Design of a Domestic Hydrogen Combustion Burner

Introduction

Reducing Greenhouse Gases using mix $\text{H}_2/\text{CH}_4$ as combustion burner fuel

Context

Climate Change Act (UK)
- Reduce GHGe by 80% between 1990 and 2050.
- Natural gas used in over 80% of households in the UK.
- Residential emissions 14% of the total GHGe in the UK
- $\text{CO}_2 + \text{NO}_x$ emissions: 2.5 tonnes/year/household in UK, 2016

Concept

- Hydrogen Enriched Combustion type:
  - Mixture $\text{H}_2/\text{CH}_4$ use as fuel burner in domestic boilers
  - Energy demand higher in January
  - Power needed $\rightarrow$ 24 kW
- $\text{H}_2/\text{CH}_4$ emissions limited by $\text{NO}_x/\text{CO}/\text{CO}_2$ constraints

Methodology

Combustion simulation changing $\%\text{H}_2$ inlet and analysing emissions outlet

1. Inlet parameters
2. Boiler Worcester = most common
3. CFD (Fluent) simulations
4. From 50%-50% ($\text{CH}_4/\text{H}_2$)
5. Increase $\%\text{H}_2$
6. Is the design meeting our energy demand?
7. Extract data from Fluent to input in Aspen
8. (Temperature, pressure, flowrate)
9. $\text{CO}, \text{CO}_2, \text{NO}_x$ emissions respect the constraints?

Aspen System

Figure 3: Aspen system used to evaluate emissions

Results

FINDINGS

- $\%\text{H}_2$ optimal $= 95\%$
- Meet $\text{NO}_x/\text{CO}/\text{CO}_2$ emissions constraints
- Class A energy efficiency
- Single flame, non-premixed, bluff body burner
- Tiered, overhead primary heat exchanger

IMPROVEMENT

- Increasing Bluff body:
  - Decreasing maximum T on the heat exchanger
  - Better heat distribution
  - Reducing cost material

Figure 4: Temperature profiles variation raising the bluff body


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