Dependance the height of the flame from velocity of outflow in diffusion combusting

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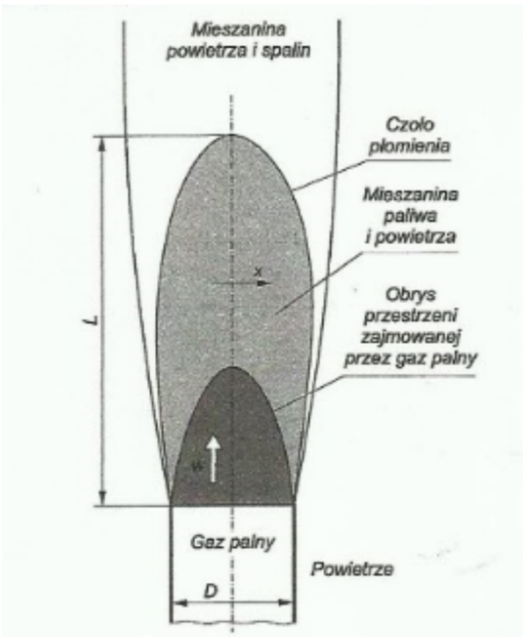
1 Theoretical introduction

In combustion, a diffusion flame is a flame in which the oxidizer combines with the fuel by diffusion. As a result, the flame speed is limited by the rate of diffusion. Diffusion flames tend to burn slower and to produce more soot than premixed flames because there may not be sufficient oxidizer for the reaction to go to completion, although there are some exceptions to the rule. The soot typically produced in a diffusion flame becomes incandescent from the heat of the flame and lends the flame its readily identifiable orange-yellow color. Diffusion flames tend to have a less-localized flame front than premixed flames.

The contexts for diffusion may vary somewhat. For instance, a candle uses the heat of the flame itself to vaporize its wax fuel and the oxidizer (oxygen) diffuses into the flame from the surrounding air, while a gaslight flame (or the safety flame of a bunsen burner) uses fuel already in the form of a vapor.

Diffusion flames are often studied in counter flow (also called opposed jet) burners. Their interest is due to possible application in the flame model for turbulent combustion. Furthermore they provide a convenient way to examine strained flames and flames with holes. These are also known under the name of "edge flames", characterized by a local extinction on their axis because of the high strain rates in the vicinity of the stagnation point.



The purpose of this simulation is to show how height of the flame, volume of mix area and volumie yield is changing reference to pressure and temperature of burning mixture.

2 Description of combustion process

Fuel and oxidizer are supplied to burner through separated channels and are mixed in outflow area. Mixing depends from velocity of outflow (we can spot the laminar, turbulent or transitory flow). In each type of flow the velocity of mixing is less than velocity of chemical reaction. Because of that combustion process is controlled by diffusion the both components. We call it diffusion combusting.

The diffusion combusting process is intrested by theoretical and practical way. The diffusion flames research are often spotten in a lot of universities. Most difficult is to research local mixture composition, velocity of burning and analysis diffusion processes in areas of high temperature.

3 Description of program code

We can declare: Outflow velocity of the gas from nozzle Average diameter of the nozzle Molecular diffusion coefficient

Transformation of equations:

$$t = (\frac{L}{2})$$

Equation which combining average square the route of the molecules with the route which was spend:

$$(x)^2 = (2 * Dm * t)$$

For

$$(x) = (\frac{D}{2})$$

$$(\frac{2D}{4}) = (2 * Dm * t)$$

$$(\frac{np.pi * (D)^2}{4}) = (\frac{np.pi * (D)^2}{2 * np.pi * Dm * t})$$

Approximated volume of the mix area

$$V = (np.pi * (\frac{(D)^2}{4}) * L)$$

$$V = (2 * np.pi * Dm * t * L)$$

Volume changes in time t: Vt = Volume yield of the gas

$$Vt = (\frac{V}{t})$$

$$Vt = (2 * np.pi * Dm * L)$$

Now we can calculate the height L: ro= Density of the gas mt= Mass yield of the gas

$$L = (\frac{mt}{2ro * np.pi * Dm})$$

We know that

$$t1 = t2$$

4 Results

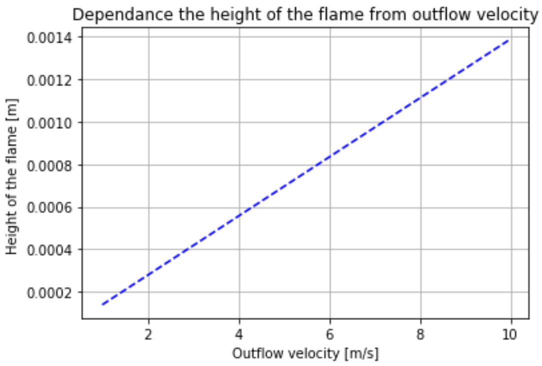
5 Bibliography

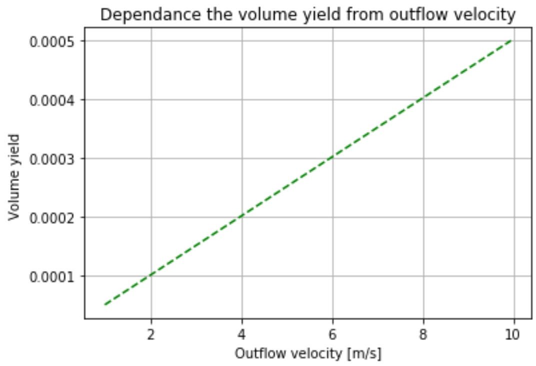
Webpages and books used to make project and report: Marian Gieras "Spalanie. Wybrane zagadnienia w zadaniach"

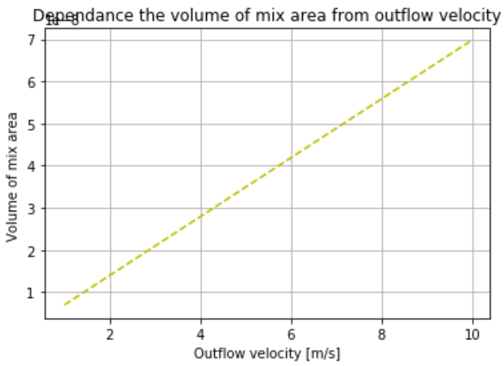
Kowalewicz Andrzej "Podstawy procesów spalania"

https://matplotlib.org/users/pyplot_tutorial.html

https://matplotlib.org/examples/pylab_examples/simple_plot.html







http://www.cantera.org/docs/sphinx/html/cython/tutorial.html
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