Title: Numerical simulation of the combustion chamber for a new reference combustion calorimeter computation simulation

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Introduction

Today natural gas is the third model most widely used fuel in the world.

Measuring the amount of heat that would be released by the complete combustion in air of a specified quantity of gas (on a molar, mass or volume basis), superior calorific value (SCV) (ISO 15971:2010, 2008).

¿ What is Superior Calorific Value?

There are different methods (P. Ulbig, 2002), apparatus Cutlass hammer (P. Ulbig, 2002), there are instruments commercial falling in indirect methods and which are the most used. Such devices can calculate the SCV of natural gas by chromatography, supported with ISO 6976

Today several institutions around the world such as (P. Schley, et al., 2010), (Haloua, Filtz, & et.al, 2009) and (A. Dale, et al., 2009), have developed their own devices which operate under the same principle as the calorimeter by (F.D. Rossini, 1931) called Class 0 mass-basis calorimetry by ISO 15971 and its main feature is the accuracy of measuring the SCV of pure gases that can be achieved with this type of equipment,
Introduction

Schematic diagram of class 0 calorimeter. (1) water pump; (2) stirrer motor; (3) spark ignition electrode; (4) thermometer; (a) secondary oxygen; (b) combustion products, (c) primary oxygen plus argon; (d) fuel gas; (CV) calorimeter vessel; (J) jacket; (CH) combustion chamber; (B) burner; (H) heat exchanger.

Source: (ISO 15971:2010, 2008)
Numerical model

\[ CH_4 + 1.5O_2 \rightarrow CO + 2H_2O \]

\[ CO + 0.5O_2 \rightarrow CO_2 \]

Parameters:
- Solver $\rightarrow$ Pressure-Based
- Non Premixed
- Transient State
- Modelado 3D
- Viscous model $\rightarrow$ k-epsilon (2 eqn), Realizable Combustion Eddy-Dissipation
- 3 zones, mixture methane-air; water and glass
- Air 6.66 e-6 kg/s; 23.5°C; 0.9 O2
- Methane 8.33e-7 kg/s; 23.5°C; 0.96 CH4
- Solution Methods; PISO
- Convergence 1e-3 continuity and 1e-6 energy
- time step size 0.01
- time steps 500
Methodology

Aim: Increase heat exchanged

Diameter and height equal

Criterium: The lower temperature in exhaust gases
Results

This work

Temperature (°C)

Time (s)

Literature

This work

First 8 seconds
Results

This work

Mean Temperature, Literature

Mean Temperature this work

Temperature (°C)

Time (s)
Results

100 seconds
Conclusions

Was shown two numerical simulations in a transient state of two combustion chambers for the reference calorimeter to measure SCV of natural gas.

The best performance was to literature chamber

maximum difference of 0.40°C in the first second

We chose a chamber with a cylindrical body and hemispherical lid

We need to increase the area where the gases are accumulated
References


