Team Second Report: Laminar Flow in Gas Burners

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Introduction

This image was taken for the Team Second project as part of The University of Colorado's Graduate Mechanical Engineering course in Flow Visualization. This was the class's second team project. The intent of this image was to capture different gas densities in a stovetop burner. I worked by myself on this lab. This was taken in my kitchen while I was cooking dinner. I was amazed by the color and smoothness of the burning gas flow and decided to capture this image.

Flow Apparatus

This flow is a basic combustion process of gas existing a nozzle. Stovetop burners work by utilizing the venturi effect. This works in principle by speeding up the gas as it enters a narrower tube. Now that the gas is flowing at a high enough rate, it exits the nozzle, mixes with air is it lit by a spark plug[1]. The flow is quite laminar as we see below:

$$Re = \frac{\rho V L}{\mu} = \sim 500$$

where ρ is density, V is the velocity of the fluid, L is the length of flow, and μ is the fluid viscosity. For low Reynolds numbers (i.e. below 2000) we can say this flow is laminar, where the viscous forces dominate the flow[2]. The photographic technique used here was quite simple. There was ample light in the kitchen to capture this image so no exterior flash or lighting was needed. For the flow, it was simply taking a picture of the existing combustion process.

Methods

This image was taken on an Olympus OMD EM-1 using an Olympus 12-150mm lens. The settings for this picture were 1/13s – f/5.6 – 150mm – ISO 1600. I was standing about 2m away from the flame to get the correct clarity. I wanted a long shot zoomed in close. This flattens the background against the image. The image above is 1300 x 900 pixels.

Discussion

The image reveals gas densities within a highly laminar flame. I like how we can see the brighter blue cones inside, noting the higher temperatures associated with the gas. The outer cone is a less dense and slightly more. To me this is a great example of how fluid flow and visualization is ever present in our everyday lives – so much so that it often goes unnoticed. My goal here was to highlight how mundane things can still be so complex and beautiful.

References

[1]Strojnik, M., Paez, G. and Scholl, M.K. (2013) 'Combustion initiation and evolution during the first 400ms in a gas burner at 10μm', *Infrared Physics & Technology*, 61, pp. 42–49. Available at: https://doi.org/10.1016/j.infrared.2013.06.001.

[2]Wu, J.-F. *et al.* (2017) 'Study on the design of high thermal efficiency gas stove based on waste heat recovery', *Proceedings of the 2nd Annual International Conference on Electronics, Electrical Engineering and Information Science (EEEIS 2016)* [Preprint]. Available at: https://doi.org/10.2991/eeeis-16.2017.56.