PREMIXED TURBULENT COMBUSTION OF HYDROGEN-CONTAINING FUELS: AN EXPERIMENTAL STUDY

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Introduction

Global fossil fuel resources are restricted. Especially, natural gas and crude oil resources are estimated to be consumed away in the near future. However, coal will be available for more than a century. On the other hand, combustion products of coal including fuel-bound nitrogen are responsible for air pollution, especially acid rain due to fuel NO_X mechanism. Because of that, coal gasification and carbonization are very important to obtain more clean gaseous fuels. These gaseous fuels are generally called as hydrogen-containing fuel as these gases include high amount of hydrogen up to 55 % (by volume).

This paper deals with premixed turbulent combustion of hydrogen-containing fuels in a cylindrical combustor. A newly generated premixed-burner has been used to combust the hydrogen-containing fuels. Temperature and emission values at axial and radial positions have been determined by using thermocouples and a flue gas analyser through the cylindrical combustor.

Hydrogen-containing fuels and combustion conditions

Specifications of hydrogen-containing fuels are given in Table 1. Species are in volumetric basis and units of LHV are given in kcal/m^3. Fuels represented by shading are coke oven gas and town gas II. Coke oven gas and town gas II have been consumed within the present study as they fall outside flashback limits under thermal powers of 10 kW, equivalance ratios of 0.83 and combustion gauge pressures of 80 mbar and 18 mbar of air and hydrogen-containing fuels combustion conditions, respectively. The other hydrogen-containing fuels those are known as town gas I and water gas including more amount of carbon dioxide compared to the coke oven gas and town gas II. Carbon dioxide as well as hydrogen is in tendency to flashback under premixed conditions [1].

Conclusions

Premixed flames of the aforementioned hydrogen-containing fuel have been experimentally investigated in this study.

Table 1. Details of hydrogen-containing fuels [2]

	H_2	CH_4	CO	CO_2	N_2	LHV
Coke Oven Gas	55	27	6	2	10	3678
Town Gas I	51	21	18	4	6	3434
Town Gas II	44	24	12	4	16	3335
Water Gas	50	0,5	40	5	4,5	2385

Temperature values have been measured at axial and different radial positions. Figure 1 shows that the axial temperature measurements of the hydrogen-containing fuels. The maximum flame temperatures of coke oven gas and town gas II were determined as of 1213,3°C and 1131,87°C, respectively.

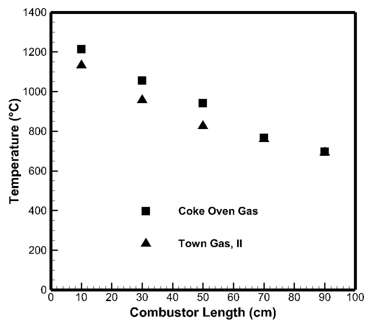

Figure 1. Axial temperature measurements

Radial temperature measurements are given in Figure 2, 3 and 4. It can be concluded that the combustion performances of coke oven gas are better than that of the town gas II because of their calorific values. In addition, Figure 5 depicts the flame photograph of the coke oven gas as an example of flame views. These gases were properly combusted under aforementioned combustion conditions in the premixed burner during the experiments. Any flashback was not observed un-

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der these conditions. It is demonstrated that the hydrogen-containing fuels may be burned at near stoichiometric conditions except for those which include a number of carbon monoxide.

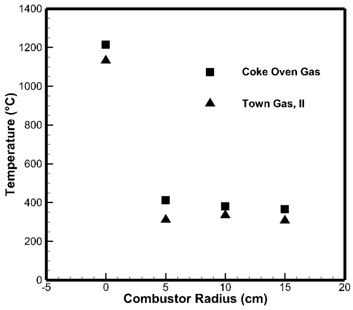

Figure 2. Radial temperature measurements at 10 cm axial location

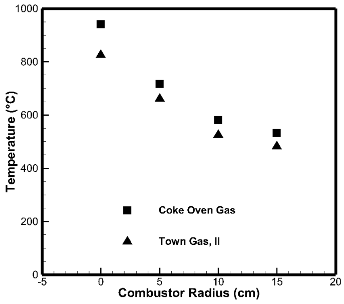

Figure 3. Radial temperature measurements at 50 cm axial location

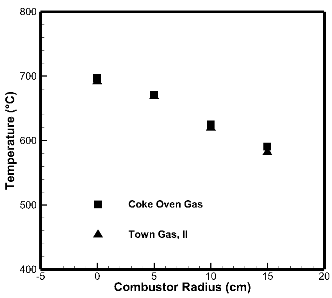

Figure 4. Radial temperature measurements at 90 cm axial location

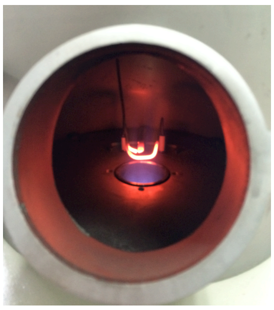

Figure 5. Flame photograph of the coke oven gas

Axial emission measurements of the hydrogen-containing fuels are shown in Figure 6, 7 and 8. NO_X measurements are relatively high as the hydrogen-containing fuels include somewhat amount of nitrogen as can be seen in Figure 6. This nitrogen contributes to the thermal NO_X as well as nitrogen in the air.

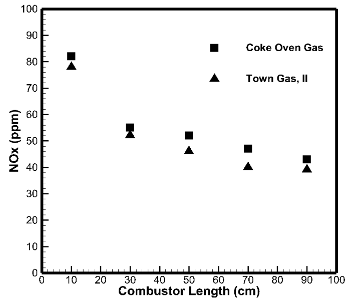

Figure 6. Axial NO_X measurements

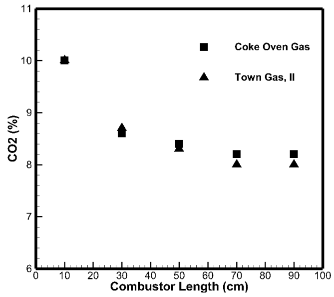

Figure 7. Axial CO_2 measurements

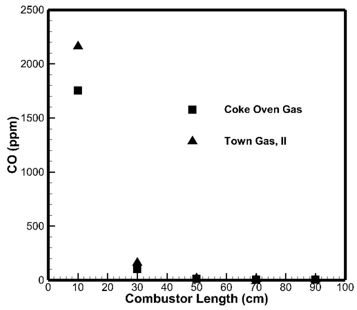

Figure 8. Axial CO measurements

Axial CO and CO_2 measurements are shown in Figure 7 and 8. The maximum CO values for both fuels are emerged in the flame zone due to incomplete combustion.

Acknowledgements

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References

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