



DESIGN OF GAS BURNER FOR THE FIRE INTEGRITY TESTING OF SEGMENTAL DOORS

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Abstract

The article focuses on the design of a medium-efficient gas burner. The fuel is a mixture of air and propane-butane. The burner is used to test the fire resistance of a segmental door sample. The door sample is built and tested in a special chamber. The result is time dependence on heat transfer, flame resistance and high temperature.

Keywords: fire, gas burner, resistance to flame, segment door.

1. INTRODUCTION

The aim was to design a medium-efficient gas burner. The fuel is a mixture of air and propane-butane. Propane combustion heat 50 kJ / kg or 101 kJ / m³, flame temperature 1980 °C air, 2820 °C oxygen. Butane combustion heat 49 kJ / kg or 134kJ / m³, flame temperature 1970°C air, 2845°C oxygen. Propane volume of oxygen required for burning 1m³ of fuel 5m³, a volume of fuel in the combusted mixture 16.67%, a volume of air required for burning 1m³ of fuel 5m³ and butane the volume of oxygen required for burning 1m³ of fuel 6.5m³ (see Table 1, 2). The propane gas content varies depending on the gas content taken. Natural gas is mainly methane and other additives. From the above values, design the optimum burner design.

2. MATERIALS AND METHODS

Propane boils at -42.1 °C, butane -0.5 °C. This has several consequences. When using a mixture of pro-butane (for example purchased on a gasoline pump), the gas composition changes gradually. At a time when the bottle is full, the mixture contains more propane, leaving a butane to evaporate. The mutual ratio of the two gases in the mixture may also fluctuate according to the season or depend on what the particular mixture is intended for. For use in summer in cookers or for car drive (such as LPG), a mixture containing 60% butane and 40% propane is used. In the winter, the ratio may be the opposite. Therefore, the mixture will only be burned correctly in the burner, which has the ability to regulate the relative ratio of fuel and air (oxygen).

For boilers that do not have the option of setting the fuel ratio, it is preferable to use a clean propane, the combustion of which is usually customized at the factory. The use of propane itself is also advantageous when multiple bottles are attached to one bottle, where the cooling of the bottle is sometimes apparent due to the rapid evaporation of the liquefied gas, which may lead to a particularly slow evaporation of the gas (especially butane). The values in Table 1 and 2 were taken from [1].

Table .1

Fuel Comb [kJ/kg]	Heat Comb[kJ/kg]	Heat Flame [kJ/m ³]	Temperature air flame (0 °C, 101,3 kPa) [°C]	Temperature Oxy- gen flame [°C]
Methane	55.760	39.888	1.957	2810
Ethane	51.690	69.250		
Propane	50.410	101.820	1980	2820
Butane	49.572	134.020	1970	2845
Hydrogen	142.443	12.790	3000	
Acetylene	50.367	58.990	2400	3200

With the increasing number of carbons in the fuel molecule, the amount of oxygen needed to burn the same volume of fuel increases. It is, therefore, necessary to vary the ratio of both gases. The values



given in the Table 2 are calculated from the stoichiometric ratios of the respective reactions. In practice, they will vary slightly, inter alia depending on the flame mode used (oxidation /reduction).

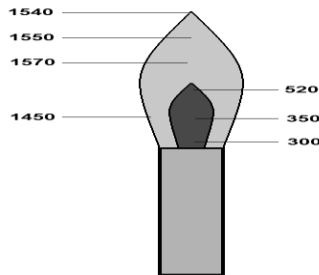
Table. 2

Fuel comb	Volume of oxygen need to burn 1 m ³ of fuel [m ³]	Volume of fuel in combustion [%]	The volume of air needed [m ³]	The volume of fuel in combustion [%]
Methane	1.75	3.36	8.33	10.71
Ethane	3.50	22.22	16.67	5.66
Propane	5.00	16.67	23.81	4.03
Butane	6.50	13.33	30.95	3.13
Hydrogen	0.50	66.67	2.38	29.58
Acetylene	2.50	28.57	11.90	7.75

When working with the burner, only the flame temperature is not decisive. The amount of heat that the burner is able to pass to its surroundings, that is the burner's thermal output, is decisive. This is due to the amount of gas that the burner is capable of burning per unit of time, and this depends on the burner design and the burn rate. Since the rate of combustion with the increasing number of carbons in the fuel molecule decreases, it may be beneficial in certain circumstances to burn less heat fuel at a higher rate.

Analyzing the structure of the flame. If the carbon-containing gas is burned only by the air in the vicinity of the flame, oxygenation occurs only with the oxygen that comes into the flame from the vicinity of the diffusion. In that case, we are talking about a so-called luminous flame, which has a relatively large volume, a low temperature, and contains heated red particles of carbon originating from thermal decomposition of fuel. This flame is not suitable for glass processing.

For working with glass, a non-flammable flame occurs when combustion of a fuel/oxygen/air mixture.

**Fig.1** The phenomenological model of flame [2]**Fig.2** The blow burner

The gas is mixed with air or oxygen as soon as it enters the burner, and this mixture is gradually spawned. In doing so, it also pours more air from its surroundings. Before the flame mouth, an internal reduction cone and an outer bluish, non-luminous wrapper can be observed (Fig. 1) [2]. The internal cone contains a mixture of unburned gas and primary air (oxygen). This mixture is partially burned on the surface of the inner reduction cone and the combustion is completed in the outer shell by the secondary air which diffuses into the flame and is entrained by the flue gas stream.

Since there is incomplete combustion in the reduction zone of the flame, there is a lower temperature than in the outer package.

The dimensions of the inner reduction cone, as well as the outer package, diminish with the increasing amount of primary air (oxygen). For air-to-oxygen burners, the flame volume can also be changed by adjusting the relative air and oxygen ratios. By adding air, the flame volume increases with the influence of nitrogen, which practically does not enter into chemical reactions. Sometimes air can also be used to stabilize the flame. The structure of the flame depends to a certain extent on the design of the burner.

From the above analyses to achieve the required temperatures in the test chamber, a suitable burner must be used. The first experiments were built with a non-airborne burner, it was found that the flame was not sufficient to achieve similar temperature values as those used in testing at a test facility. The



blower burner (see Fig. 2) has met the temperature requirements, but which was originally designed for other purposes and does not allow automatic temperature control in the chamber. Therefore, a new burner model was designed (see Fig. 3 a) that would better meet test requirements, and in the future enable automatic temperature control of the furnace according to a defined curve (according to the Fire Testing Standard). The principle of the burner lies in a controlled fuel and air supply. The amount of fuel is currently set on the propane-butane cylinder valve. The amount of air is adjusted by the size of the slot in the suction area of the fan. This design model is designed to optimally mix gas and air (see Fig. 3 b and Fig. 3c).

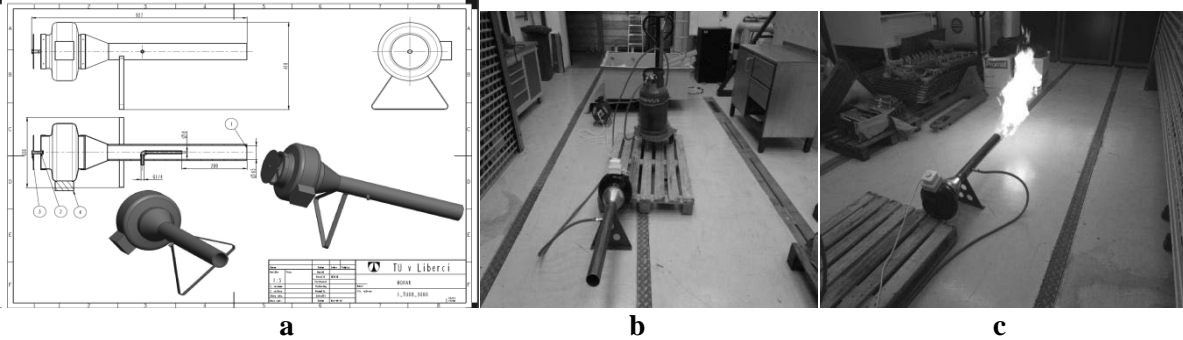


Fig.3 (a)The new shape of burner, (b) the new burner made, (c) the first tests of the new burner

4. RESULTS AND DISCUSSION

In this work, the test of reduced models of fire doors was established. Small models of fire doors were produced for chamber tests. The reality, many tests of the existing fire doors have been carried out. Firstly, the location of the fire door models in the chamber, including the location of sensors for temperature evaluation, flame supply, was approached so that we would approach test conditions in a certified laboratory. The chamber fitted with sensors before the start of the test is shown in Figure 4 a.

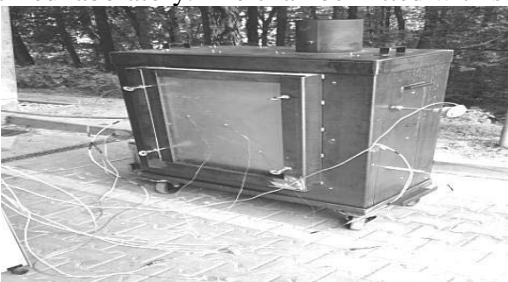


Fig. 4 a Chamber with thermocouples connected

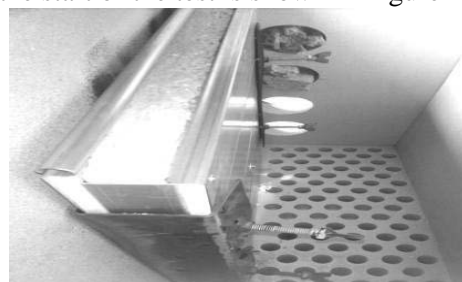


Fig. 4 b Fix the sample in the test chamber

Prior to the test, the specimen is fixed in the chamber so that the front vent hole of the chamber is sealed (see Fig 4 d). After the flame is ignited, the furnace temperature control is manually controlled by a valve on the gas cylinder. The air is fed through the blower and the amount of regulation is very difficult for the burner (see Fig 4 c and Fig 5).



Fig. 4 c Processing the flap door test and flame ignition

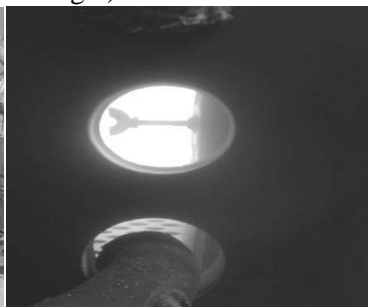


Fig. 4 d Test run of the door leaf model

Figure 5 shows the course of the test. The model of the segmental door after the test (see Fig 5 a) where apparent degradation of the material is due to extreme temperatures, Fig. 5 b a shows the image from the thermal camera, the temperature during the test refers Fig 5c.

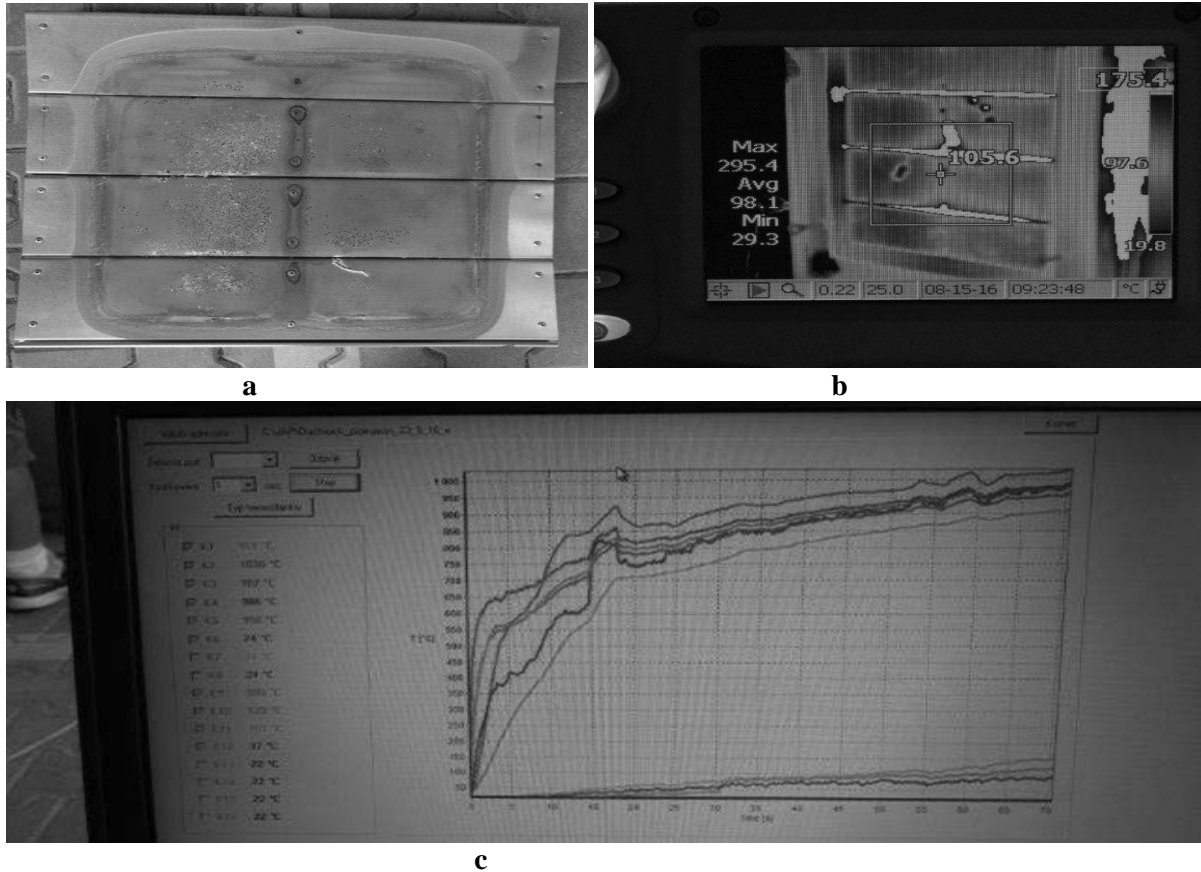


Fig. 5 Sample of test models of fire doors in the test chamber

Also, Figure 5c is clearly shown that the temperature curve on the top, in the middle, the below represent of reduced door model, the temperature range of the sample, temperature course at different locations of the chamber respectively.

4. CONCLUSIONS

The gas burner for the fire integrity testing of segmental doors equipment which designed and manufactured is satisfying design specification, their operating is good and being able to utilize for fire integrity experiment. Also in the future which could be improved the design enables automatic temperature control.

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