



Project 2 Report

Wangyang Wang

Introduction

This image was taken on Nov 1st 2015, and the purpose of this image was to be able to visualize the vapor. The vapor shown in the image was created from an electronic cigarettes, and we would like determine if the flow is turbulent or laminar.

Image Analysis

The vapor shown in the image was created from electronic cigarettes (EC), the basic idea of creating vapor from e-cigarettes was the atomizer inside the device heated the cigarettes oil to its boiling point, and the phase of the oil changed from liquid to vapor. A recent research found that the EC oil contain nicotine, propylene glycol, and flavorants among other things but the vapor from EC was not just simplify water vapor. The vapor came out the EC contains propylene glycol, heavy metals, and volatile organic compounds. Due to the different types of EC oil, the compounds of the EC vapor are slightly different. But from our experiment and observation, we can assume that the density of the EC vapor were larger than the density of air, since the vapor condensed in the air.

From the image, we observed the flow of vapor was turbulence flow. However, we couldn't really approve this phenomenal by calculation Reynold's number. We have studied that:

$$Re < 2000 - \textit{laminar flow}$$

$$Re > 4000 - \textit{turbulent flow}$$

$2000 < Re < 4000 - \textit{transition region or cirtical region,}$
 $\textit{flow can eiter be laminar or turbulent}$

$$Re = \frac{\rho VL}{\mu} \quad (1)$$

ρ is the density of the vapor, V is the velocity of the flow, L is the flow length, and μ is the dynamic viscosity of the air.

In our experiment, we couldn't really estimate what the density and the dynamic viscosity of the EC vapor. A lot research paper had been published in 2013 studied EC on health effect, but not much information on EC vapor or EC oil. Electronic cigarettes need to be continuously studied in the future.

Image setup

Picture was taken on a dark colored desk with the camera positioned about 25 cm away from the cup. Camera was tilted about 10 degree downward from the horizontal in order to capture the Vapor. Vapor was initially inhaled then pulled into the cup, cup was lifted about 15 cm above the surface of the desk and then pulled the vapor out the cup. The only light source was the regular desk lamp. The experiment setup can be seen in Figure 1.

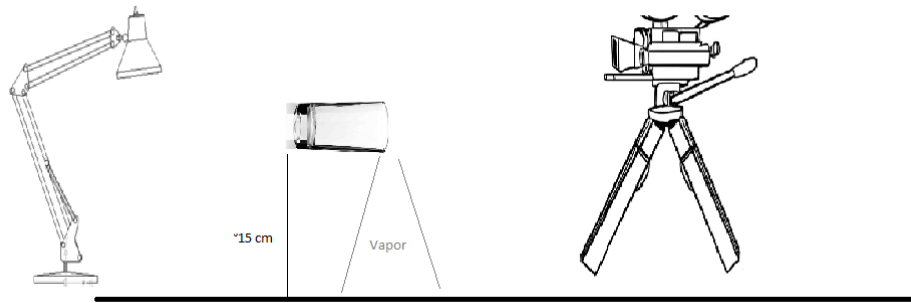


Figure 1 Image Setup

The image I got has some motion blur because the vapor was in motion, maybe a shorter exposure time would be much better for those kind of image. Also a high sensitive may also improve the picture. The camera setting are shown below:

Camera Maker: Canon

Model: Canon EOS 60D

Focal length: 18.0mm

Exposure: 1/5 Sec, f/5.6, ISO 500

Image Size: 2688 x 1712

Resolution: 240 Pixel per Inch

The image was processed using Photoshop CS6 software, curve was adjusted to enhance the color and the image was cropped with only smoke left.



Figure 2: Edited image



Figure3: Original Image

Reference:

- [1]. "Vaping 101: How Do E-Cigarettes Work?" NBCNEWS, <http://www.nbcnews.com/tech/tech-news/vaping-101-how-do-e-cigarettes-work-n88786>
- [2]. Phillip Gardiner, "E-Cigarettes: The Vapor This Time?", <http://trdrp.org/files/e-cigarettes/e-cigarettes-the-vapor-this-time.pdf>

Figure 3Original Image