ECN2 ignition and lift-off session

Deadline for contributions

- 1 August 2012 (modelling)
- 1 July 2012 (experimental)

Coordination

- Michele Bardi, Christian Angelberger, Evatt Hawkes will organise the data collection with assistance from Yuanjiang Pei and will do the tasks of synthesis, interpretation, and presentation of results.

Objectives

- Characterization of lift-off length, ignition delay, and other available measures relating to gas-phase chemical reactions.
- To check reproducibility between experimental facilities.
- To compare and contrast experimental measurements of the lift-off length, ignition delay, ignition location, and any other reacting scalar measurements that may be available.
- Compare different models against experiment for the purposes of validation and identification of what works and what needs improvement.
- Clarify issues of chemistry and turbulence-chemistry interactions in models.

Data needed from modellers

Definitions

- Ignition: Please submit both definitions.
  1. First time at which Favre-average OH mass fraction reaches 2% of the maximum in the domain after a stable flame is established.
  2. Time of maximum rate of rise of maximum temperature.
- Lift-off: First axial location of Favre-average OH mass fraction reaching of 2% its maximum in the domain.

Useful parameter studies to do

- Fix the turbulence-chemistry interaction model and study chemistry models. Most people should be able to do a well-mixed model so that is a good target.
- Fix the chemistry model and study turbulence-chemistry interaction model. See below for recommended chemistry models to chose.

Spray A

- Baseline condition: 15% O2, 900K, 22.8 kg/m^3, 1500 bar injection pressure, 4ms
    - (See ECN website for listing of full baseline conditions.)
- Suggested chemistry: contact Sibendu Som <ssom@anl.gov> and Tianfeng Lu, or make your suggestion to the group.

Results as T_a varied:

- **750K**, **800K**, 850K, **900K**, 1000K, **1100K**, 1200K
    - Other conditions all as baseline.
    - If you cannot do all, preference to the ones in bold.
- Will request:
    - Ignition delay versus T_a
        - Simple three column text file T (K), Ignition delay (μs) definition 1., Ignition delay (μs) definition 2..
    - Lift-off length versus T_a
        - Simple two column text file T (K), LOL (mm).
    - Ignition location versus T_a
        - Simple two column text file T (K), Ignition location (mm).

Drill down just for T_a = 800K and T_a = 1100K

- Lift-off versus time
    - Simple two column text file time (ms), LOL (mm).

- OH mass fraction field at 0.5ms and 1.5ms ASI
    - Ideally, as a raw binary image file with only the image data, similar to the Rayleigh images that are on the ECN website. We will need to load and convert into a common format.
    - Otherwise, actual data interpolated to a structured grid.

Other parameter studies to do:

- Please make temperature the first priority, but for those who want to do more.
- Oxygen concentration: 15 – 21 – 13 %
- Injection pressure: 50 – 100 – 150 MPa
- Ambient density: 22.8 – 15.2 – 7.6 kg/m^3
- Will request ignition delay and lift-off length as functions of the above parameters.

Spray H

- Lift-off length (mm) and ignition delay (ms)
    - for ρ_a=14.8 kg/m^3
        - at 21% O_2, versus T_a : 750K – 1300K
        - at T_a =1000K versus % O_2 : 8 – 21
    - for ρ_a= 30 kg/m^3
        - versus % O2 : 8 – 15
    - Simple two-column text files.
    - See ECN website for listing of full conditions.

- OH mass-fraction fields
    - For 21% O2, T_a=1000K, ρ_a = 14.8 kg/m^3 at 0.6 ms and 1.5 ms
    - For 10% O2, T_a=900K, ρ_a = 14.8 kg/m^3 at 1.8 ms and 3.0 ms
    - See instructions for Spray A.

- Chemistry models that more than one group are using:
    - Lu et al. 53 species: http://www.engr.uconn.edu/~tlu/mechs/mechs.htm
    - Seiser et al. https://www-pls.llnl.gov/?url=science_and_technology-chemistry-combustion-nc7h16_reduced_mechanism

Data needed from experimentalists

Spray A

Techniques

- Ignition delay
    - Broadband chemiluminescence (<600 nm + regular lens)
    - Pressure rise
    - Schlieren method
- Lift-off length
    - OH* chemiluminescence: modellers needs time resolved LOL (still images or fast acquisition)
    - OH PLIF?

Test conditions:

- Spray A (reference condition)

- Parametric variations (numbers indicate the priority):

    1. Ambient Temperature: 750 – (800) – 900 – (1000) – 1200 K
    2. Injection pressure: 50 – 100 – 150 Mpa
    3. Ambient density: 22.8 – 15.2 – 7.6 kg/m3
    4. Oxygen concentration: 15 – 21 – 13 %
    5. Fuel: n dodecane – n heptane (for n-heptane, diaphragm fuel pump is strongly suggested)

In order to extend the comparison to a larger number of test conditions we propose to perform tests with long injections (injection time: 4000 µs)

Data submission:

- Raw Images with spatial coordinates will be the best way to compare tests from different facilities
- The experimental diagnostic and processing methods are described in the ECN webpage (http://www.sandia.gov/ecn/cvdata/expDiag.php). For more details please contact Michele Bardi (mbardi@mot.upv.es).