Combustion Research
W. Hallett, Mechanical Engineering

Main themes:
- solid fuel combustion/packed beds
- liquid droplet combustion
- biofuels (biomass, pyrolysis oil, biodiesel, alcohol blends, etc.)

http://www.genie.uottawa.ca/~hallett/hallett.htm
Solid Fuel Combustion/Packed Beds
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- solid fuel particles in bed on grate
- main applications: biomass energy, trash incineration

Experiments
- fully instrumented lab. combustor
Solid Fuel Combustion/Packed Beds
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Computational Modelling:
- to include all significant heat and mass transfer processes and chemical reactions, as well as ash and particle behaviour.

mass transfer (CO, O₂, CO₂)
heat transfer to/from surface
C + ½ O₂ → CO
CO₂ + C → 2 CO
CO + ½ O₂ → CO₂
particle motion
ash behaviour
particle burnout/shrinkage
species diffusion and heat conduction in gas phase
gas flow
heat conduction in solid
radiation between particles
Liquid Droplet Combustion

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Main interest: - combustion of complex mixtures such as bio-fuels, commercial petroleum fuels and their mixtures

- model approach: “Continuous thermodynamics”: mixture modelled as probability density function rather than as individual components

\[ \text{multicomponent mixture} \quad \rightarrow \quad \text{model - “continuous” mixture} \]

\[ yi = f(l)i \delta li \]

\[ f(l) \]

\[ yi \]
**Liquid Droplet Combustion**

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**Recent Work** - biomass pyrolysis oil, biodiesel, alcohol/oil blends

Behaviour of a pyrolysis oil droplet during evaporation:

- Heating
- Bubbling/disruption
- Residue (char)
Combustion research integrates many disciplines: heat and mass transfer, chemical reactions, fluid mechanics, instrumentation, numerical models. Working on combustion provides a broadly-based education in the thermal/fluids area.