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OSU Analysis with FDS

Haiqing Guo, Mike Burns, Richard E. Lyon

William J. Hughes Technical Center, FAA, Atlantic City, NJ

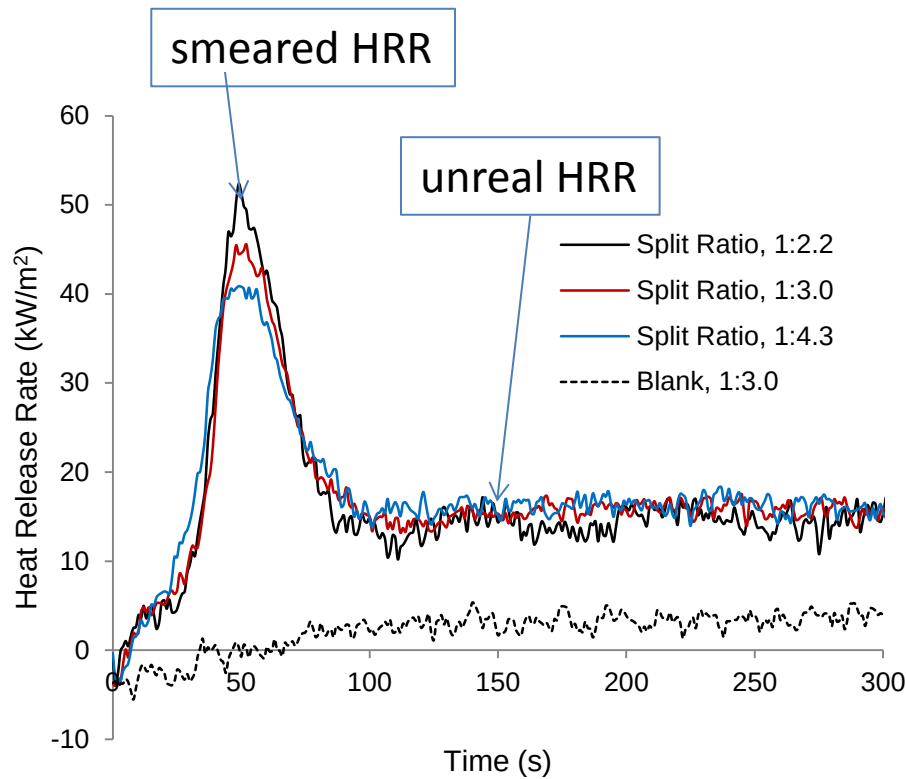


Introduction

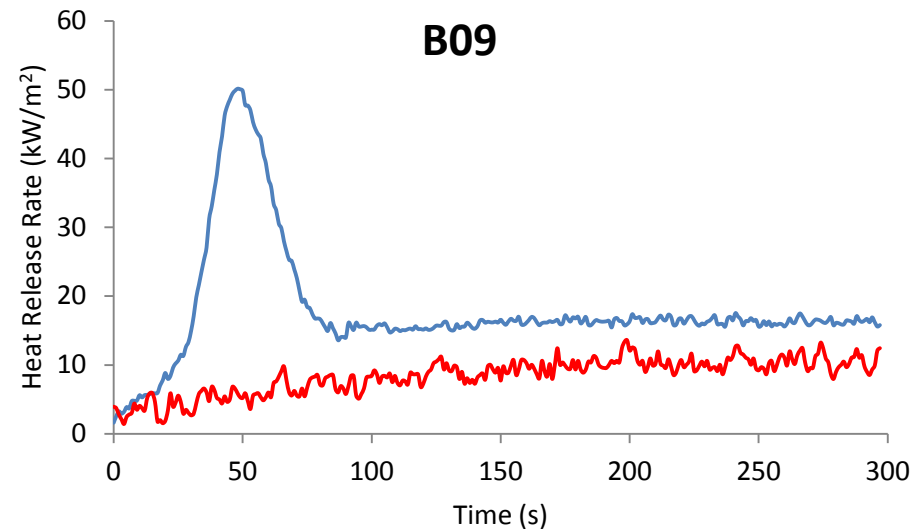
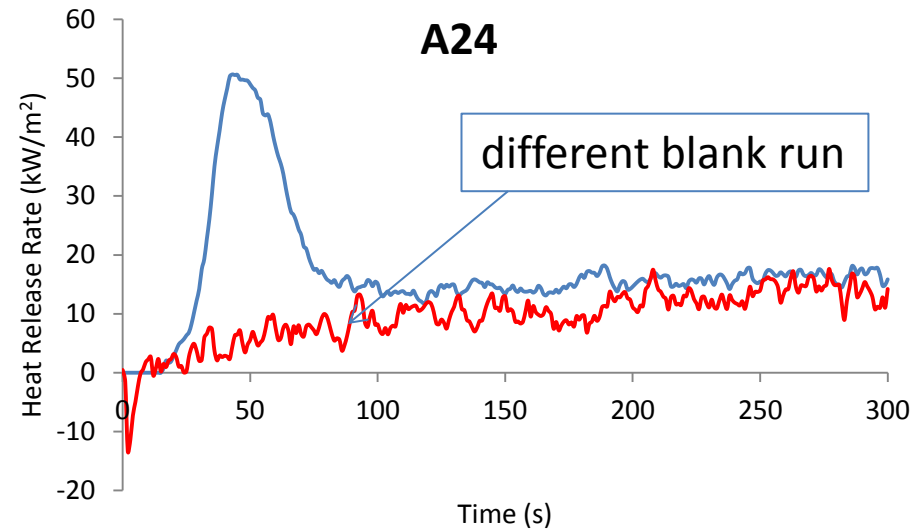
- OSU test instrument is subject certain level of irreproducibility.
- There exists certain time delay on the OSU signal response.
- More accurate and more reliable HRR test method needs better understanding of the current OSU design.
- Perform detailed characterization and heat transfer analysis (analytical and numerical) on OSU.



Representative OSU Tests



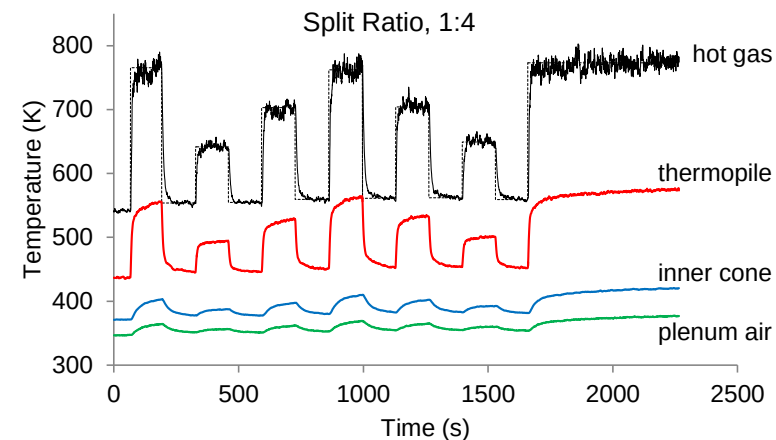
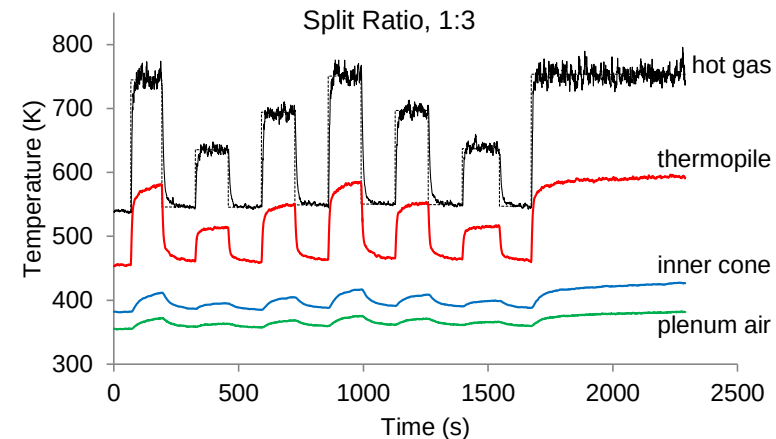
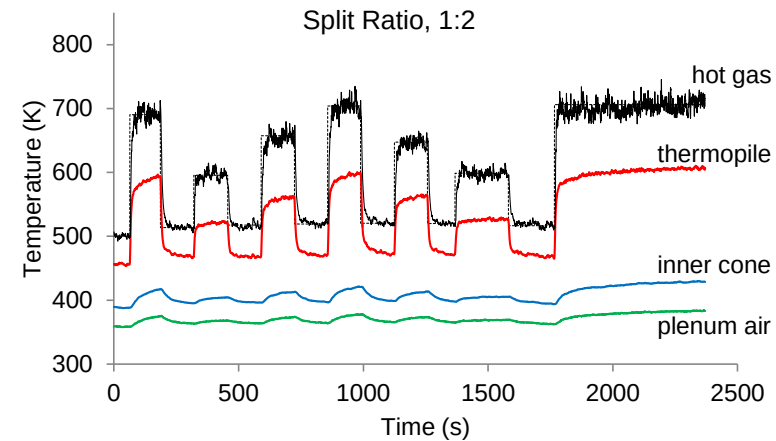
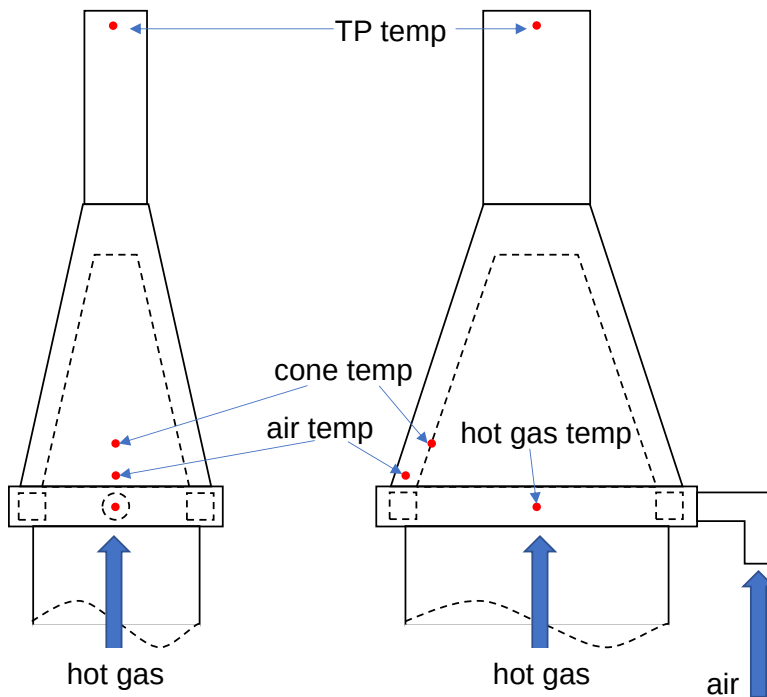
Schneller Panel Test





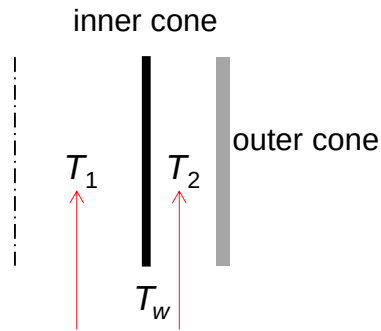
OSU Calibration

standard calibration procedure
+ detailed characterization





Thermal Analysis on Inner Cone



1-D Model

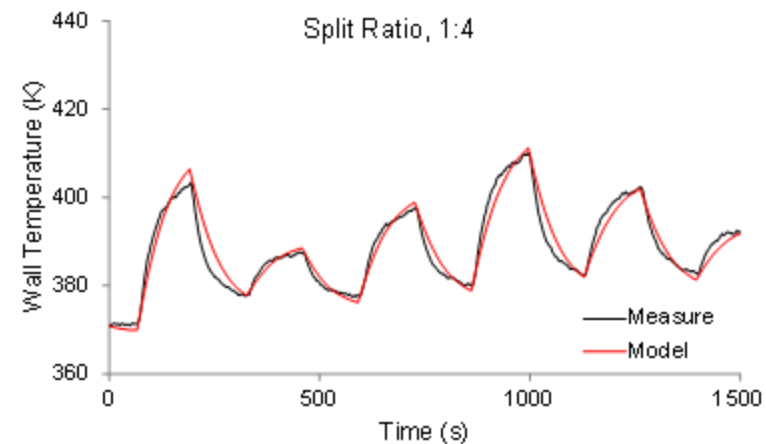
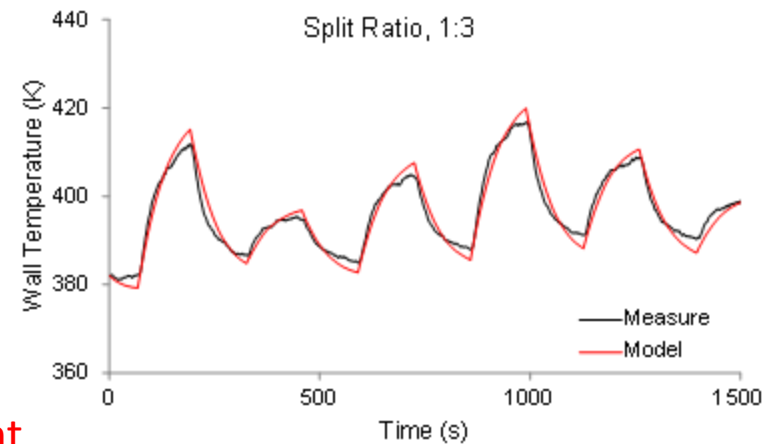
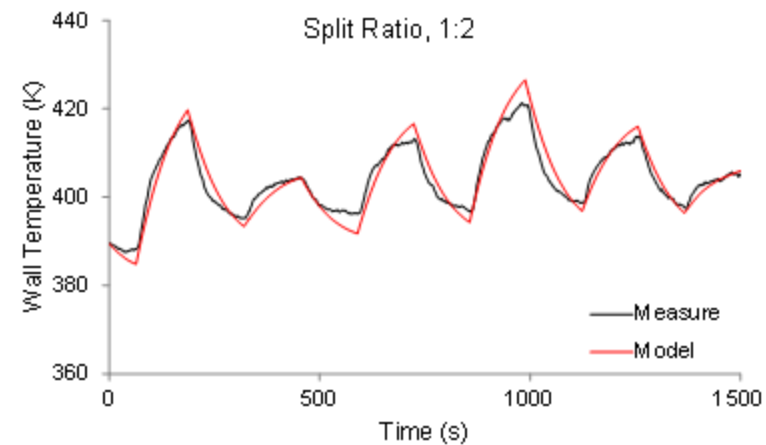
energy equation: $h_1 A (T_1 - T_w) = h_2 A (T_w - T_2) + \rho A \delta c \frac{dT_w}{dt}$

square wave constant

$$T_w = \frac{h_1 T_1 + h_2 T_2}{h_1 + h_2} + \left(T_{w,0} - \frac{h_1 T_1 + h_2 T_2}{h_1 + h_2} \right) e^{-\frac{t(h_1 + h_2)}{\rho \delta c}}$$

time constant

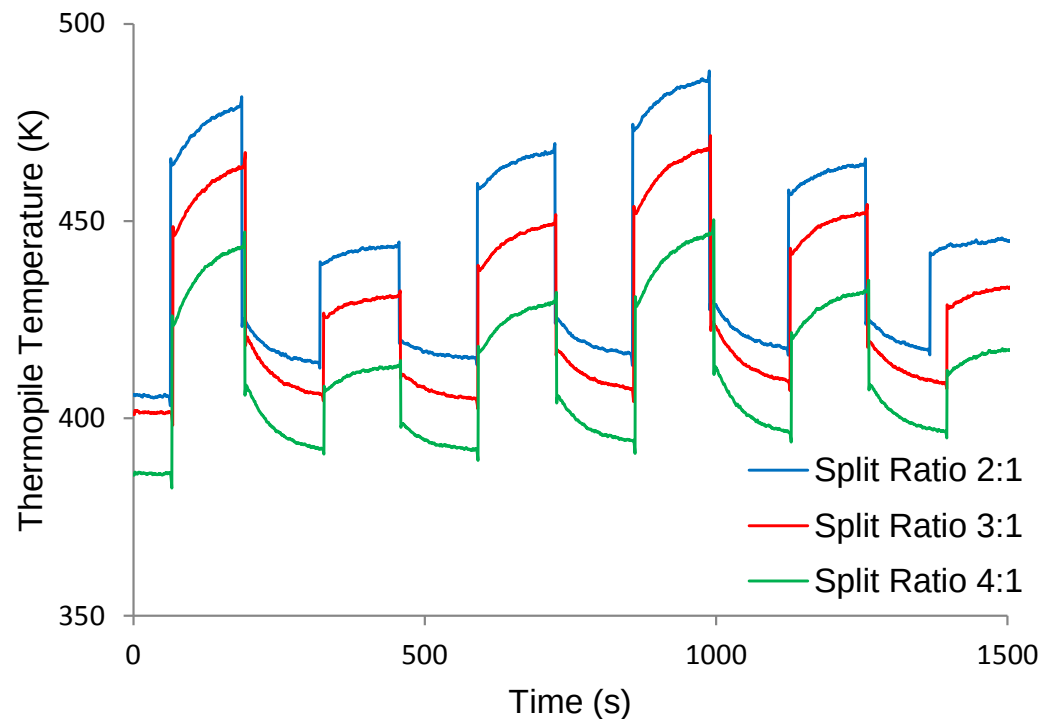
	Split Ratio (1:2)	Split Ratio (1:3)	Split Ratio (1:4)
h_1 (W/m ² -K)	5.5	6.0	6.5
h_2 (W/m ² -K)	27.2	41.2	49.1
τ (s)	60	42	35





Cone Wall Effects on Thermopile

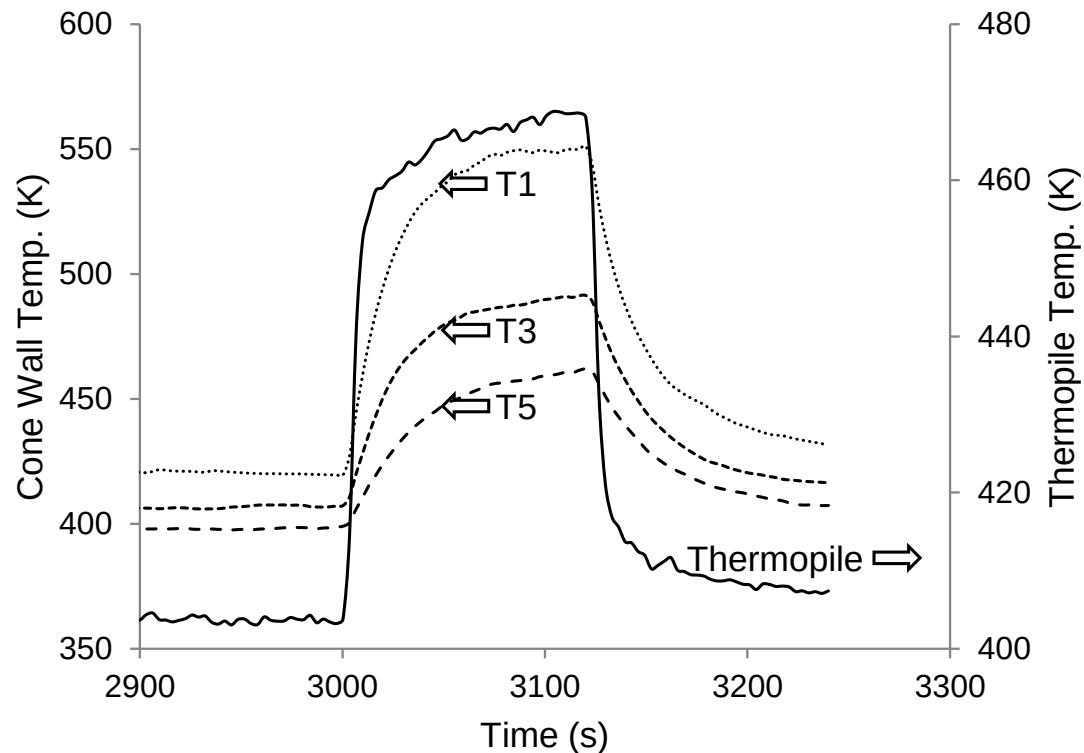
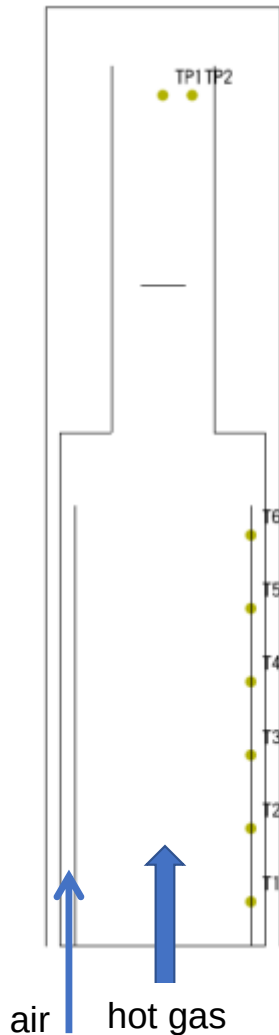
Based on inner cone wall temperature, plenum air and hot gas temperature, the thermopile temperature can be calculated using mixing theory.





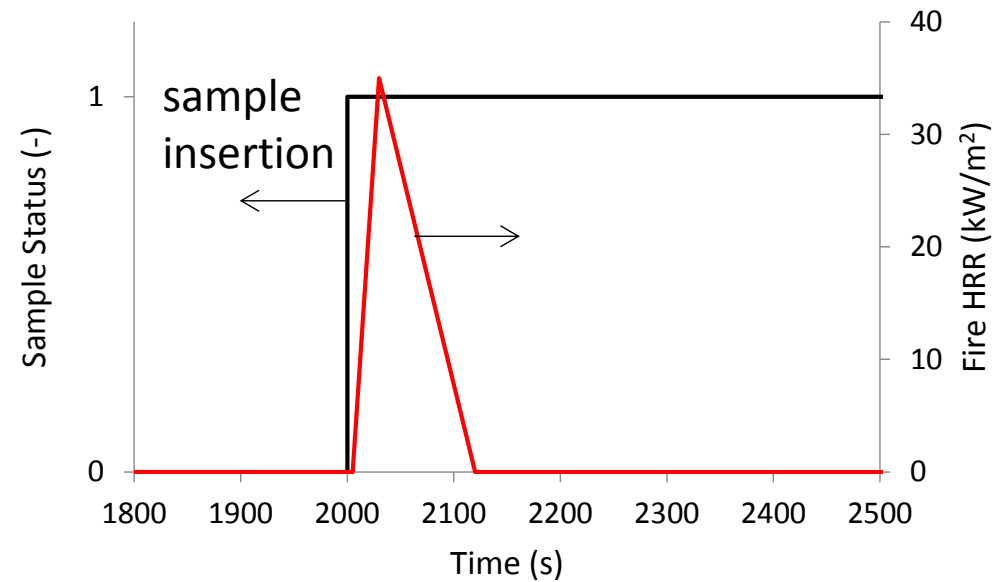
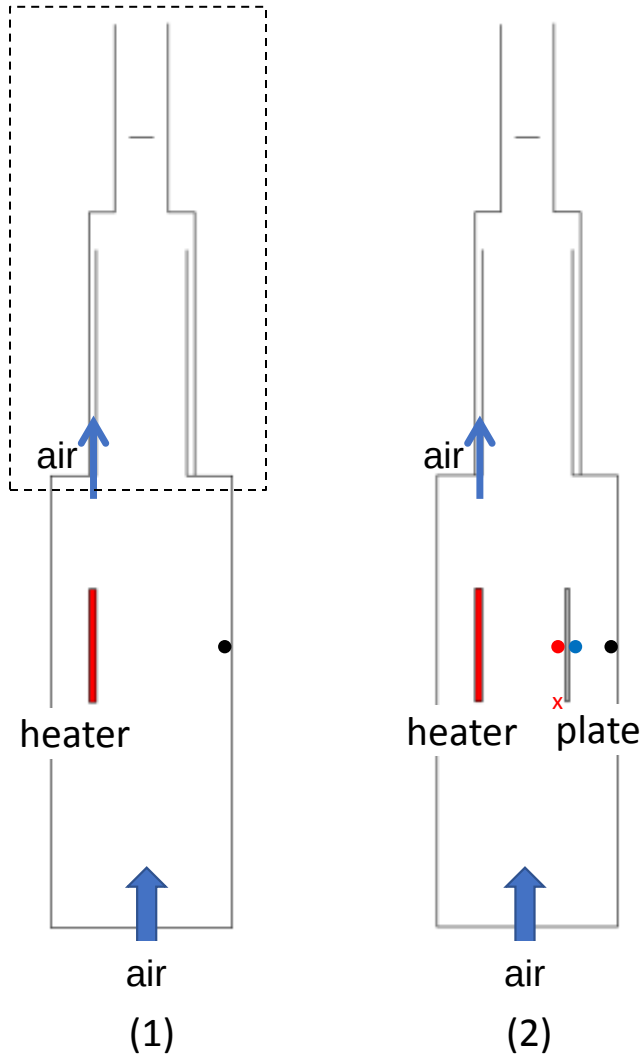
CFD Modeling (2D Model)

- 2-D FDS model.
- Hot gas T is following a step change.
- Air T is constant.
- Both Ts are based on the characterization results.



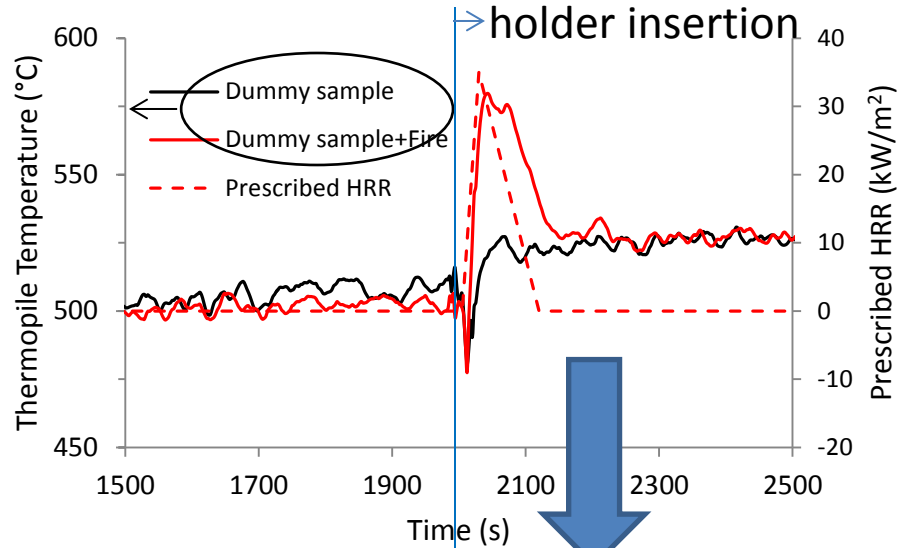


Model of Sample / Holder Insertion

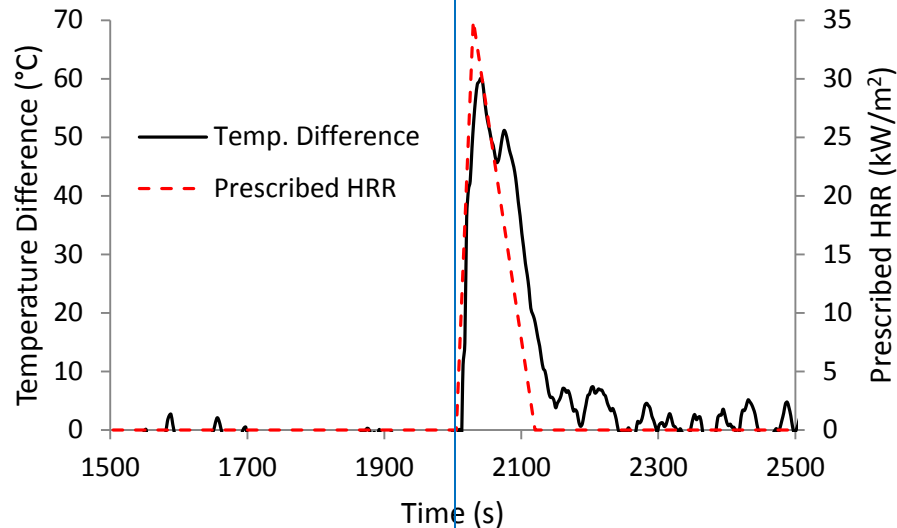




Sample Holder Effect



The modeled thermopile temperature is overlaid with prescribed HRR for comparison.

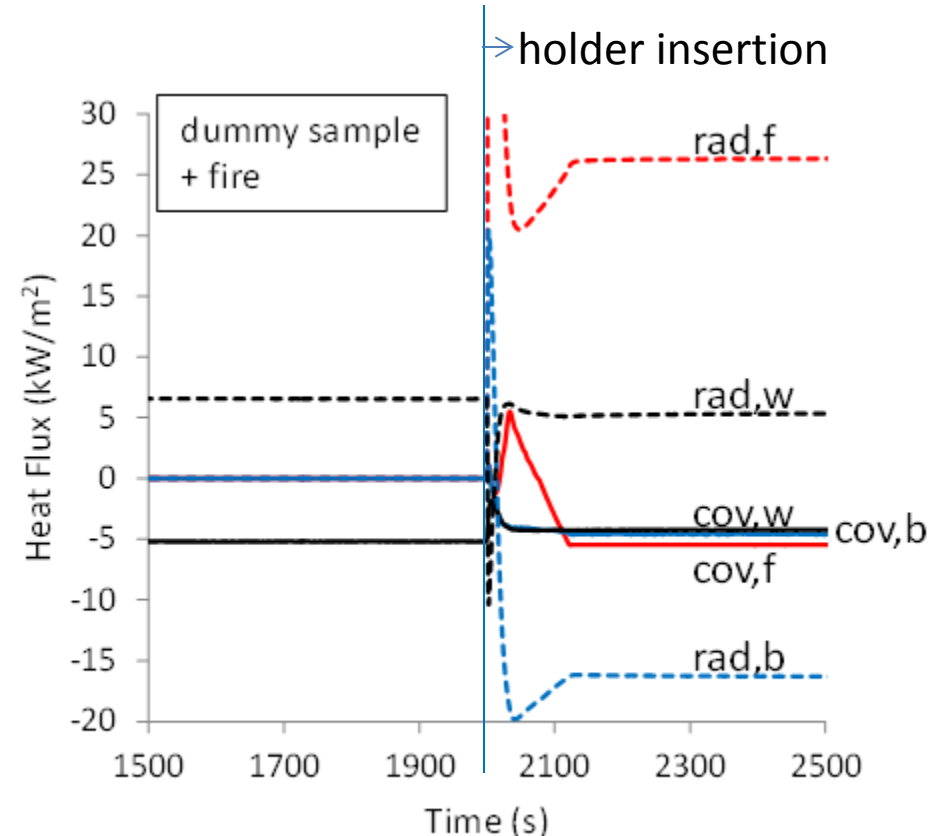
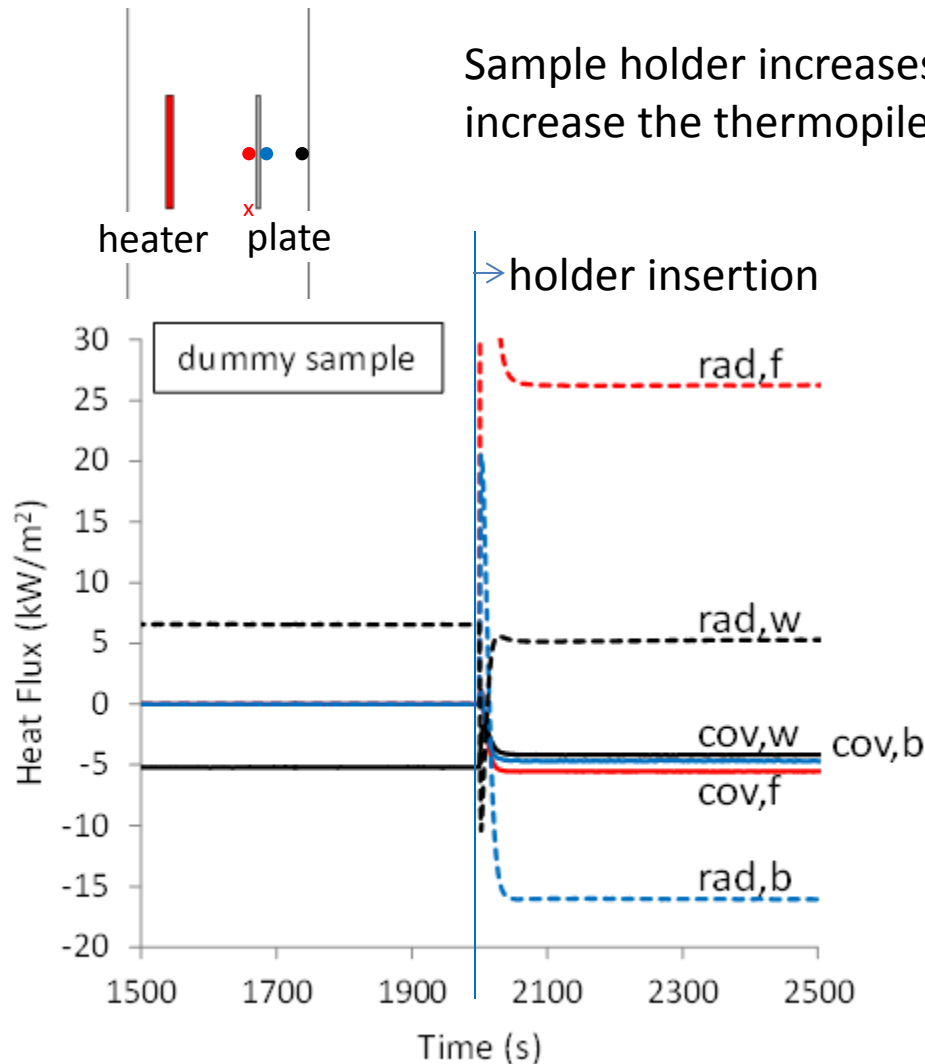


Thermopile temperature after baseline subtraction.



Sample Holder Effect on Heat Flux

Sample holder increases surface area for heat convection and hence increase the thermopile temperature.





Summary

- Upper region, the double-cone system dominates the dynamics of the system.
- Lower region, the sample holder causes unreal heat release signal. Blank run with a dummy sample needs to be subtracted.
- etc.