REVIEWS ON THE MANUSCRIPT [2]

Reviewer 1:

The paper is well written. It has straightforward and clear structure, involves good qualitative analysis, and the descriptions of experiments.

Therefore, it is recommended to be published if the following details are corrected.

Page 2 – **Flame Deviation**. ”there would be another force applied to the system due to the difference in momentum of input and output particles” – more information is needed.

You consider the forces acting on a single molecular particle of the system (microlevel) or a particle of much larger size (a carbon particle)?

In the first case, there is no buoyancy force and air drag force acting on a single particle (they act on macrolevel).

In the second case, more information needed on the force due to difference in momentum. What is its physical nature? How it is connected to the fact that the system is not isolated?

The corresponding figure (Figure 1) should be improved with necessary descriptions (What do the letters mean? Which forces do they indicate?)

Also, all notations of forces should be provided with vectors above the letters.

Page 3 – **Flame Oscillation**. Very small part of your article is devoted to this phenomenon. Try giving more descriptions on the physical behavior of your system. A figure or a diagram would look really great here, because it is one of the most important parts of your problem.

Page 3 – **Numerical Analysis**. Euler method can be either *explicit* or *implicit* one. You should write definitely which one you used, or not write about the method of ODE solution at all (writing just “Euler method” gives the reader incomplete information).

Reviewer 2:

My comments are directly in the pdf in yellow balloons and I did some corrections. In general, I think the authors got a good feeling what is physically going on in the task, it is supported by experiments and simulations but some assumptions are incorrect and they are often not enough precise and complete in the description of the phenomena. If it was a scientific journal paper, as a reviewer I would require major revision. I let the editor decide having in mind a typical level of the book. At least some precisions, missing equations that simulations are based on, and conclusions should be done.

page 2

>> Electron reaction:

This process is the electron attachment and is the main sink mechanism of free electrons in air. It is temperature dependent and strongly declines with rising T. In the flame where T reaches >1000 K it almost does not occur, on the flame-air boundaries it becomes playing role.

>> After this process the total flame charge will be positive in the presence of electric field.

There are also other negative ions forming in the flame: HCO3-, CO3-, etc., not just positive ion. I admit positive ions will be dominant. See A M Starik: Formation of charged nanoparticles in hydrocarbon flames: principal mechanisms, Plasma Sources Sci. Technol. 17 (2008) 045012

>> particles exiting from the upper part of the flame

I am afraid this simplified consideration is not perfectly correct. The combustion occurs not only in the bottom of the flame but also higher up. The combustion increases the number of particles and gives them higher momentum and also temperature. They are certainly not cooled in the flame.

>> toward the lower part of the flame (Figure 1).

make text consistent with Fig. 1.

>> a small part in the flame consists of negative ions

Yes, correct!

page 3

>> So in this case the plasma flame does not deviate at all

The space charges are in equilibrium within the plasma but when it is inserted into important external E-filed, they will feel it and will redistribute. I think the real cause why e.g. pre-mixed flames do not deviate is their fast upward flow velocity which dominates over the sideward velocity of exiting ions that cause the flame deviation.

>> will be repeated causing the flame an oscillatory motion.

Even when the flames does not touch the electrode, there will be a positive ion motion towards the cathode and one can measure a current. I admit, this current can be stronger when a discharge occurs between the flame and the cathode - this can indeed cause the oscillations. However, be more careful with your expressions to make them more precise and describing the complete physical phenomenon, not just the desired point of view.

>> There is a force applied to the flame, in its inverse direction

But this force is just to balance the buoyancy and electric force, as you described above. Please precise what is meant here.

>> Electric and mass density are both uniform in the flame

This is certainly not true. The mass density is a function of temperature that is not homogenous in the flame and the density of electric charge (if this is meant under "electric density") is also non-homogeneous.

>> electric load of the flame

What is "electric load"? What current is due to combustion? If no external field, there is no current. Assumption 3 is unclear.

>> used to solve the ODE

What is ODE? Please provide the basic set of equations that were used in numerical calculations.

page 4

>> reason of the oscillation as the electric discharge.

Very good idea!

page 5

>> could get sufficient in high velocities.

Any discussion on the measured/modeled frequency function? Why is there a maximum?

>> According to the presented results of

Conclusions. Please briefly resume the physical mechanism of the bouncing flame.

Reviewer 3:

The strongest and weakest aspect of the paper

The strongest aspect of the paper is the clear introduction to the problem. The weakest part is the lack of interpretation of experimental data.

Organization and presentation

The paper is organized in a clear and intuitive manner. Sectioning is proper. All the necessary illustrations are included.

Style

The paper is written in good English. There are several typos (e.g. unnecessary capital letters) which need to be corrected.

Additional questions & remarks

• When naming the forces acting on the flame, include the symbols from the figure in the text.

• In the assumptions of the numerical model, the ’electric density’ is not clear. It can be supposed that this is the electric field energy density – please clarify this issue.

• Have you conducted any tests of the numerical integration scheme? Euler scheme is known to be pretty bad in some situations. Could you comment on the choice of numerical method and its reliability?

• Caption of fig. 3 is unreadable. Please adjust it properly.

• The presented graphs (figs. 5-7) present results of experiments compared with a theory. How do you get these dependencies? Are the curves fitted? It remains unclear what is the source of these predictions.

• The data in figs. 5-7 are shown but not interpreted. Why are these dependencies looking like this? E.g. why is there a threshold value of voltage for oscillations? The data needs further comments!

References

Please format the references indicating not the address of the institution but the name and volume of the journal in which the article has appeared.

E.g. [5] J.M. Goodings, D.K. Bohme, Chun-Wai Ng, Detailed ion chemistry in methane-oxygen flames. II. Negative ions, Combustion and Flame, Volume 36, 1979, pp. 45-62.

Recommendations

• Check the remarks from this review and apply them.

• Add the interpretation of experiments; discuss the theory used in the graphs in more details.

• Add a short discussion of the numerical model and integration scheme used. What is the output of your program?

Summary

The paper is recommended for publication after revision and some changes.

Editorial request

Being specific: The following two sentences in the abstract are not specific and may work well for almost any IYPT report:

"Theoretical explanation has been proposed for the phenomena and has been proved by the experiments in qualitative predictions. A numerical model has also been developed based on the theory to be compared with the experimental data quantitatively."

Please consider revising any parts of the text that are unspecific and do not clarify of *what* results are obtained and *what* conclusions are drawn.

References: The literature has been used in the manuscript in a professional way. The list of references, however, is not typeset properly. Please note that the mail address of the authors is not a reference. Please add the detailed journal references or URLs.

Figure 3: consider adding a scale bar.