

# Experimental study on the enhancement of the thermal efficiency of a household gas water heater

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## Abstract

In this paper improvement of efficiency of a household gas water heater has been investigated experimentally. For this purpose, six baffles have been used for deceleration of the hot exhaust gases in the middle tube of the water heater. Three of the baffles have almost the same geometry and dimension and the other three are different from geometry and dimension points of view. Also, the same distances between the baffles have been considered. The geometry and dimension of the baffles have been chosen by experimental tests. Experimental results show that by employing the optimum geometries and dimensions of the baffles and by selecting the optimum arrangement of the baffles, the thermal efficiency of the household gas water heater has been improved and increased up to 82.5 percent. Experimental results also show that by the improvement of the thermal efficiency of the household gas water heater, pollutant emissions which have been measured by the gas analyzers at the laboratory remained almost at the lowest level. Finally by taking into account the effective parameters on the uncertainty for the thermal efficiency, in terms of the level of almost 95 percent for insurance against the reported number for the efficiency, the total uncertainty of the final optimized model for the thermal efficiency is  $\pm 0.17$ .

## KEYWORDS

Household gas water heater, baffle, thermal efficiency, Experimental test

## 1. Introduction

Energy audit in the industry has received significant importance in recent years. Also, in many countries, home appliances and high energy consuming gas household appliances have been subjected to mandatory standards and energy rating by their National Standards Organizations. In this regard, the enhancement of the thermal efficiency of gas household appliances is of great importance. The main aim of this research is proposing an optimal design for improving the thermal efficiency of the household gas water heaters in a manner that it would be attractive for the manufacturers from the manufacturing and economical point of views. Hossein-pour and Kashaniasl [1] and Kashaniasl [2] have shown that considering baffles in the fire tube and exhaust ducts of a gas fireplace in a proper manner can lead to the improvement of their thermal efficiency. Choudhury et al. [3] have investigated the influence of the addition of hydrogen the natural gas in the fire tube of a gas water heater. Amini et al. [4] have reported that using spiral finned pipes can improve the thermal efficiency of shell and pipe heat exchangers. Nshimyumuremyi and Junqi [5] have shown that replacing a galvanic iron plate by a slitted black aluminum plate in a solar water heater increases its thermal efficiency. In the present

paper, the effects of both controlling of combustion by orifice and proper use of baffles in the mid tube of a gas household water heater on the enhancement of its thermal efficiency have investigated experimentally.

## 2. Methodology

In this research, a household gas water heater with a warhead has been employed for experimental investigating of both controlling of combustion and employing baffles on the enhancement of the thermal efficiency of the gas water heater. Figure 1, illustrates the schematic representation of the mid tube of the household gas water heater with different baffles which are located against the flow of exhaust gases for preventing their quick exit and for reduction of waste of their thermal energy.

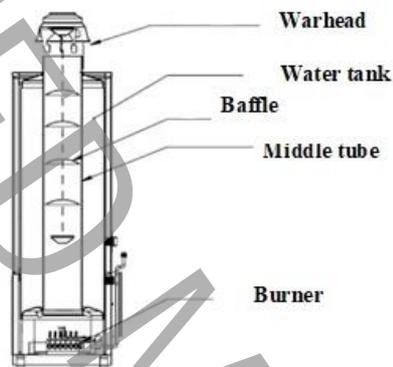


Figure 1: Schematic representation of gas water heater

For improving the combustion efficiency, the orifice has been tuned properly for the elimination of the carbon mono oxide from the exhaust gases. Production and elimination of the carbon mono oxide takes place in two stages through the following chemical reaction:

First stage:



Second stage:



## 3. Discussion and results

The experimental measurements of the mass fraction of different species of the exhaust gases at the downstream of the warhead of the household gas water heater together with the national standard magnitudes of these species [6] have been shown in Table 1.

**Table 1: Optimized water heater test results**

Measured magnitudes of species of the exhaust gases	Experimental measurements	National standard magnitude of species of the exhaust gases
Ambient oxygen (percent)	5.8	20
Carbon mono oxide (ppm)	18	200
Carbon dioxide (percent)	8.5	-
Temperature of the exhaust gases (°C)	89	It must not be less than 80 °C
Temperature of body, side walls, top and warhead of the water heater (°C)	93	These temperatures must not exceeds the ambient temperature plus 80 °C

The ambient temperature, absolute pressure and humidity have been measured as 19.1 °C, 830.5 mbar and 46 percent respectively.

#### 4. Conclusions

In this paper, an experimental investigation has been carried out for enhancement of the thermal efficiency of a household gas water heater and for the reduction and elimination of the carbon mono oxide in its exhaust gases. Experimental results show that proper controlling of combustion with orifice and optimal arrangement of the baffles in the middle tube enhances the thermal efficiency of the household gas water heater and almost eliminates the carbon mono oxide from the exhaust gases.

#### 5. References

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