Combustion 522 Review 3 Questions

Soot

- What is a typical soot volume fraction?
- what is a typical soot primary particle size?
- What are the four key soot formation steps?
- Is assuming spherical particles a better assumption in a small candle flame or a large fire, or both?
- Rank order the computational cost from low to high of the following models for representing a soot particle size distribution: sectional, direct, method of moments.
- Describe the closure problem when using the method of moments.
- One is one type of closure method when using the method of moments?
- Rank order the following fuels in sooting propensity (least to greatest): acetylene, methane, ethylene.
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- **Thermophoresis** velocity
- **Calculate soot properties**

Turbulence

- List two key ways that turbulence enhances molecular mixing rates.
- What names do we give to the large and small scales of turbulence, respectively?
- If the small scales depend only on ν and ϵ, what is the equation for the small lengthscale?
- If the small scales depend only on ν and ϵ, what is the equation for the small timescale?
- In a turublent jet, the Reynolds number is given by $Re = Dv/\nu$, where D and v are the jet exit diameter and velocity, respectively, and ν is kinematic viscosity.
- When we double the velocity in a turbulent jet, by what factor does the flame length change by?

- If we double the velocity in a turbulent jet, does the mixing timescale increase, decrease, or stay the same?
- For a term like $\frac{du\xi}{dx}$, write the average of this term when a Reynolds decomposition is applied…
- For a term like $\frac{d\rho u\xi}{dx}$, write the average of this term when a Reynolds decomposition is applied using Favre averaging.
- What general approach is used for closing Reynolds stress terms that arise when solving mean flow equations in turbulent flows?

Turbulent premixed flames

- Write the idealized relationship between turbulent flame speed and laminar flame speed.
- What are four regimes of turbulent premixed flames?
- How does the flame thickness in each of the four turbulent premixed flame regimes compare to the small and large turbulent scales?
- Combined problem: in an engine with some given properties, compute the turbulent scales and the turbulent flame speed (requires some correlation (provided) for the laminar flame speed).

Turbulent diffusion flames

- Do buoyant effects tend to increase or decrease the length of a turbulent diffusion flame? Why?
- For turbulent momentum-dominated jet flames, if we double the jet diameter, how does the flame length change?
- For turbulent momentum-dominated jet flames, if we double the jet velocity, how does the flame length change?
- For turbulent momentum-dominated jet flames, if we halve the fuel density, how does the flame length change?
- Given some properties and a chart or an equation, do a calculation of a flame length. (Possibly combined with other concepts, such as evaluating a combustion equation, and properties like an adiabatic flame temperature.)
- How do we define the flame length in a turbulent jet?

Radiation

- All things equal, how do you expect radiative loss fraction to change if we increase the velocity through a jet? Why?
- All things equal, how do you expect radiative loss fraction to change if we increase the diameter through a jet? Why?
- All things equal, how do you expect radiative loss fraction to change if we decrease the hydrogen saturation of the fuel (increase number of double and triple bonds)? Why?
- How many steradians are there in a sphere?
- If you double the distance of the sun to the earth, how does the intensity of the sun as seen from Earth change?
- Given a radiative heat flux field (that is, the flux vector $\vec{q}$ at every grid point), how would you compute the radiative source term Q (W/m^3) for use in an energy transport equation?

Detonation

- Given the $P(\nu)$ plot, what is the name of the linear curve? What is the name of the curved curve? What are the names of the points where the linear and nonlinear curves are tangent?
- Sketch the curves that determine one-dimesional detonations and deflagrations. Indicate the five regimes. Show specific locations where typical detonations and premixed flames occur.
- For deflagrations, consider the ratio of product to reactant temperature, pressure, and velocity. Are these greater than one, less than one, or nearly equal?
- For detonations, consider the ratio of product to reactant temperature, pressure, and velocity. Are these greater than one, less than one, or nearly equal?
- Describe breifly the difference in propagation mechansim for premixed flames and detonations.
- What were three of the four key relations we used to derive equations for detonations?
- What were two assumptions we made when deriving equations for detonations?

Droplets and sprays

- What are three applications of spray combustion?
- If we double the diameter of a droplet, how much longer will it take to evaporate?

- Given some data, compute a droplet lifetime determine the largest reasonable size of a droplet in a diesel engine (based on whether a droplet in a spray will evaporate or boil away before striking the cylindar wall.)