

## AME 514 Applications of Combustion - Fall 2008

### Assignment #5: Due Tuesday 12/16/08, at 7:00PM, i.e. at the time of the final exam.

#### Part 1: paper review

ONLY PAPERS ON THE APPROVED LIST BELOW ARE ACCEPTABLE. EXCEPTIONS CAN BE MADE WITH PRIOR APPROVAL FROM PDR. Read any of the research papers listed below. **For your convenience, most of the papers are available on the class website in the /Lecture13/ folder (you're welcome...)** In most cases you can tell from the title what the subject is but in a few cases I've mentioned the importance of the paper.

- Budrene E.O., Berg H. C., "Complex patterns formed by motile cells of *E. coli*," *Nature* 349, 630 (1991). (Sorry, only paper copy available.)
- Clavin, P., Masse, L. (2004). "Instabilities of ablation fronts in inertial confinement fusion: A comparison with flames." *Physics of Plasmas* 11:690-705.
- Clavin, P., Williams, F. A. (2004). "Asymptotic Spike Evolution in Rayleigh-Taylor Instability." *J. Fluid. Mech.* 525:105-113.
- Clavin, P., Almarcha C. (2005). "Ablative Rayleigh-Taylor instability in the limit of an infinitely large density ratio." *Comptes Rendus Mechanique* 333:379-388.
- Gamezo, V. N., Khokhlov, A. M., Oran, E. S., Chtchelkanova, A. Y., Rosenberg, R. O. (2003). Thermonuclear supernovae: Simulations of the deflagration stage and their implications. *Science* 299, 77-81.
- Gamezo V. N., Khokhlov A. M., Oran, E. S. (2004). Deflagrations and Detonations in Thermonuclear Supernovae. *Phys. Rev. Lett.* 92, Art. No. 211102.
- Gjaltema, A., Arts, P.A.M., Loosdrecht, M.C.M., van Kuenen, J.G., Heijnen, J.J. (1994). "Heterogeneity of biofilms in rotating annular reactors: Occurrence, structure, and consequences." *Biotechnol. Bioeng.* 44:194-204.
- Heydorn, A., B. K. Ersboll, M. Hentzer, M. R. Parsek, M. Givskov, and S. Molin (2000). Experimental reproducibility in flow-chamber biofilms. *Microbiology* 146:2409-15.
- Gorby, Y., *et al.* (2005). "Electrically conductive bacterial nanowires produced by *Shewanella oneidensis* strain MR-1 and other microorganisms." *Proc. Nat. Acad. Sci. U.S.A.*, **103**:11358 – 11363.
- Kim, B-H., *et al.* (2002). "A mediator-less microbial fuel cell using a metal reducing bacterium, *Shewanella putrefaciens*." *Enzyme and Microbial Technology* 30, 145-152. (Most cited paper on Kim's work on mediatorless microbial fuel cells).
- Myers, C.R. & Nealson, K.H. (1988). "Bacterial Manganese Reduction and Growth with Manganese Oxide as the Sole Electron Receptor." *Science* 240, 1319-1321. (Paper that started the whole subject of microbial fuel cells by identifying the bacteria that can do the job.)
- Kocha, S. S. Yang, J. D., Yi, J. S. (2006). "Characterization of Gas Crossover and Its

Implications in PEM Fuel Cells. *AIChE J.* 52:1916 – 1925.

- D. Lieberman, J. Shepherd, F. Wang and M. Gundersen (2005). “Characterization of a Corona Discharge Initiator Using Detonation Tube Impulse Measurements,” AIAA Paper 2005-1344.
- E. Wintenberger, J. M. Austin, M. Cooper, S. Jackson, J. E. Shepherd (2001). “An analytical model for the impulse of a single-cycle pulse detonation engine,” AIAA paper no. 2001-3811.

Prepare a critical review of the article, not to exceed 2 pages, structured as follows:

- Why the author(s) conducted the work
- Summary of the results
- Summary of the conclusions
- Your opinion of the merits of the work
- Your opinion of the shortcomings of the work

## **Part 2: “White paper” research proposal**

(Since the “emerging topics” part of the class does not lend itself well to the usual type of homework or exam questions, this part of the homework assignment takes the place of a question on the in-class final exam. Think of this as a “take home” part of the final exam.)

This section of the course considers recent developments and emerging technologies in reacting flows. Thus, I think it is only reasonable that you try to identify your own “niche” in one of these emerging areas. Prepare a “white paper” (basically a highly compressed, top-level, research proposal), structured as follows (e.g. one paragraph for each bullet item; some bullets may be combined into one paragraph):

- State what your topic is and why it is important
- State what is known about the subject
- Complain about what is lacking in the current state of knowledge
- Explain what you would do that would improve the state of knowledge (i.e. specifically what computer simulation or experiment or analysis you would perform)
- Describe how you would analyze or interpret the data once you had them
- Speculate as to what results you might obtain
- State how these results would advance the state of knowledge of the field

I am looking for about 2 – 3 pages but I won’t set a specific page limit. You may want to include a couple of key figures that would increase the page count. In the real world white papers are almost never allowed to be more than 2 pages.

Also, I am NOT looking for a “position paper” about how important a subject is and in general terms what type of research should be done, nor a whole development program to design a new hypersonic propulsion aircraft or a PEM fuel cell powered vehicle. I am looking for a specific, concrete, idea of narrow scope and specific means to test the idea.

Also, if you're going to use a numerical model, just saying, "numerical modeling will be done and compared to experimental results" isn't enough. You need to state what model predictions will be compared to experiments. Also, you need to state what equations will be solved (i.e. Navier-Stokes, Euler, incompressible flow), how many dimensions (1, 2 or 3), steady or unsteady, whether you will use a direct numerical simulation or a "modeled" set of equations (e.g. Large Eddy Simulation of turbulence), what type of chemical scheme (1-step, reduced, or detailed mechanism), and what makes you think you have sufficient computing power to get the job done.

To save time and energy you may want to prepare your white paper on the same general topic as your paper review, i.e. you could make your white paper an extension of the paper you reviewed in Part 1 of this assignment. I also expect that you will verify that what you propose hasn't already been done; at a minimum you should check the ISI Web of Science (<http://isi1.isiknowledge.com/portal.cgi?DestApp=WOS&Func=Frame>) for similar topics. (See the course home page for details on accessing the Web of Science.)

(This might sound like a strange assignment but trust me, if you do any sort of Research and Development in your engineering career you WILL be preparing "white papers." Get used to it...)