed a reduction in the NO\textsubscript{x} and CO emissions by increasing the degree of mixing of partially premixed flames stabilized over a perforated-plate burner.

Various methods were used to improve the stability of turbulent flames, such as using conical nozzle at the burner exit [1, 7], pilot flame [5], swirling flow [8], and air co-flow [2]. Several research groups studied the impact of the degree of mixing and the nozzle geometry on the partially premixed flame structure and stability [2, 3, 9–12] using different burner configurations. El-Mahallawy et al. [12] studied the effect of mixture inhomogeneity on flame stability in a conical stabilized burner. They found that the flame optimum stability occurs at the mixing length of L/D = 5, at which a triple-flame structure was observed. Meares and Masri [11] achieved the optimum stability in their piloted stabilized flames at a range of mixing length, L/D = 8~15. Also, Zayed [13] reported that the optimum stability in the concentric flow conical nozzle burner was observed around L/D = 6. Mahallawy et al.[12] showed that flame stability is enhanced by decreasing the exit nozzle angle. The flow field measurements inside the conical nozzle showed that the entrained air from the surrounding is heated by the flame while flowing along the cone's inside wall to the flame root [14]. Meares et al. [15] studied the early stabilization region of the Flame using Raman, Rayleigh, LIF, and Large Eddy Simulation (LES) in a modified piloted
burner. They showed that the flame stability was increased in inhomogeneous inlet conditions in contrast to homogeneous counterparts. Thereafter, different designs of burners were proposed, such as the concentric flow conical nozzle burner [9], modified piloted burner [11], and concentric flow slot burner [3]. The effect of the conical nozzle angle and the degree of premixing in the LPG flame stabilized in a conical nozzle burner was investigated by Elbaz [4]. Moreover, Elbaz [4] reported for the first time the thermal flame structure and the species concentration close to the burner tip and within the vicinity of the conical nozzle. Most of the previous studies either stabilized in a conical nozzle burner or piloted flames indicate that a certain degree of partial premixing leads to a highly stable flame relative to fully premixed or non-premixed flames.

Mansour et al. [2, 7] provided extensive investigations on the relation between the mixing field, flame stability, and flame structure of inhomogeneous jet flames. They reported the dependency of flame stability on the initial jet radius and curvature. Consequently, they recently proposed a concentric flow slot burner (CFSB), inspired by the Wolfhard-Parker slot burner, to create turbulent planar 2D flames. Mansour et al. [7] studied the mixing field and flame structure in a concentric flow slot burner using the Rayleigh scattering technique and the laser-induced fluorescence of OH. The impacts of mixing length, equivalence ratio, and Reynolds number on the structure of the mixing field were discussed, and the results showed an insignificant effect of the Reynolds number on the mixing field. The OH results discussed a more distributed profile and lower flame curvature at lower equivalence ratios, while thinner OH profiles were observed at higher equivalence ratios. Moreover, a clear correlation between the mixing field structure, flame stability, and flame structure was observed in their work. Reynolds number was found to be significant on the heat release rate, as discussed by Wang et al. [16], who studied this correlation in non-premixed flames.

Elbaz et al. [17] very recently focused on studying the main parameters that impact the mixing field structure to achieve highly stabilized flames in the CFSB. The data showed a strong link between the mixing field structure and these parameters [7, 17]. The combustion mode with a specific inhomogeneous mixture distribution showed higher stability and better performance due to rich and lean pockets within the reaction zone. This structure promoted a higher production rate of radicals from the rich pockets for the lean mixtures to sustain the reaction.
None of the previous works on the flames with mixture inhomogeneity investigated the mixing field near the flame zone. Consequently, this study examines the mixing field downstream the burner exit and near the reaction zone in planar partially premixed flames issued from a concentric flow slot burner under different degrees of mixture inhomogeneity. This burner can control the mixture inhomogeneity between the fuel and air jets by varying the mixing length "L", as will be described in the experimental setup section. The impact of the mixing length on the fuel mixture fraction field was investigated. Moreover, the mixing field data were analyzed statistically to classify its structure using the regime diagram proposed in [18] to understand the inhomogeneous flames better.

2. Experimental Setup

2.1. Concentric Flow Slot Burner, CFSB

The current study uses the concentric flow slot burner (CFSB) [7] to create turbulent planar flames with a controlled level of mixture inhomogeneity. Previously, the circular version of this burner illustrated and discussed in [2], showed that the flame stability is improved by increasing the burner diameter. Accordingly, the slot burner design was proposed to avoid the impact of the jet radius [2] on flame stability. The current burner controls the mixture inhomogeneity level to create a wide range of turbulent flames between fully premixed and non-premixed flames. The flame developed in this burner is turbulent planar at different levels of mixture inhomogeneity. The air passes through the inner slot while the fuel (methane in this study) passes through the outer slots, as shown in Fig.1a. The degree of mixture inhomogeneity is controlled by varying the mixing length, L, where L represents the central slot's recess distance relative to the outer slots. The width of the inner air slot, a, is 6 mm, and the width of the fuel slot, b, is 1 mm, as shown in Fig. 1b. The burner exit slot is 60 mm long and 10 mm in width, which leads to a hydraulic burner diameter, D, of 17.14 mm. A direct photo of the flame issued from the current burner is illustrated in Fig. 1c.

2.2. Simultaneous 2-D Rayleigh Scattering and PLIF of OH Technique:

The present measurements aim to resolve the mixing field and reaction zone in partially premixed planar turbulent methane flames using simultaneous 2-D Rayleigh scattering and PLIF of OH. The mixing field is studied using Rayleigh scattering in the non-reacting zone while the flame front is captured using the PLIF-OH imaging. The combined Rayleigh/PLIF techniques layout is shown in Fig. 1d. This setup uses one laser and two intensified charge charge-coupled

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device (CCD) cameras. The laser is a tunable KrF excimer laser (Lambda Physik, EMG 150 TMSC) at 248 nm with a narrowband linewidth of 0.001 nm for PLIF measurements. The laser pulse energy is 300 mJ. A laser sheet of 30-mm height and 150-µm thickness is formed using one cylindrical lens, \( f = 300 \text{ mm} \). The Rayleigh and PLIF images are collected at 90° to one side of the laser sheet. A dichroic mirror is placed at 45° between the flame and the Rayleigh and PLIF cameras to reflect the Rayleigh signal and pass the PLIF signal. The OH-PLIF camera is a CMOS camera (ANDOR, iStar Model, 1024 X 1024 pixel array with 12-bit dynamic range). The Rayleigh camera is an intensified CCD (PI-MAX 4, 16-bit dynamic range, 774 X 1024 pixel array).

**Figure 1.** (a) 3-D drawing of the burner showing the mixing length, \( L \), and the inlets of air and fuel streams (b) Top view of the slot (c) Direct flame image from the front and side views of the developed planar flame (d) The experimental 2-D Rayleigh/PLIF-OH technique.

For OH-PLIF, the laser is tuned to P2 [19] line to excite the \( \text{A}^2 \sigma \) \( \rightarrow (\text{X})^2 \Pi \) state, as previously reported [20, 21]. A Schott UG11-glass filter was used in front of the OH-PLIF camera. Spectroscopic scanning had been made for the stoichiometric methane-air flame to ensure that the signal is free from other interferences within the glass filter's spectral range. The OH-PLIF images were corrected for background emissions. The data, however, were qualitative and used to identify the reacting regions in the flame and discriminate against hot gases without reaction. The laser and the two cameras were simultaneously triggered, and the images were collected with a gate width of 400 ns to eliminate background effects. Up to 500 simultaneous Rayleigh-OH-PLIF images were gathered at two heights above the burner tip. The image window was selected to be about 45 mm along the radial direction and 30 mm along the axial direction with a pixel scale of 23 pix/mm. The two cameras were matched by simultaneously imaging a fine circular mesh. The magnification, spatial overlap, and position of each camera were adjusted.
accordingly. The details of the mixture fraction, \( Z \), and its 2-D gradient calculations from the Rayleigh signal were reported in detail in our previous work, see Elbaz et al. [17].

3. Results and Discussion

3.1. The Mixing Field Structure

The feature of the mixing field is a crucial parameter that impacts flame stability, structure, and emissions [7, 17]. This study investigated the mixing field between air and fuel in the downstream region of the burner exit and near the reaction zone in turbulent planar partially premixed methane flames. The effect of mixing length "L" is discussed, through the inspection of the instantaneous mixture fraction field (\( Z \)) and its two-dimensional gradient \( \frac{dZ}{dl} \); as illustrated in Fig. 2. Moreover, simultaneous OH-PLIF images are presented, where the mixture fraction, \( Z \), and \( \frac{dZ}{dl} \) are obtained inside the non-reacting mixture area within the central area of the flame. The mixture fraction area is contoured and specified for constant temperature data inside the flame central region, whereas the Rayleigh intensity is directly proportional to the mixture fraction. On the other hand, the temperature calculation zone is specified at a constant Rayleigh cross-section medium while the intensity is inversely proportional to the temperature. The gap separating the mixture fraction calculation field and OH-zone may be defined as the preheat flame zone. This gap is masked during mixture fraction and temperature calculations to avoid misleading the data and is shown in the plots as a black-masked area.

As shown from left to right of Fig. 2, the mixing length, L/D, is varied as L/D = 3, 7, and 15, while the mixture global equivalence ratio, \( \Phi \), and Reynolds number, Re, are kept constant at 2 and 4000, respectively. Increasing L/D from 3 to 15 changes the mixing field structure from a strongly inhomogeneous structure to a less inhomogeneous structure. As shown in the Z field of the flame at L/D = 3 (Fig. 2a), a wide variation in the mixture fraction is seen, where rich mixture pockets have appeared. These observed pockets are decreased at L/D = 7 (Fig. 2b). Less segregation in the Z was observed in the mixture fraction fields with increasing L/D, where longer length provides a longer mixing time for the same Re. The decrease in the mixture fraction fluctuations with L/D has been reflected in the gradient distribution of the mixture fraction field \( \frac{dZ}{dl} \), as shown in Fig. 2. A reduced mixture fraction gradient with increasing L/D is also noticed.

In addition, to better understand the development of the mixing field along the central flame area, the overall mixture fraction field is divided into two zones; each zone is 12 mm in height downstream of the burner exit, namely Zone I and Zone II. Zone I starts at 6.3 mm downstream
of the burner nozzle, and Zone II begins immediately after Zone I. The PDF of both $Z$ and $dZ/dl$
calculated within these two zones for the same flames presented in Fig. 2 are illustrated in Fig. 3.
The PDF($Z$) is shown in black, and the corresponding gradient of the mixture fraction PDF
($dZ/dl$) is illustrated in red. The solid lines represent the average PDFs, while the dotted points
represent the 500 single shots PDFs data. As shown in Fig. 3a., at Zone I, the PDF($Z$) distribution
covers a wide range of the mixture fraction from the far rich to the far lean mixture. The
corresponding PDF ($dZ/dl$) also covers a relatively wide range of gradients with a peak around
the lean flammability mixture fraction (shown by a vertical black solid line). Further downstream,
as shown in the PDFs of Zone II (Fig. 3b), the same observations are still there, but the peak
value of the PDF($Z$) slightly shifted towards the rich mixture fraction flammability limit $Z_R$. With
increasing $L/D$ to 7, as shown in Figs. 3c-3d, less broad PDF($Z$) but with higher peak values are
seen relative to the corresponding profiles at $L/D = 3$. A more change is seen in the mixture
fraction gradient, where the corresponding mixture fraction gradient covered a narrower range of
the mixture fraction, showing a higher peak towards the lean mixture. With the further increase in
$L/D$ to 15, the PDF($Z$) profiles covered a smaller range of the mixture fraction and shifted
towards the lean mixture fraction composition. It is obvious that at $L/D = 15$ less gradient
structure in the mixture fraction. One can notice no changes in both PDF($Z$) and PDF($dZ/dl$)
distributions in Zone I and Zone II at $L/D = 15$, indicating the enhancement of the mixing. This
indicates that a broad low peak mixture fraction distribution is seen at the shorter mixing length
with a wide range in its gradient and would be transferred into a sharp, still higher peak
distribution with a narrow mixture gradient as the mixing length is increased.

![Figure 2](https://ssrn.com/abstract=4499168)

**Figure 2.** Samples of single shots of OH images, mixture fraction field ($Z$), and its two-dimensional
gradient (on the right side) within the non-reacting mixture at $L/D = 3$, 7, and 15, equivalence
ratios, $\Phi = 2.0$, and Reynolds number, Re = 4000.
Figure 3. The pdfs of the Z for Zone I and Zone II. The dots represent the single pdfs of all measured 500 shots, the solid lines represent the corresponding mean value at normalized mixing length, L/D = 3, 7, and 15, equivalence ratios, Φ = 2.0, and Reynolds number, Re = 4000.

The axial and radial profiles of the mixture fraction, Z, and its standard deviations, Z_{STD}, are illustrated in Figs. 4 and 5, respectively. The axial profiles shown in Fig. 4 are almost constant. The mean mixture fraction, Z, is almost the same for all cases while the standard deviation of the mixture fraction, Z_{STD}, is decreased from L/D = 3 to L/D = 15, where the standard deviation, Z_{STD}, drops from 40% to 20%. This is consistent with the expected higher level of mixture inhomogeneity at smaller L/D as compared to those at higher values of L/D where mixing is enhanced. The same trend is observed along the radial profiles shown in Fig. 5. The radial profiles in Fig. 5 are illustrated at two axial locations downstream of the burner exit; L1 at 7.5 mm above the burner and L2 at 17.5 mm above the burner. Higher standard deviations are also observed along the radial direction at L/D = 3 as compared to that at L/D = 15. At L/D = 3, where the level of inhomogeneity is expected to be higher, the radial profile of the mixture fraction at L1 shows a small peak at the outer edge of the burner due to the fuel feeding at the outer slots. These peaks disappear downstream to the mixing. The flatness of the radial profiles in the current burner, as shown in Fig. 6, is an advantage of the CFSB where the mixing field has a uniform mean value with higher fluctuations to create lean and rich pockets that should be able to stabilize the flames created in this burner as compared to normal jet flames, either non-premixed or premixed.
Figure 4. The centerline axial profiles of Z, black, and $Z_{\text{STD}}$, red, at $L/D = 3$, 7, and 15, for equivalence ratios, $\Phi = 2.0$, and Reynolds number, $Re = 4000$.

Figure 5. Radial profiles of the mean Z, black, and $Z_{\text{STD}}$, red, at $L/D = 3$, 7, and 15, equivalence ratio, $\Phi = 2.0$, and Reynolds number, $Re = 4000$. L1 refers to the position 7.5 mm above the burner and L2 refers to the position 17.5 mm above the burner.

The mixing field, as discussed above, is mostly affected by $L/D$ and $\Phi$. In our previous work [2,7], we derived a relation between $\Phi$ and the velocities of the fuel stream, $U_F$, and air stream, $U_{\text{air}}$, as $\Phi = C_1 U_F / U_{\text{air}}$, where $C_1$ is a constant equal to 3.174 for the current burner dimensions, and methane as a fuel [7]. Mansour et al. [7] used a normalization factor $(U_{\text{air}} - U_{\text{fuel}})/(U_{\text{air}} + U_{\text{fuel}})$ to obtain a correlation between the range of mixture fraction, $\Delta Z$, and $L/D$, where $\Delta Z$ is defined as $(Z_{\text{max}} - Z_{\text{min}})$ where $Z_{\text{max}}$ and $Z_{\text{min}}$ are the maximum and minimum mixture fractions within a certain area. Via this definition, the mixing field at various mixing lengths ($L/D$) could be changed from the physical burner domain into the mixture fraction domain. Mansour [18] introduced a regime diagram for the mixing field based on the mean and range of mixture fraction fluctuations. This diagram defines the different mixing modes based on
the normalized range of mixture fractions, $R_\Delta$, which is defined as \((Z_{\text{max}} - Z_{\text{min}})/(Z_R + Z_L)\) on 
the x-axis and the normalized average mixture fraction, $R_Z$, defined as \((Z_{\text{max}} + Z_{\text{min}})/(Z_R + Z_L)\) 
on the y-axis. $Z_R$, and $Z_L$. The rich and lean flammability limits are set for methane as 0.0894 and 
0.0284, respectively, at 1 atm and 298 K [22, 23]. The $Z_{\text{max}}$ and $Z_{\text{min}}$ were determined from $P(Z)$ 
at the threshold of 10% of its peak. In this diagram, eight regions for the degree of the mixture 
inhomogeneity are bounded by boundaries from I to VII. These boundaries are defined as I: $Z_{\text{min}}$ 
$= 0$, II, $Z_{\text{min}} = Z_L$, III: $Z_{\text{min}} = Z_{\text{st}}$, IV: $Z_{\text{min}} = Z_R$, V: $Z_{\text{max}} = Z_L$, VI: $Z_{\text{max}} = Z_{\text{st}}$, and VII: $Z_{\text{max}}$ 
$= Z_R$.

The current data are illustrated in this regime diagram for different values of mixing length 
$L/D = 3, 5, 7, 9, \text{ and } 15$ as shown in Fig. 6 for the same equivalence ratio, $\Phi$, of 2 and Reynolds 
number, Re, of 4000. The data are illustrated as scatter plots of the 500 measured shots for each 
case. On the other hand, the mean values of $R_\Delta$ and $R_Z$ by a single point for each case with error 
bars representing their standard deviations. Each case is characterized by one color for 
clarification. The data from our previous measurements [14] at the nozzle exit for the non-
reacting case at $L/D = 3$, Re = 5000, and $\Phi = 2$ is illustrated as the mean value in Fig. 6 for 
comparison. As explained above, the current work investigates the mixing field near the reaction 
zone downstream of the nozzle exit to study its structure development downstream. The current 
data show the shift of the data toward the stoichiometric zone identified by the dotted lines as 
shown in Fig. 6 and between limits II and III, $Z_L < Z_{\text{min}} < Z_{\text{st}}$, and this is relative to the reported 
data immediately downstream of the burner exit. This is clear by comparing the location of the 
previous measurements at the nozzle exit at $L/D = 3$ [14] and the current measurements 
downstream near the reaction zone. This indicates the mixture developing from the burner exit to 
the downstream at the reaction zone. The mixture is providing a mixture fraction around 
flammability limits as the distance increase downstream On the other hand, the trend observed by 
Elbaz et al. [14] and Mansour et al. [7] of the shift of the scatter data within the regime diagram 
from higher values to lower values of $R_\Delta$ due to the increase of $L/D$ was also observed in the 
current data, see Fig. 6 from $L/D = 3$ to $L/D = 15$ for the same Re, and $\Phi$. Measurements of the 
mixture fraction at the reaction zone, using other mixture fraction techniques, e.g., Laser-Induced 
Breakdown Spectroscopy, LIBS [24], or line Raman [25], should show a further shift of the data 
near the limits II, III, VI, and VII in Fig. 6.
Figure 6. Scatter plot of $R_Z$ versus $R_\Delta$ at $L/D = 2, 3, 9,$ and $15,$ near the reaction zone. The data for $L/D=3,$ measured at the nozzle exit [16], at an equivalence ratio, $\Phi = 2,$ and Reynolds number, $Re = 5000$ is also illustrated for comparison.

3.2. The OH Structure

This section presents a qualitative comparison of the flame structure in terms of the OH distribution. Figure 7 depicts single shots of the OH images for flames at $Re = 4000,$ and $\Phi = 2,$ but at various $L/D$ of $3, 5, 7, 9,$ and $15.$ As shown at short $L/D = 3,$ the OH field reveals a thinner and sharper OH layer. With a further increase of $L/D$ to 5, another OH layer starts to appear at the outer boundaries of the flame, and it merges into one layer as $L/D$ increases to 7. At $L/D > 7,$ i.e., $L/D = 9$ and $15,$ there is not much change is observed in the OH appearance. The flame structure varies significantly with the level of mixture inhomogeneity. These OH images have been used to calculate the flame corrugation factor, CF. Wesley et al. [26, 27] investigated the corrugation factor in sooting turbulent non-premixed flames at elevated pressures. The corrugation factor, $CF,$ was defined as the ratio of the length of the OH layer to the length of the mean OH layer along the jet [28].

The corrugation factor, $CF,$ can quantify the flame sheet's corrugation degree in any image [28]. Figure 8a shows the corrugation factor versus the mixing length, $L/D,$ at $Re = 4000,$ and $\Phi = 2.$ As shown, a higher corrugation factor is seen when the flame approaches the non-premixed or premixed mixture, where a minimum CF is recorded at $L/D = 7.$ In Fig. 8b, the PDFs distribution of the corrugation factor are presented for the different mixing length, as shown at $L/D = 7,$ the distribution of the PDF(CF) shows a peak value around a relatively low CF value; however much broader but with low peaks are seen at $7 < L/D < 7.$
Figure 7. Samples of single shots of OH images at L/D = 3, 5, 7, 9, and 15, equivalence ratio, Φ = 2.0, and Reynolds number, Re = 4000

Figure 8. The average corrugation factor, CF, (a) and its PDF (b) for all measured 500 shots for L/D = 3, 5, 7, 9, and 15 at equivalence ratio, Φ = 2.0, and Reynolds number, Re = 4000.

4. Conclusions

The current work explores the mixing field and the flame front characteristics of inhomogeneous turbulent planar natural gas flames near the reaction zone using Rayleigh scattering and OH-PLIF. The mixing field structure within the non-reacting region in front of the preheat zone and the OH at the reaction zone were measured simultaneously at different levels of mixture inhomogeneity and certain equivalence ratios and Reynolds numbers. The following main conclusions are observed:
1. The mixture fraction approaches near-stoichiometric conditions at the reaction zone as
compared to our previous measurements [16] at the nozzle exit where the mixture fraction is
very rich. This indicates the continuous mixing between the fuel and air downstream the
nozzle exit.

2. The pdf of the mixture fraction and its standard deviation indicates the level of inhomogeneity
was reduced by increasing the mixing length from L/D = 3 to L/D = 5. This is similar to our
previous study. The gradients are also reduced by increasing L/D.

3. Lower flame front corrugation was observed at the highest stabilization point at a certain level
of mixture inhomogeneity. It increases by increasing or decreasing the mixture inhomogeneity.
So, higher stability is achieved at lower flame front corrugation.

4. The reaction zone exhibits a shift from a single reaction zone to a double reaction zone by
decreasing the mixture inhomogeneity.

5. The data recommends further measurements of the mixture fraction structure within the
reaction zone at different levels of mixture inhomogeneity using other laser techniques.

Acknowledgment

This work was financially supported by the American University in Cairo.

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