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The blowoff limits and flashback limits for different diameter to length ratio burner

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ABSTRACT

A 129 kWh swirl gas burner was used, where the effect of the burner geometry on the operation window was studied. Using LPG. The length of the burner edge was studied by taking three values of length (5 cm, 10 cm and 15 cm) which represent the ratio (1,2 and 3) to the diameter of the burner respectively. To enhance the combustion stability a swirl vane guide was used to obtain swirl flow and improve the flame structure. The result show that the increase in length of burner neck will decrease the swirl coherent structure and turn the flow to diffusion flow which increase the ability to have boundary layer flashback. However with the limit of burner used, increasing the length of burner neck gives a good result in blowoff side by bush it to leaner limits around ϕ=0.38 but in term of flashback it will bring it to leaner limits too, which is not preferable.. Although, this improvement is linked to the fuel type in first place but the flow structure has a significant impact on flame stability.

Keywords: Blowoff, Burner, flashback, equivalent ratio, operating window.

INTRODUCTION

Demand for energy is so high that it becomes the de facto measure of the growth of industrial development. However, excessive energy consumption is an important issue. Thus, this excessive consumption will play an increase in emissions and pollution, and thus affect all aspects of life and other sectors related to human life.

These emissions and pollution absorb the solar heat reflected from the Earth's surface and reissue it in all directions, causing a significant rise in global temperature,[1] .

Comparisons between fossil and renewable energy sources (cost of production and CO2 emissions) [2] . The introduction of new fuels must meet several rules such as real estate development through renewable production. At present, biofuels are an indisputable source of renewable fuel and flexible engine operation.

However, a reliable and safe transition from fossil fuels to alternative sources of ownership remains an important subject of analysis. In general, several options will address fuel flexibility for power generation.

Various fuels have been introduced into many combustion systems to allow fossil fuel consumption to also be reduced to meet clean energy needs [3], [4] , [5]. Different fuels such as biofuels are multifunctional functions in energy and geographically distributed resources [6] . There has been a strong tendency to seek additional reliable and environmentally friendly energy resources. Thus renewable energy comes from natural resources such as sunlight, wind, tides, rain, waves and geothermal area - a catalytic energy source. However, this contribution to the overall international energy sector remains low and relates to the revolutionary organization with 17% of the world's total energy consumption [7] .

The purpose of this worksheet is to determine the boundaries of the blowoff and Flashback through the effect of changing the length and diameter of the burner on the operating window using liquefied gas.

EXPERIMENTAL WORK

The experimental dredger in this work is a whirlpool stove, used in industrial uses and small power plants, about 129 kWh as shown in Figure 1.1 and Figure 1.2. Liquefied petroleum gas (LPG) is used as the main fuel, to protect the environment from the pollution resulting from the combustion process.

Fig.1. 1 Photograph experimental system

All tests were conducted at the College of Technical Engineering in Najaf, AL- Furat AL-Awsat Technical University located in Najaf, Iraq. The main parts of the system are (small blower, cylindrical stove containing different cross-section areas, rotary vortex guide, secondary fuel system acts as a deceptive body and a bank of rotometers and electric control system).

Three models of the stove neck were used with a fixed diameter of 5 cm and the height is changed according to the model used. The first model is 5 cm long, the second model is 10 cm long, and the third model is 15 cm long, the ratio of 1/2 and 3 respectively as shown in Figure 1.3.

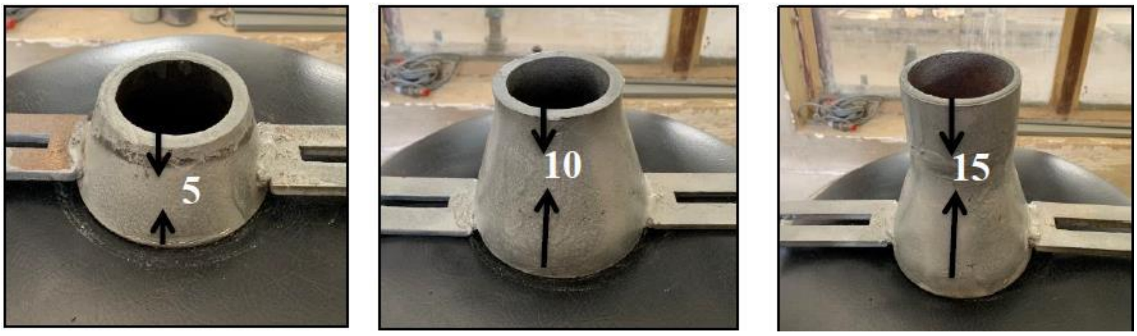

Fig.1.3. Rim burner section

RESULTS AND DISCUSSION

The results obtained from the eddy burner using LPG as fuel and the effect of changing the length of the burner neck on the stability of the flame. The operating window of the 10 cm long burner neck that was used in our work (model II) was compared with a 10 cm swirling stove used at the University of Cardiff [8] , and the results are shown as shown in Figure 1.4.

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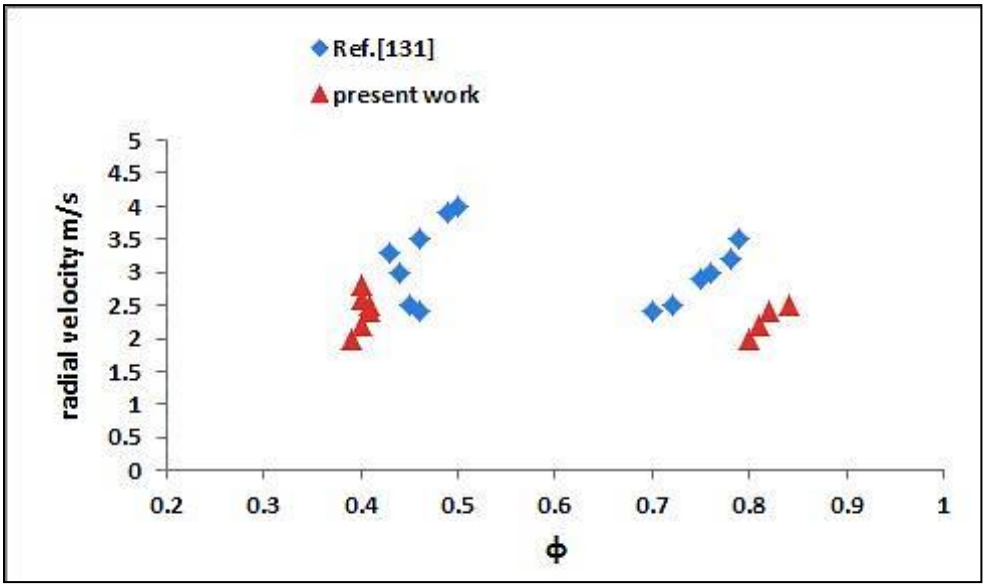

Fig.1. 4 Validation of the experimantal work.

Although the type of fuel used [8] is natural gas and its chemical formula is CH_4 and the fuel used in this study is LPG and its chemical formula C_3H_8, the trend remains the same and the process window has been calculated using the data collected. LPG is more worried about stability.

The basic measure of the success of any combustion design in external combustion systems depends on the ability of the stove to operate under variable conditions in terms of temperature and proportion. , Which is more difficult because the stability of the burner is closely related to the type of fuel used, so the stability map of a single burner is difficult to apply when using another type of fuel. In order to map the stability of any Holocaust, it must be done according to the following steps, which is followed in this research to find a map of the stability of the Holocaust:

1- The stove is operated within an equation of 0.5 - 0.6. This ratio is safe for many designs currently used in incinerators when using hydrogen-enhanced fuel. When the flame stabilizes, we increase the fuel content of the mixture while maintaining a constant amount of air in order to obtain a rich mixture,

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Stimulating the flame to move towards the stove nozzle and continue to increase the fuel ratio to where the flashback phenomenon occurs.

2- After the phenomenon of flashback and the entry of flame inside the stove and its stability on the border between the base of the neck and the body of the stove where many designers rely on a reverse limit for the purpose of installation returns fire and prevents him from attacking the fuel source in the system except in the case of high fuel rates in the mixture. Reduce fuel to push the mixture into the combustion area, lifting the flame from inside the combustion nozzle outward. By continuing to reduce the fuel ratio, the flame is pushed further and further away from the burner nozzle until it reaches a detachment or fire (explosion) state. By recording the parity ratio in which flashback phenomena occurred respectively.

3- Repeat the above process after increasing the airflow rate to a higher rate than before and recording new flash and flash points.

4- By repeating the process over the air flow rate, we obtain what is known as a stability map as shown in Figures (1. 5, 1.6 and 1.7).

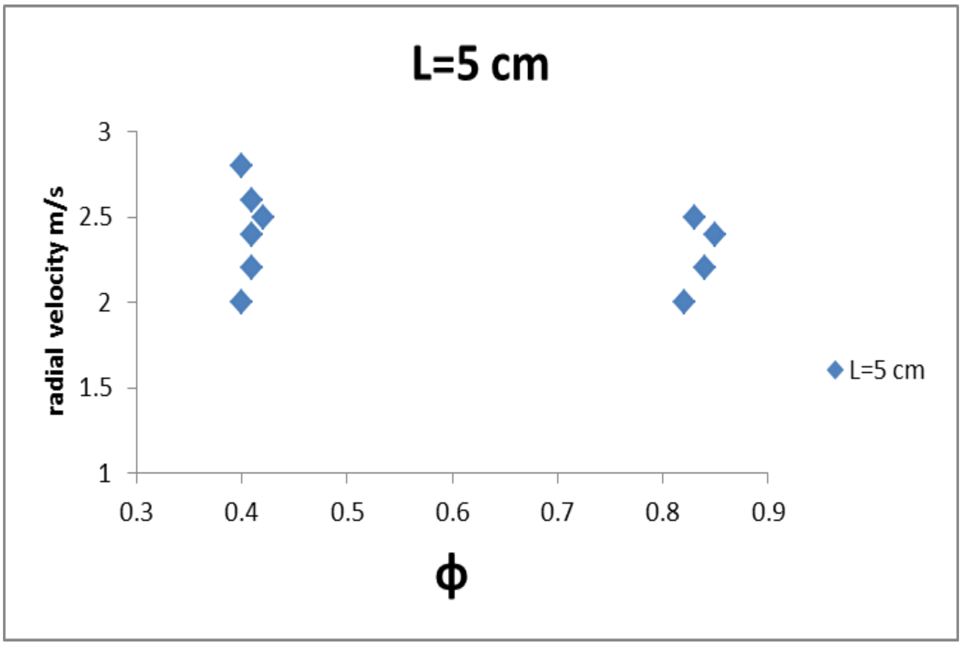

Fig.1. 5 Operation widow of the burner with 5 cm long neck

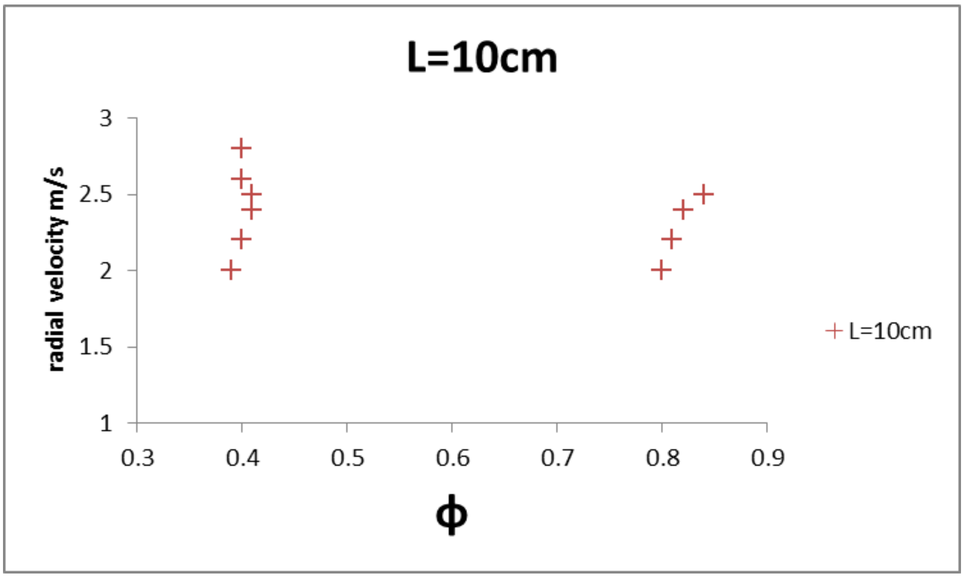

Fig.1. 6 Operation window of the burner with 10 cm long neck

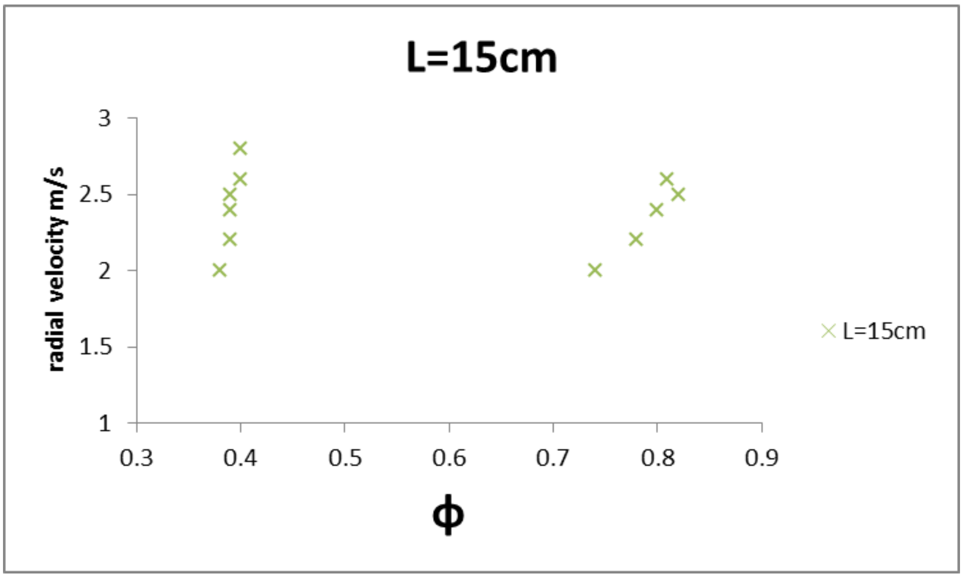

Fig.1. 7 Operation window of the burner with 15 cm long neck

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The increase in the length of the neck accelerated the emergence of the flashback phenomenon where the flashback phenomenon occurred in a ratio less than the need for a 5 cm burner as shown in Table 1.1 below in which the operating window borders of the blowoff and Flashback were drawn for the three models Used in the experiment.

Table 1. 1 Varation length with velocity

		15cm		**10cm**		**5cm**	
		velocity (m/s)	**Φ**	**velocity (m/s)**	**Φ**	**velocity (m/s)**	**Φ**
lean	1	2	0.4	2	0.39	2	0.38
	2	2.2	0.41	2.2	0.4	2.2	0.39
	3	2.4	0.41	2.4	0.41	2.4	0.39
	4	2.5	0.42	2.5	0.41	2.5	0.39
	5	2.6	0.41	2.6	0.4	2.6	0.4
	6	2.8	0.4	2.8	0.4	2.8	0.4
rich	1	2	0.82	2	0.8	2	0.78
	2	2.2	0.84	2.2	0.81	2.2	0.78
	3	2.4	0.85	2.4	0.82	2.4	0.8
	4	2.5	0.83	2.5	0.84	2.5	0.82
	5	2.6	-	2.6	-	2.6	0.81
	6	2.8	-	2.8	-	2.8	

CONCLUSIONS

The main conclusions that could be concluded from this work are:

1- From the aerodynamic point of view, it is concluded that the strength of the vortex will decrease with increase length due the friction with burner inner walls. As a consequence, the swirl flow will turn to jet or diffusion like flow.

2- Increasing the length of the neck of the burner leads to higher stability in term of the equivalent ratio. At constant equivalence value the burner showed higher stability than the other two models and therefore requires an increase in the rate of air flow in the mixture area and thus get a poor mixture so it works Its application in the few loads for power plants.

3- Increasing the length of the burner neck has precipitated the flashback phenomenon.

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