USE OF HYDROGEN AS AN ALTERNATIVE AND BLENDED FUELS

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Abstract

Hydrogen is a very important fuel of clean energy future. Hydrogen may be the fuel of the future and gradually it may replace all current fossil fuels. Hydrogen can be used as a fuel for vehicles, to heat homes and offices, to produce electricity, and to fuel ships and aircraft. The present study provides an overview of hydrogen as an alternative fuel, which can be used in industrial burners, internal combustion engines and in fuel cells. Hydrogen can be the renewable and sustainable fuel as it can be produced by using renewable energy sources such as solar and wind energy. Blending fuel is defined as a mixture of different gaseous fuels such as methane, hydrogen, carbon monoxide and etc.

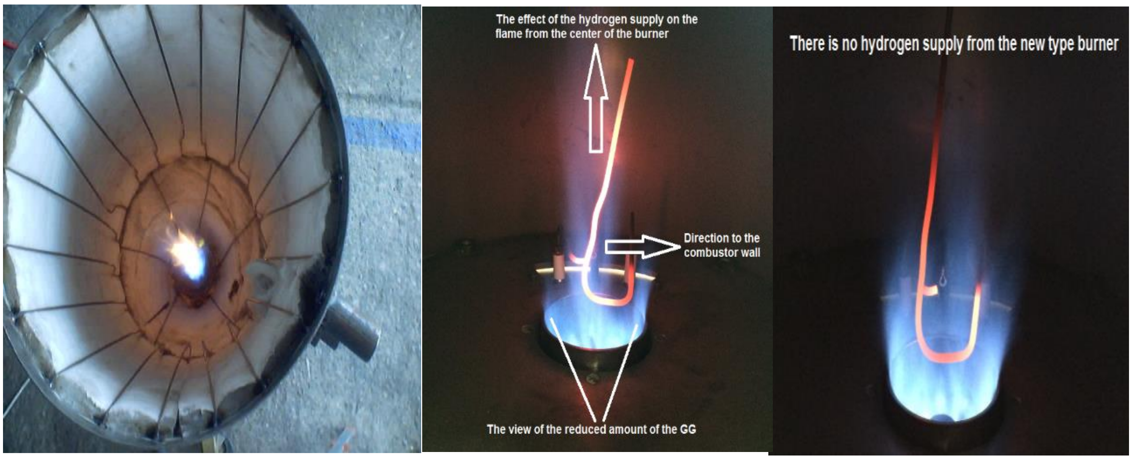
In this presentation, hydrogen usage as an alternative fuel, hydrogen blending fuels, obtaining blending fuels, combustion of hydrogen-methane blending fuels, combustion of hydrogen-coal gas or hydrogen-syngas, combustion of hydrogen-biogas have been evaluated.

Keywords: Hydrogen, Blended Fuels, Combustion, CFD Modelling

Results and Discussions

Combustion and emission characteristics of hydrogen-methane/coalgas/biogas blending fuels have been experimentally and numerically investigated in different combustion systems. Obtained results have been analyzed and obviously presented as follows;

- The effect of methane addition on flammability of hydrogen–air mixtures was investigated. The flammable regions were widened with hydrogen content increased in the mixtures.
- The addition of hydrogen to methane gives a good alternative fuel to hydrocarbon fuels as giving good flame stability, wide flammable regions and relatively higher burning velocity.
- The coal-derived low calorific value syngas mixtures have been properly consumed through the new type of burner coupled with the combustor within the present study. Therefore, it has been proven that these syngas mixtures can be burned as alternative fuels through the new type of burner.
- It is demonstrated that hydrogen supply highly affects conversion of CO (in the syngases) to CO_2 in combustion products.



Different blending fuels flames examples

Figure 1: Flame examples of different fuels [1, 2].

The above photographs in Figure 1 show the hydrogen blending on the flame shape clearly. The flame became thinner and longer when hydrogen added to the gas fuel. The maximum flame temperature increses and emissions of COx decrease gradually in all cases [1, 2].

Combustion and emission characteristics of hydrogen-methane blending fuels have been experimentally and numerically investigated in different combustion systems. Obtained results have been obviously presented in this part of the paper;

Figure 2 represents the effect of the fuel content on temperature levels. As can be seen in the Figure, the temperature levels increaseas the hydrogen content increases in the mixtured fuel, especially in the near-burner region. Temperature profiles at the combustor wall are given in Figure 2 for different study cases. 70%H_2–30%CH_4 flame has the peak temperature in the near-burner zone and has a value of 1260 K at z=0.2m and 1120 K at z=0.56m for 40 kW thermal power. 30%H_2–70%CH_4 flame has the peak temperature. Temperature profiles gradually decrease towards the combustor outlet in all cases[1, 2, 4, 5, 6, 7, 8, 9].

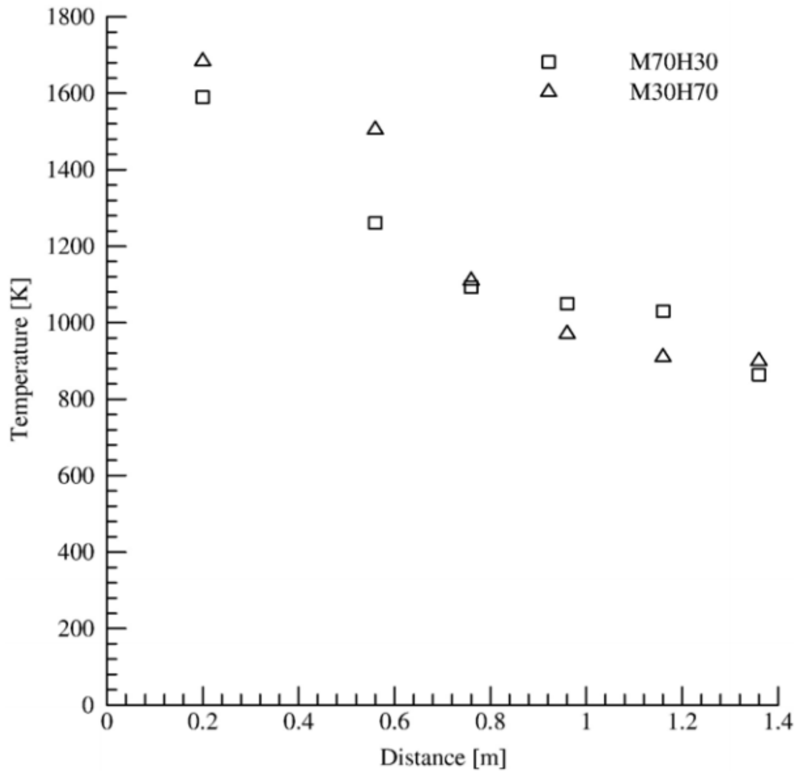


Figure 2: Temperature distributions for different hydrogen contents [1, 2].

Figures 3, 4 and 5 represent the effect of the fuel content in fuel blends on CO, NO_x and CO_2 concentrations respectively. As seen in the Figures, CO and CO_2 levels gradually decrease towards the combustor outlet. On the other hand NOx levels are higher for higher hydrogen content in the blended fuel in most of the cases [1, 2, 4, 5, 6].

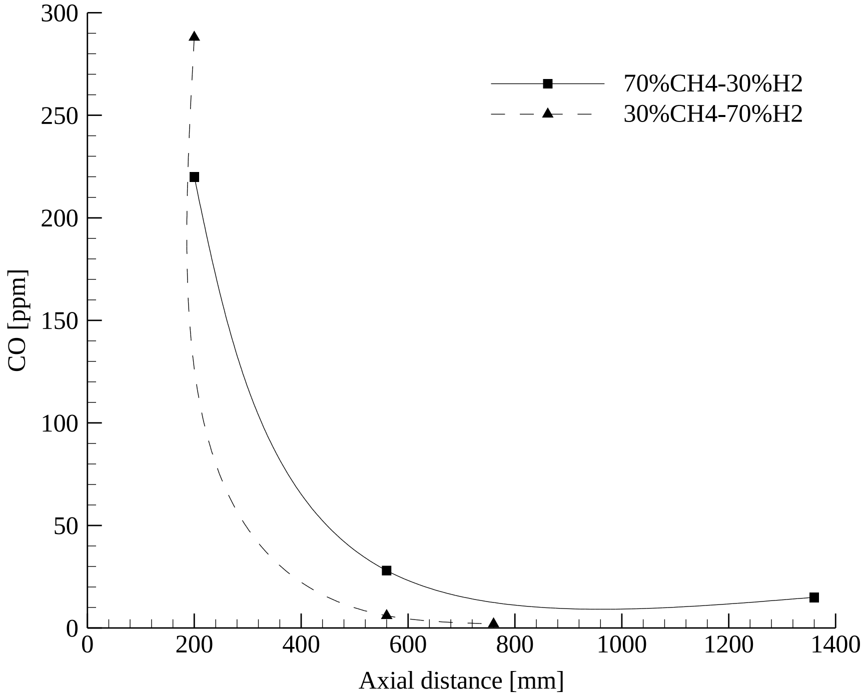


Figure 3: CO distributions for different hydrogen contents [1, 2].

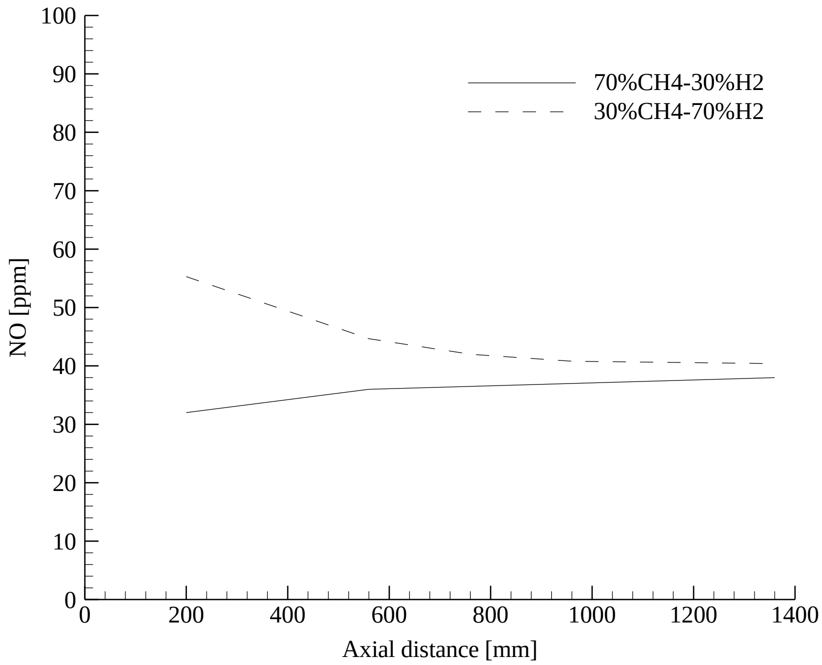


Figure 4: NO distributions for different hydrogen contents [1, 2].

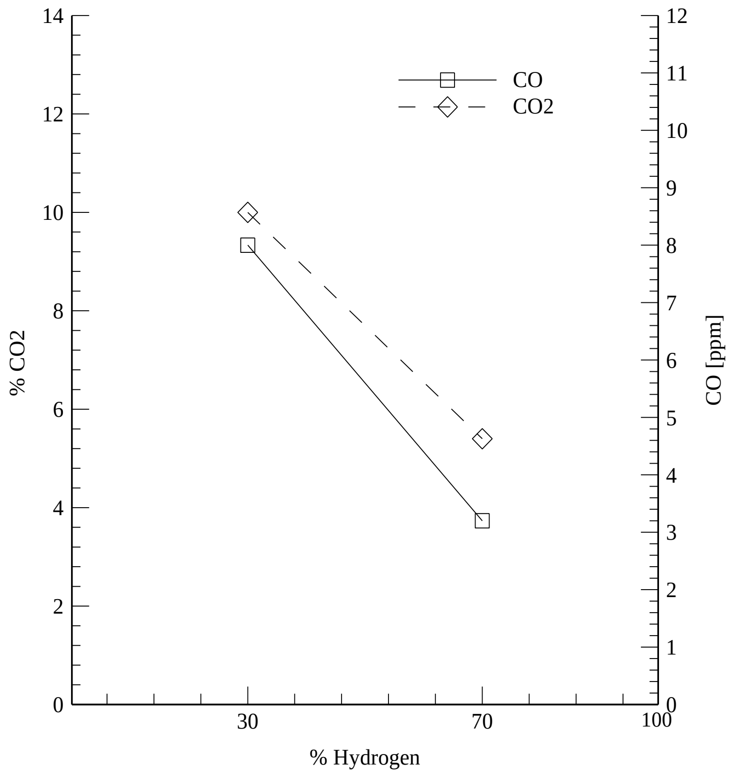


Figure 5: CO_2 distributions for different hydrogen contents [1, 2].

Figures 6 and 7 show the flame speed changes with equivalence ratio and hydrogen content in methane, respectively. The maximum burning velocity was of about 3.2 ms-1 for 100% H_2 at Ø=1.8, whilst the minimum burning velocity was about 0.25 ms-1 for 100% CH_4 at Ø=0.8. The maximum velocity of about 3.0 ms-1 for hydrogen–air mixtures and 0.3ms-1 for methane–air mixtures have been measured for similar conditions [3].

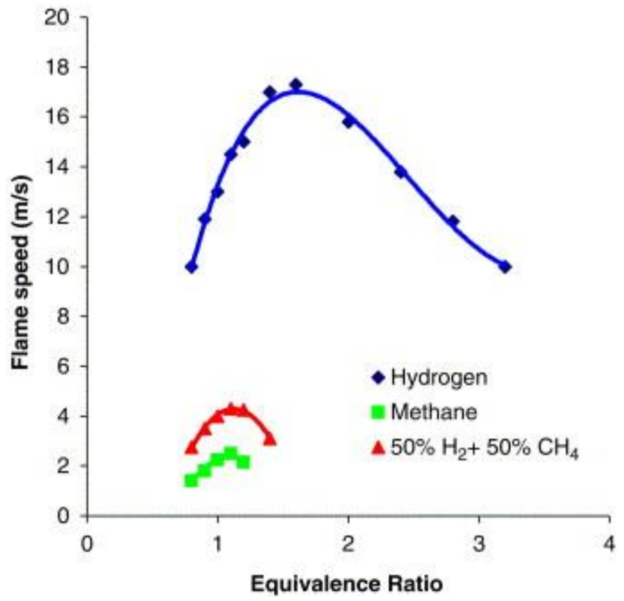


Figure 6: Flame speeds of different fuels for different equivalence ratios,∅=1.1 [3].

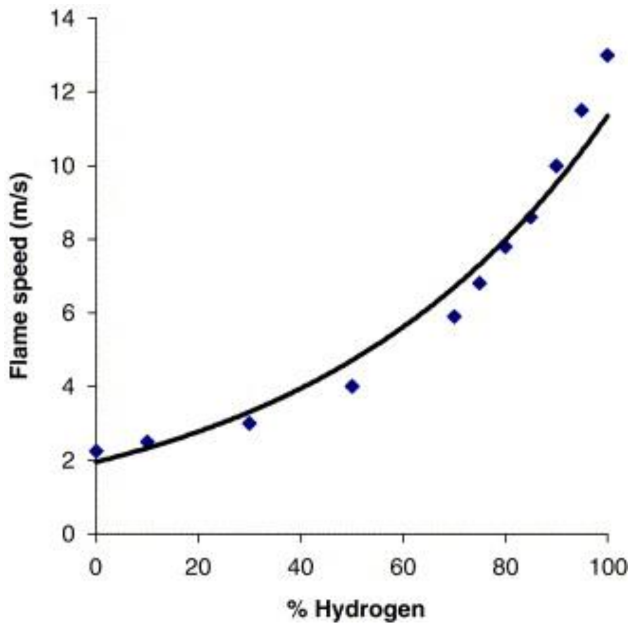


Figure 7: Flame speed for different percentage of hydrogen in methane, ∅=1.1 [3].

The use of hydrogen as an alternative fuel for internal combustion (IC) engines is also being considered in most of the studies. However, several problems have to be overcome before the aplications of hydrogen as an IC engine fuel for the automotive sector. Hydrogen and CNG blends (HCNG) may be considered as an automotive fuel without requiring any major modification in the existing CNG engine and infrastructure for low hydrogen contents such as less than 20% [10].

Conclusions

In this study, the use of hydrogen blended fuels as fuel in industrial burners, internal combustion engines and fuel cells was evaluated. Combustion and emission characteristics of hydrogen-methane/coalgas/biogas blending fuels have been experimentally and numerically investigated in different combustion systems [1, 2,3, 4, 5, 6, 7, 8, 9, 10].

The use of hydrogen blended fuels in fuel cells is also evaluated. Obtained results have been analyzed and obviously presented. Main conclusions are as follows;

- There is an interest in the use of hydrogen–hydrocarbon mixtures as an alternative fuel for improved performance as hydrogen haveingf the high reactivity and heating value.

- The hydrogen–methane blending fuels may be used without any important modification in gas burners and IC engines for low hydrogen contents such as less than 20%.

- Increase in hydrogen content in the fuel mixture led to an increase in the flame temperatures because of the higher energy input and increased flame radiation.

- The increase of hydrogen content in the fuel mixture can result considerable reduction in CO and CO_2 emissions.
- Hydrogen addition to gas fuels causes an increase in laminar flame speed and therefore turbulent flame speed.
- The flashback propensity increases with increasing of hydrogen content of the fuel blends.
- The increase of hydrogen content in the hydrogen–methane mixtures results the higher flame speeds and thus the higher burning velocities.

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