Characterizing secondary size distributions for single drop impacts at high wall superheat

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Motivation

- Incomplete vaporization is an undesirable outcome in compression ignition devices.
- Mitigation strategies:
  - Ignition-assist devices
  - Finer atomization of liquid
- Do multicomponent liquids behave the same as pure liquids?

Goals:

- Perform experimental trials and analyze characteristics of child droplets after the parent droplet impacts a heated wall.
- Determine effects of wall temperature and impact momentum on secondary droplet sizes and velocity.
- Provide experimental data to validate numerical simulations.

Introduction

Groups of secondary droplets resulting from an impact event are best represented by a distribution:

- Weibull
  \[ p(d) = \frac{q}{d^q} \left(\frac{d}{\bar{d}}\right)^{q-1} \exp\left(-\frac{d}{\bar{d}}\right)^q \]
- Log-normal
  \[ p(d) = \frac{1}{d\sqrt{2\pi}} \exp\left(-\frac{(\ln(d) - \ln(\mu))^2}{2\sigma^2}\right) \]

Previous studies on wall temperature and Weber number effects on droplet sizes have been done for limited cases/liquids.

Experimental Setup

20 trials at We < 150 (only n-decane)
15 trials at all other sets of conditions.

The number of tracked droplets per parent droplet are plotted and fit with an empirical power law. The resulting correlation is \( N = 0.3525W^{0.92} \).

Conclusions

- Used a dual-view high-speed camera setup to examine droplet impacts of n-decane and F-24 at variety of temperatures and Weber numbers in the Leidenfrost regime.
- Fitted log-normal distributions to experimental histograms of secondary droplet sizes and extracted distribution parameters.
- Results compared well with existing literature.
- Results will be used to validate numerical simulations.

References