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Effect of Oxygen Enhancement on Methane Diffusion Flames

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Abstract

A computational study has been reportedfor methane fuel diffusion flames. The flame configuration of methaneis observed computationally using tool UNICORN and verified with experimental results. Lifting velocity and the blow off velocity for methane fuel is measured. Flame length for methanewith oxygen enrichmentis observed. Relation between flame temperature and oxygen enrichment is reported. It is observed that flames under oxygen enhancement are sootier and have high adiabatic flame temperature. Various parameters on graphs are reported (temperature vs velocity and temperature vs velocity).Images of different flames are reported under different percentage of oxygen.

Keywords: Methane, diffusion flames, oxygen enrichment, laminar jet.

1. Introduction

With increasing concern on fossil fuel shortage and strict emission regulations, the development of alternative fuel engines has attracted more and more attention around the world. Natural gas, is a clean fuel in which methane is its major component, is considered to be one of the most favorable fuels for engines. The fuel composition is an important element in the development of current combustion systems. Nowadays, common fuels such as gasoline or Diesel are more and more replaced by alternative fuels, which have raised a growing interest these last years because of economic and technical advantages.

Georgios Tsatsaronis (2010) studiedcharacteristics of methane/oxygen and methane/air laminar flames with the help unsteady-state, one-dimensional, flame propagation model. Further L.Douglas et al. (1976) studied the kinetics and propagation of laminar methane-air flames using a one-dimensional, flame propagation .Sunderland et al. (2005) measured stoichiometric flame shapes for buoyant and non-buoyant methane, ethane and propane laminar gas jet diffusion flames in air. FurtherZhanget.al. (2005) experimentally investigated quenching limits of laminar axi symmetric inverse diffusion flames of methane, ethylene and propane flames. The quenching limits of the inverse diffusion flames scale with $Xo_2^{-1.4}$,the quenching limits of the inverse flames depend largely on the diameter of the oxidizer port, the quenching limits of the inverse flames are proportional to the fuel quenching distance and the heat release rates of the quenching inverse flames vary from 1-2W. Yoshimoto et.al. (2005) experimentally investigated the flame stability flame limits and flame structure of methane, propane and for hydrogen and the flame stability mechanism has been studied.

2. Flame Behaviour

Fig. 1 & 2 shows computational results of inverse diffusion flames (methane IDF). With varying oxygen content 21% and 40% respectively. Air spouts from the fuel nozzle with 50 mm diameter and outside environment is made up of methane.It is observed that Flame length in 21% oxygen is smaller as compared to 40% oxygen content.

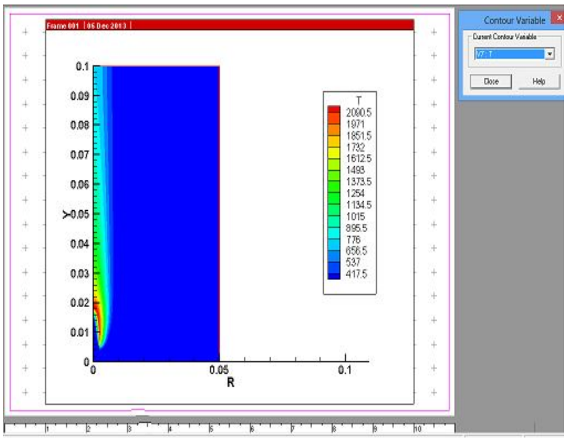

Fig. 1: Flame configuration at 21% oxygen.

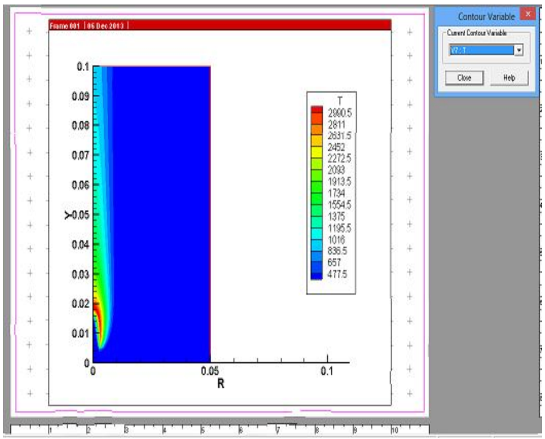

Fig. 2: Flame configuration at 40% oxygen

Fig. 3 shows temperature vs Oxygen enrichment rate .It is observed that with oxygen enrichment temperature of flame is increasing

The flame length of methane inverse diffusion flames with increasing air velocity is shown in Fig. 4.Fig. shows that the flame length is proportional to the velocity of the air. Fig. 5 shows Temperature vs Density chart and it shows that density decreases with increasing temperature. Fig. 6 shows Temperature vs velocity chart and it shows that velocity decreases as the temperature increase

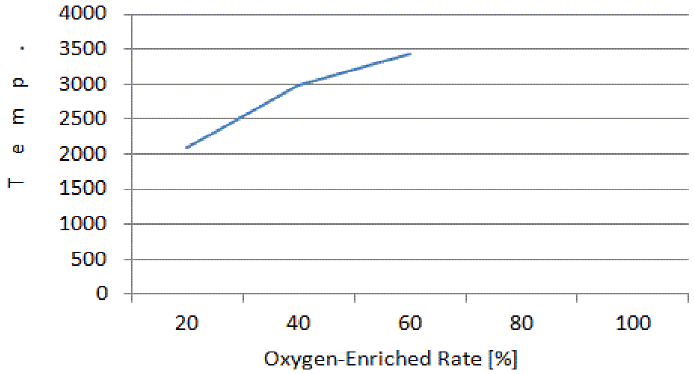

Fig. 3: Temperature vs Oxygen enrichment rate.

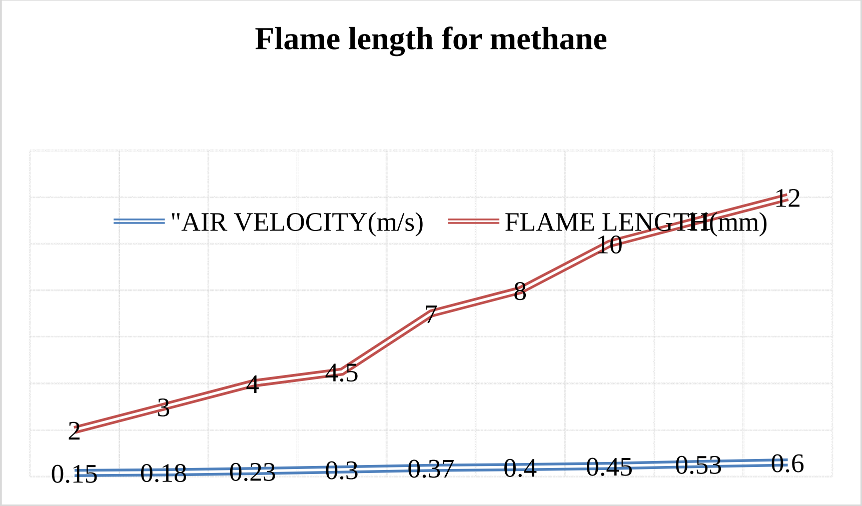

Fig. 4: Air velocity vs Flame length chart.

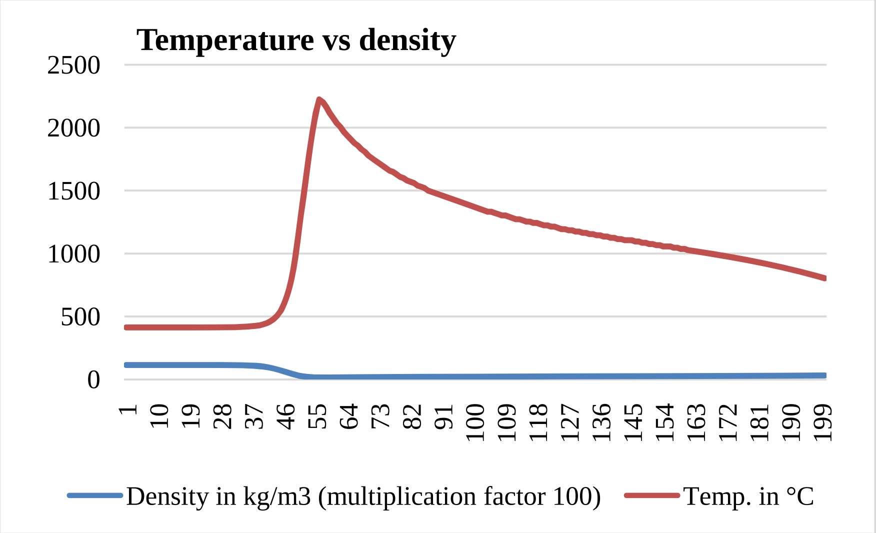

Fig. 5: Temperature vs Density chart.

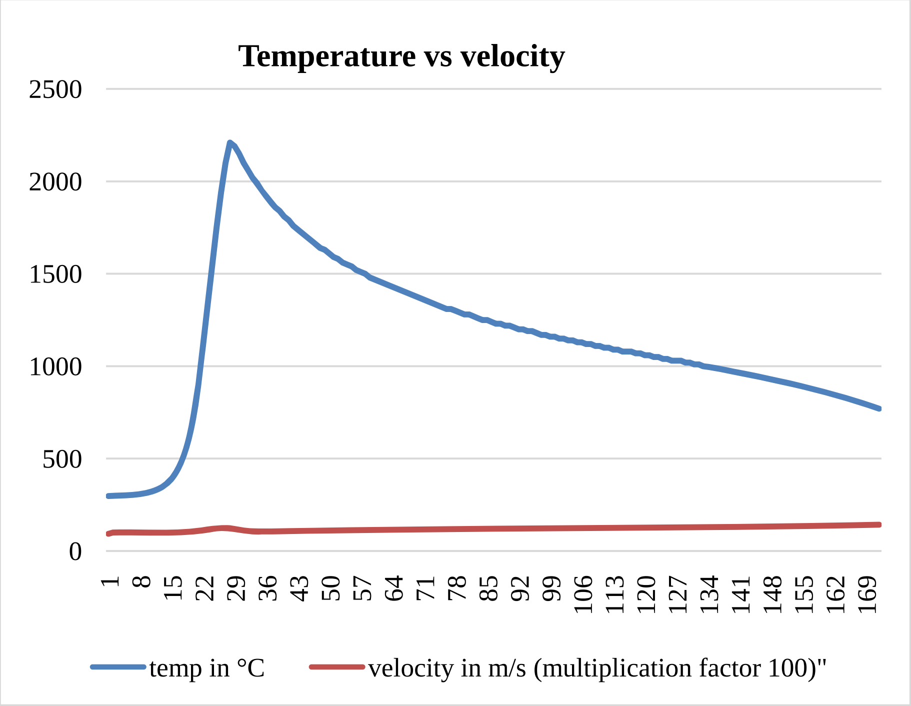

Fig. 6: Temperature vs Velocity chart.

3. Conclusions

The fuel combustion process is mainly affected by the amount of the combustion air oxygen enrichment air. The performance of many air-methane combustion processes can be improved by enhancing air and oxygen enrichment air. The performance of many air-fuel combustion processes can be improved by enriching the combustion air with oxygen. Oxygen enrichment of the combustion air increases both the flame temperature and the thermal efficiency and the improvement in reduction of harmful emissions. An increase in oxygen content in the combustion results in a decrease of the amount of combustion products. The increase of the oxygen content allows more stable combustion and higher combustion temperatures that can lead to a better heat transfer.

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