TESTING OF RESIDENTIAL SPRINKLERS AND WATER MIST NOZZLES IN RESIDENTIAL AREA FIRE SCENARIOS

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(presented by Are Wendelborg Brandt, RISE Fire Research AS)

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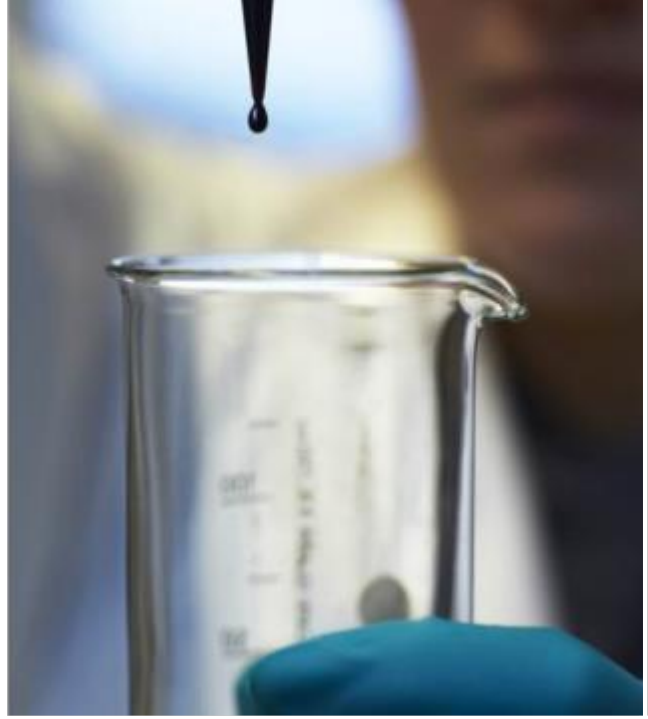
SAFETY AND TRANSPORT
SAFETY

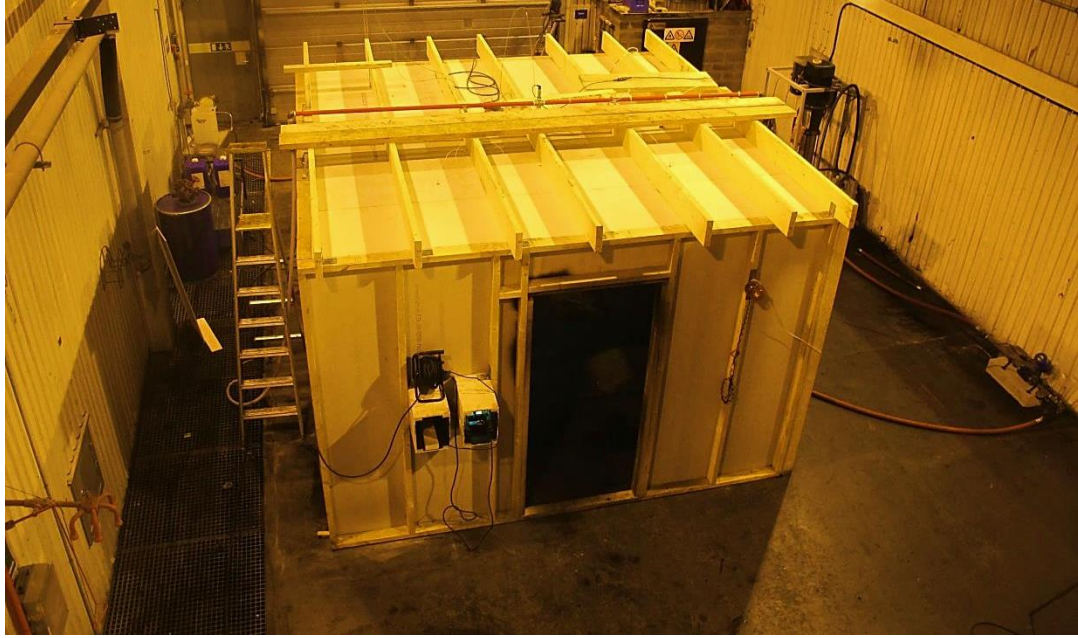


Objective of this study

- The influence by activation time on the performance of a commercial residential sprinkler.
- The influence on the performance of the residential sprinkler attributable to the discharge density (2.05 mm/min vs. 4.1 mm/min).
- A performance comparison with commercial water mist nozzles:
  - Low-pressure nozzles.
  - High-pressure nozzles.
  - Stand-alone high-pressure water mist system.

Test compartment

- Area: 3.66 m × 3.66 m (=12 ft. × 12 ft.).
- Ceiling height: 2.5 m.
- Doorway opening: 0.90 m (width) × 2.08 m (height).
- Lintel over opening: 0.42 m.
- Built from non-combustible boards on wood studs.
- No combustible wall panels.



Fire scenarios

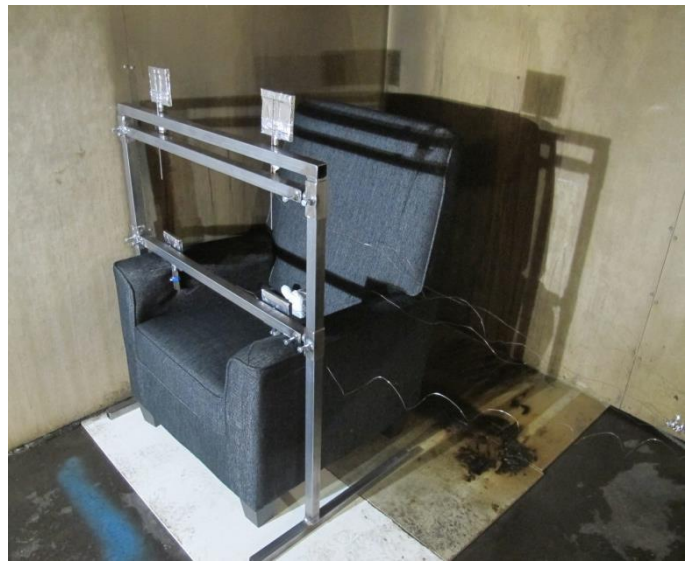
Simulated upholstered furniture

- Orientated with front towards the compartment.
- Orientated with front towards the back wall.

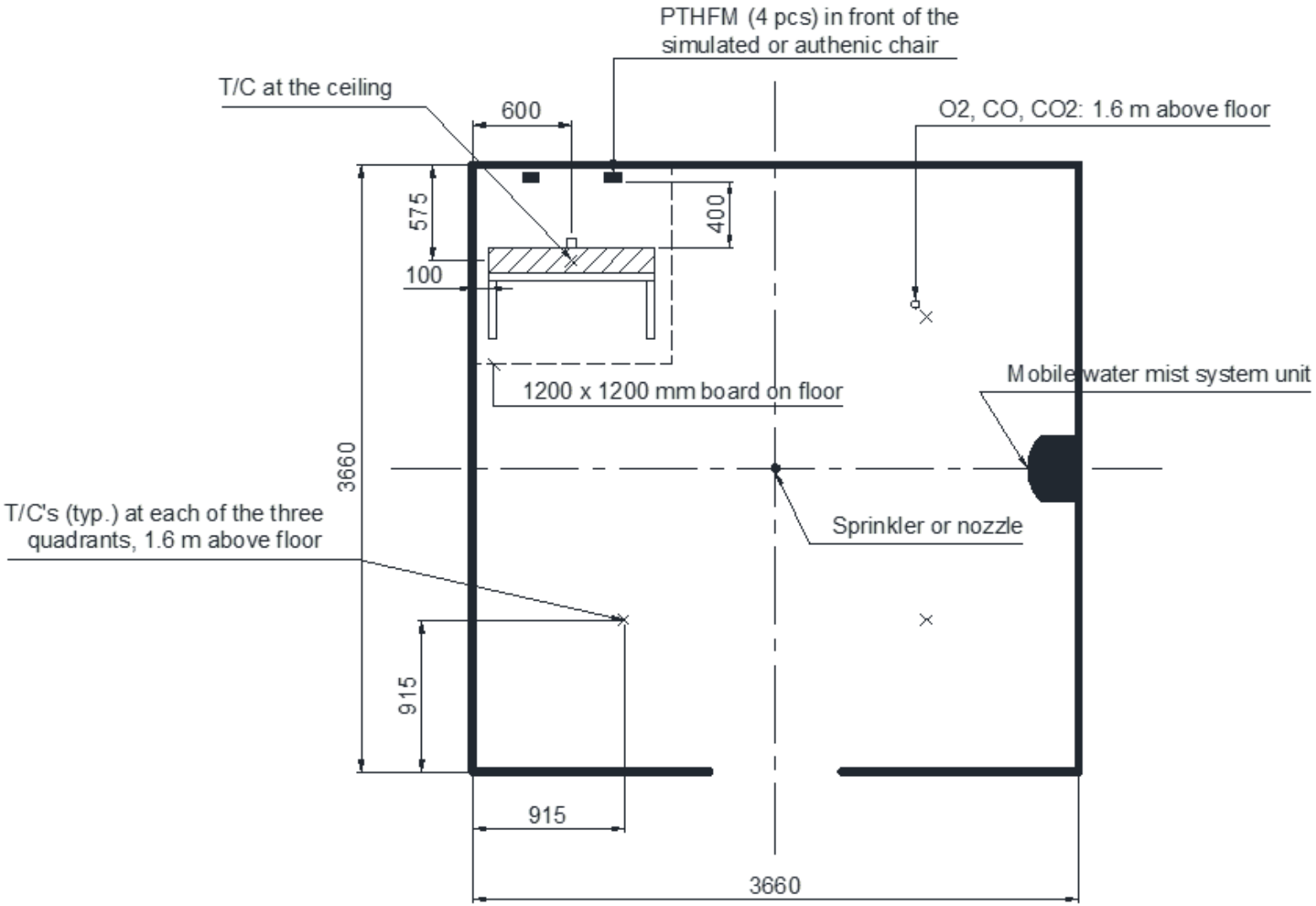
Authentic upholstered furniture

Orientated with front towards the compartment.

Standardized fire igniter. Wood fiber cube soaked in heptane.



Measurement equipment

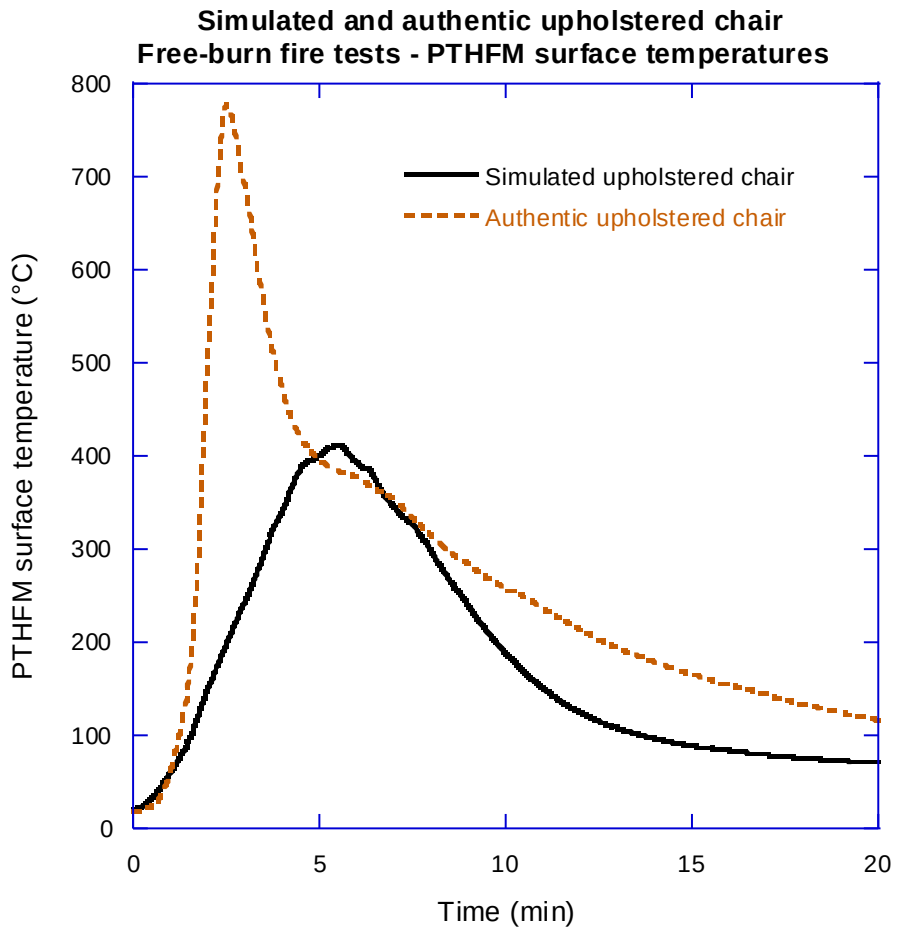


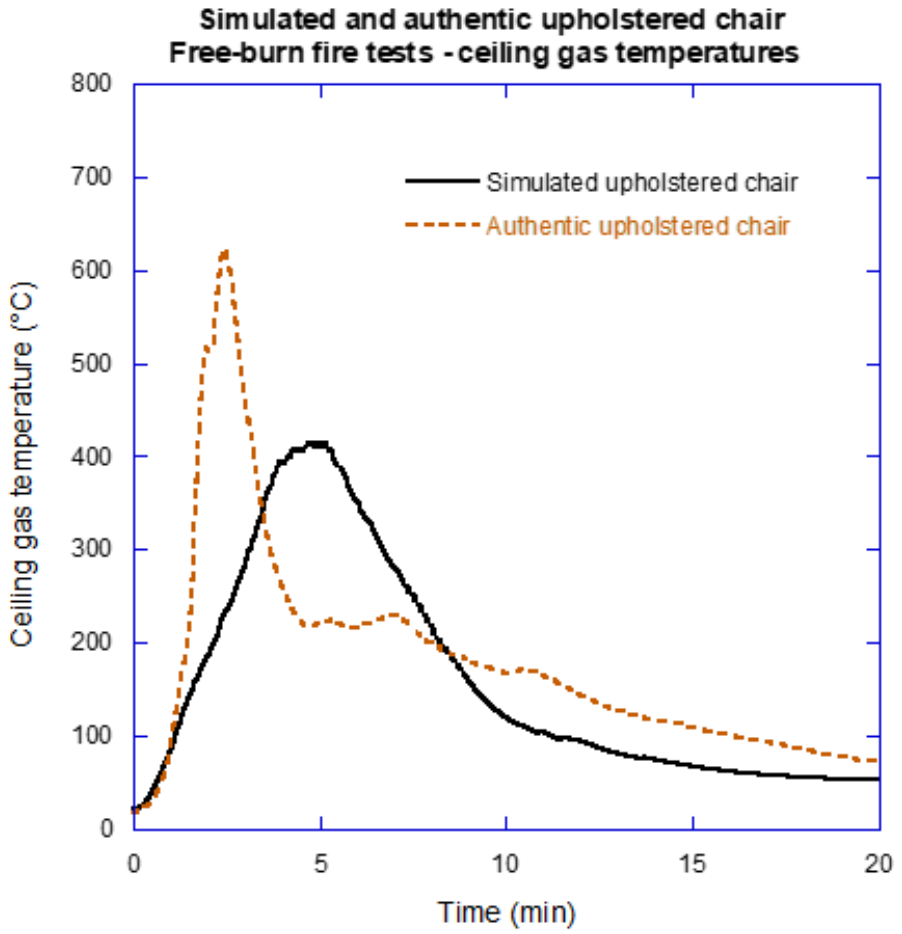
- Ceiling gas temperature directly above the fire.
- Plate Thermometers in front of the fire.
- Gas temperature at eye-level (three points).
- Gas temperature at the sprinkler/nozzle.
- The gas concentrations of: O_2, CO, CO_2 at eye-level (one point).
- Visibility.

The sprinkler and nozzles that were tested

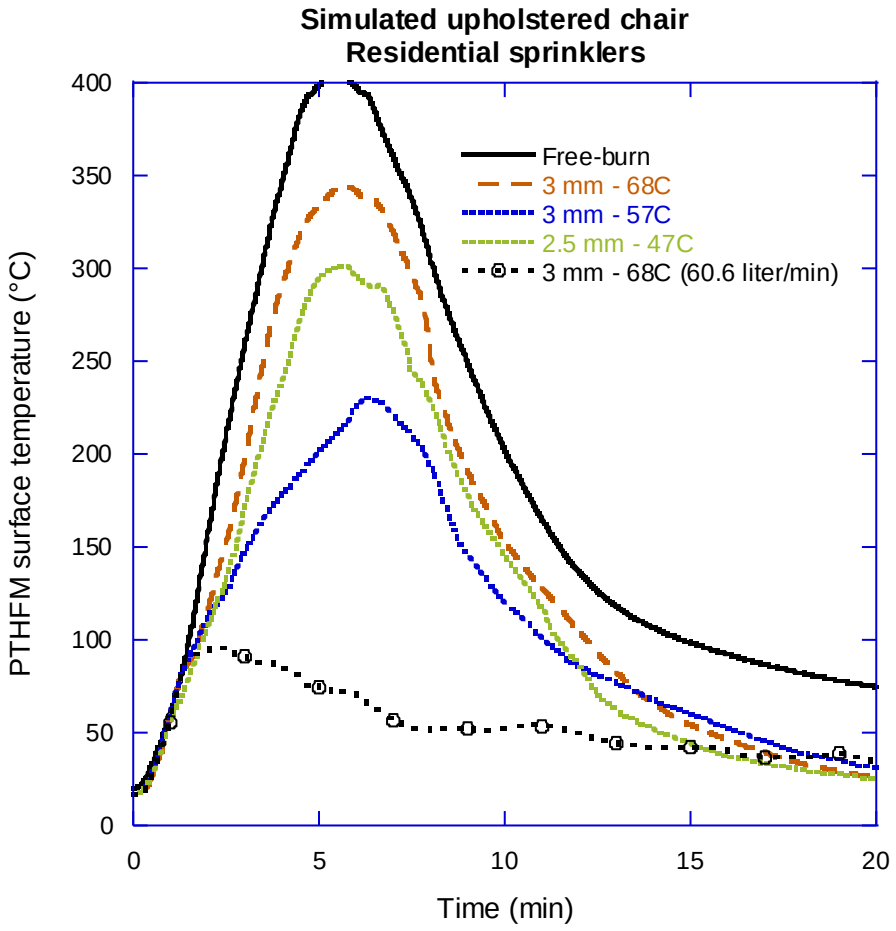
System	Type of sprinkler or nozzle	Glass bulb	Temp. rating [°C]	K-factor [(liter/min/) $\sqrt{\text{bar}}$]	Operating pressure [bar]	Water flow rate [liter/min]
Residential sprinkler	Single-orifice	3 mm	68	43.2	0.49	30.3
		3 mm	57			
		2.5 mm	47			
		3 mm	68		1.97	60.6
Low-pressure	Multi-orifice	3 mm	57	14	5.2	32
Low-pressure	Single-orifice	3 mm	57	8.5	7.6	23.4
High-pressure	Multi-orifice	2 mm	57	4.1	80	36.7
High-pressure	Multi-orifice	2 mm	68	2.4	52	17.2
Stand-alone, high-pressure	Multi-orifice	Fire detector		0.75	120	8.2

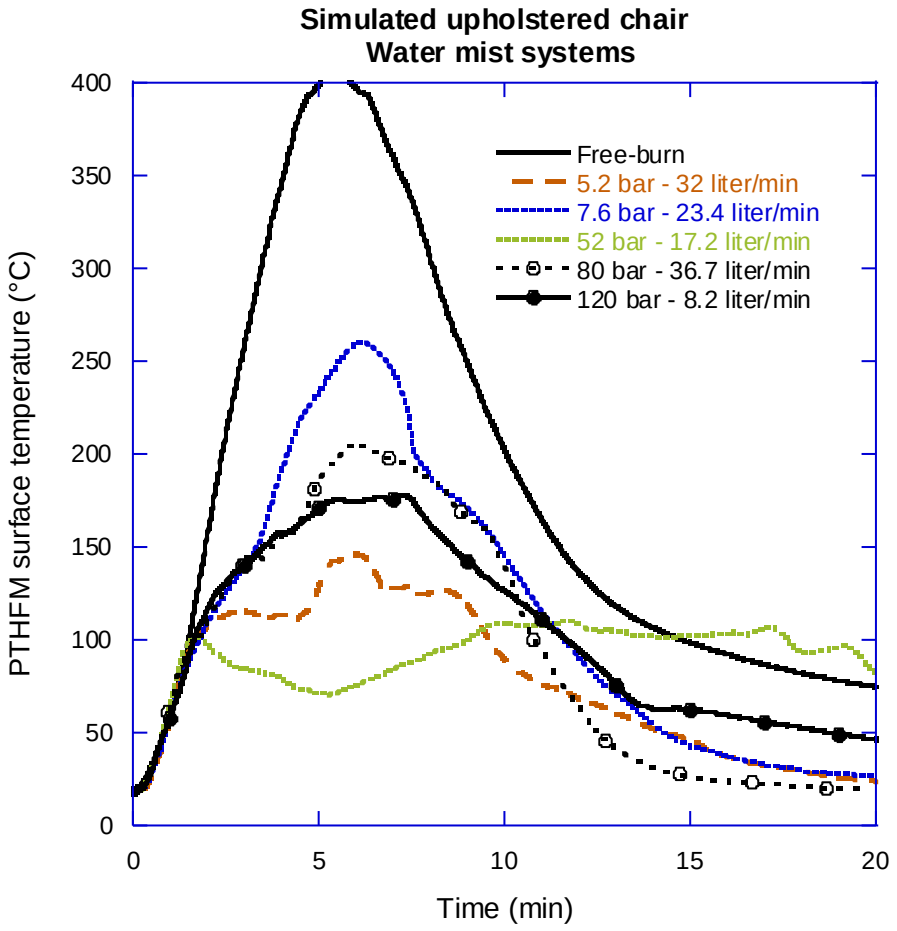
Free-burn fire tests inside the test compartment





Surface temperature of the Plate Thermometers





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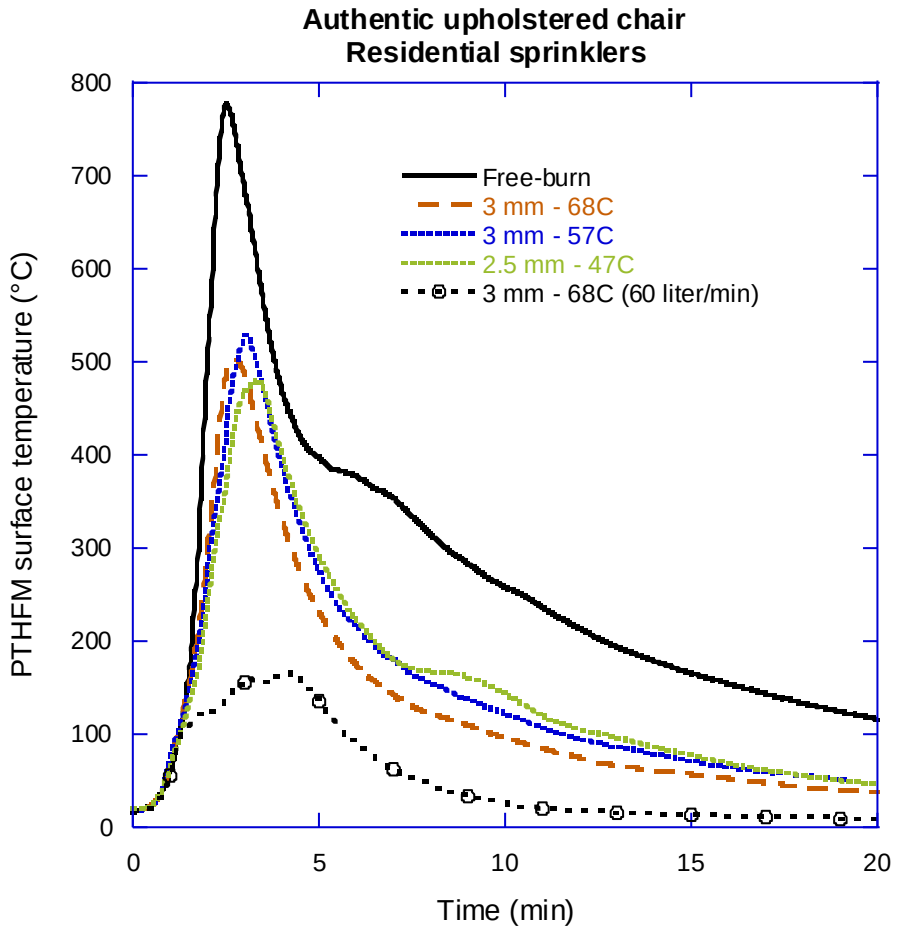
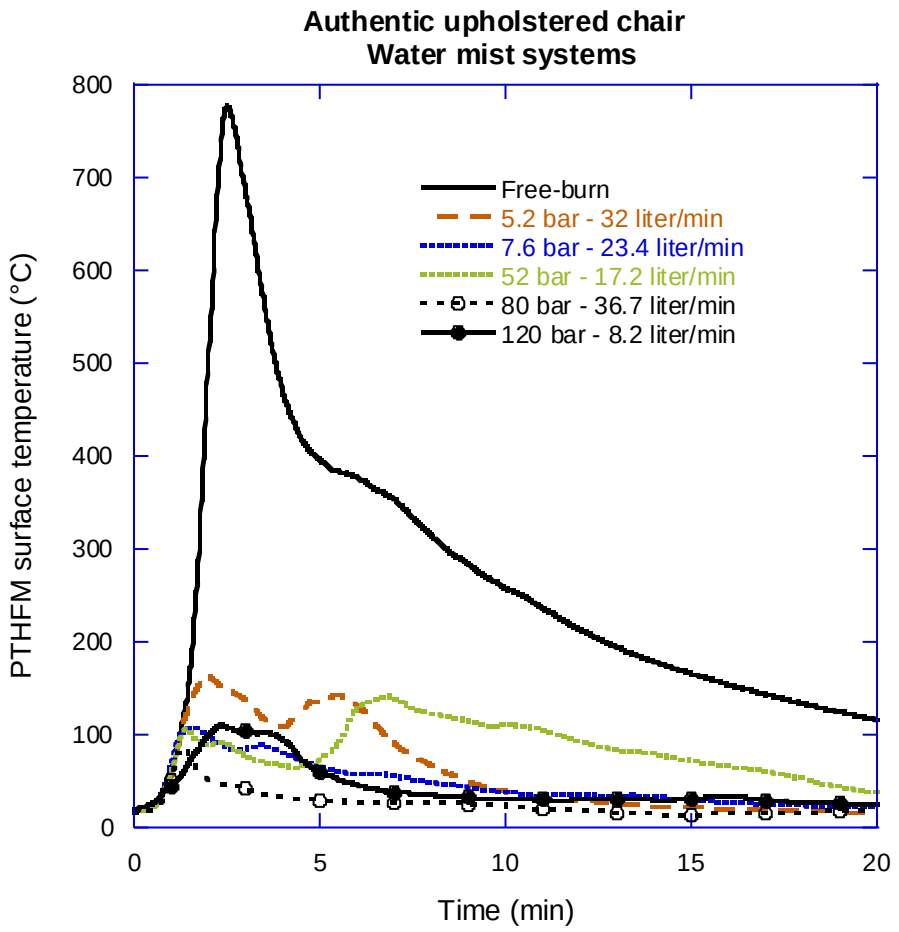




Res. 3 mm | 68°C – 30.3 liter/min

5.2 bar – 32 liter/min

7.6 bar – 23.4 liter/min

52 bar – 17 liter/min

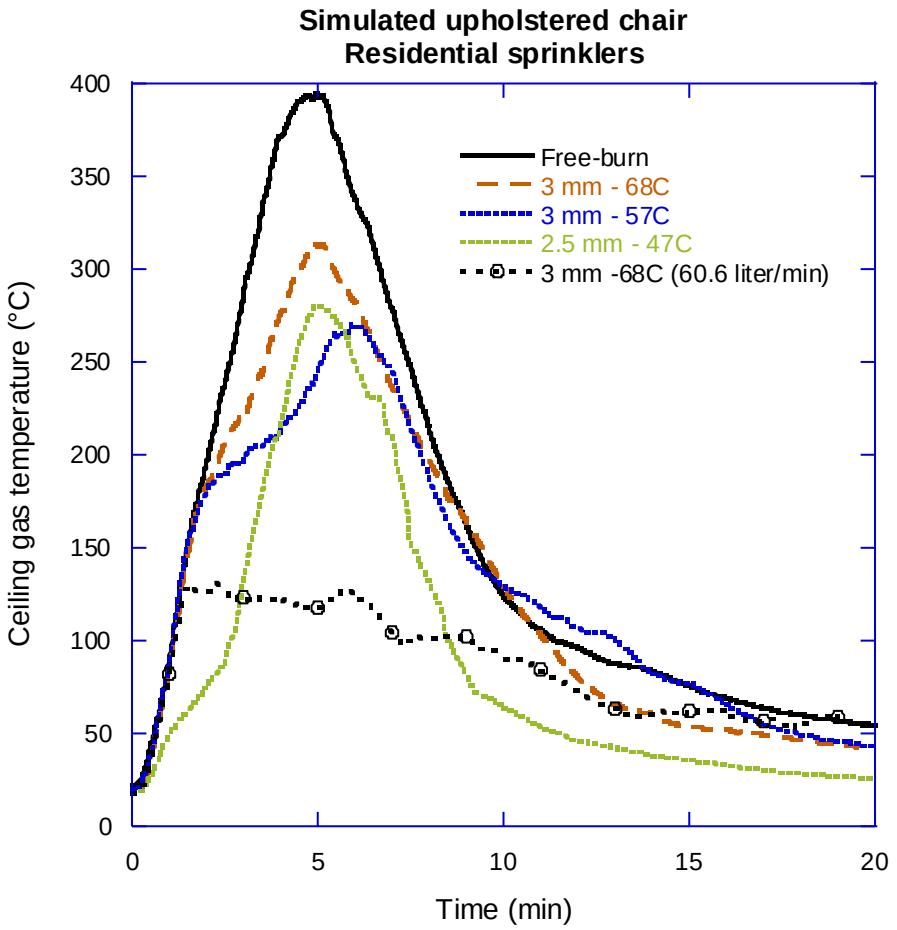
120 bar – 8.2 liter/min

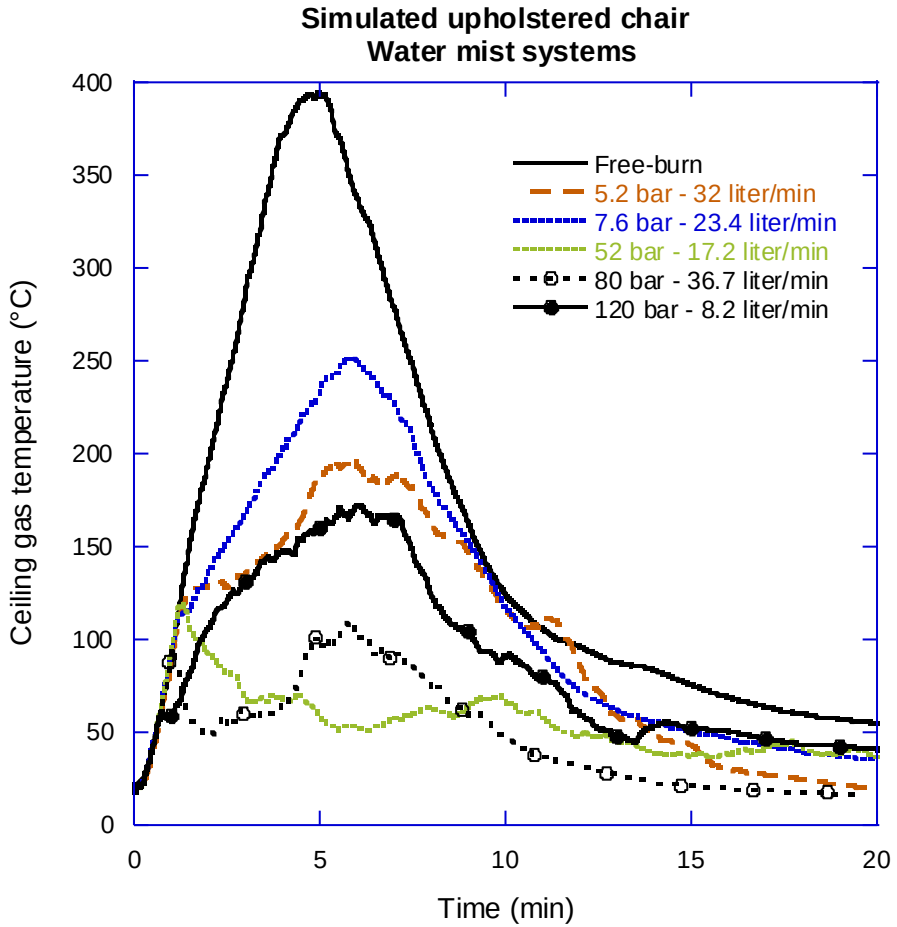
80 bar – 36.7 liter/min

Res. 3 mm | 68°C, 30.3 liter/min

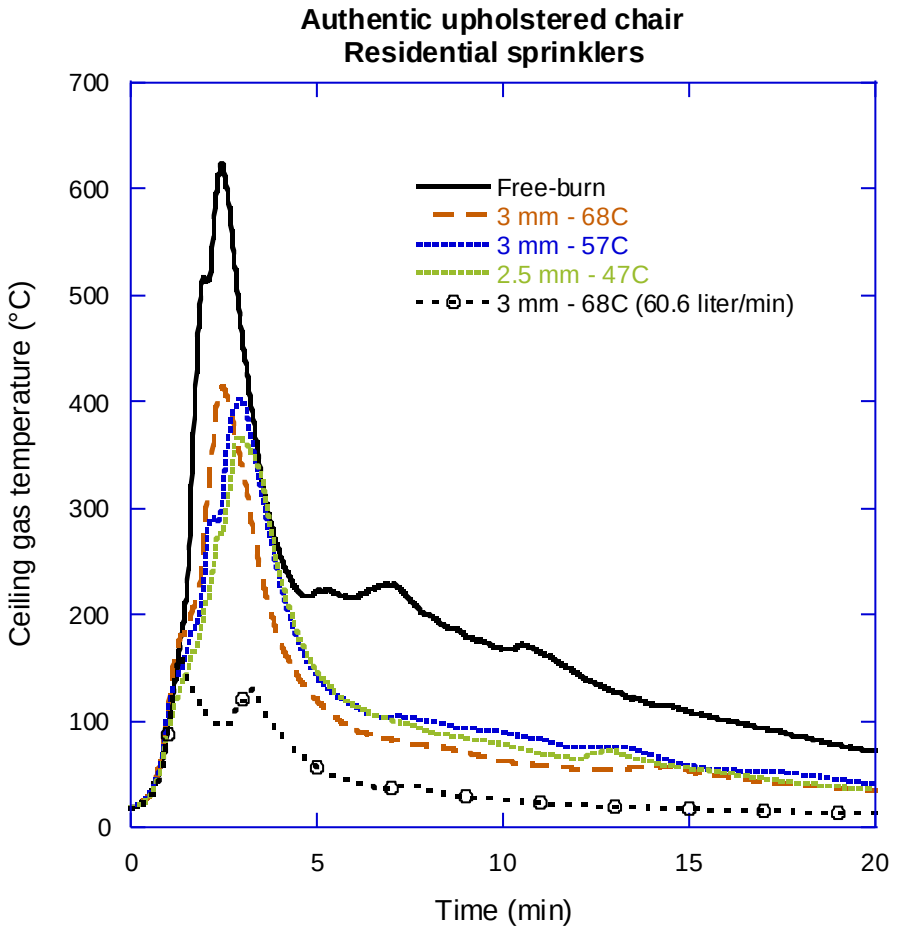
Res. 3 mm | 68°C, 60.6 liter/min

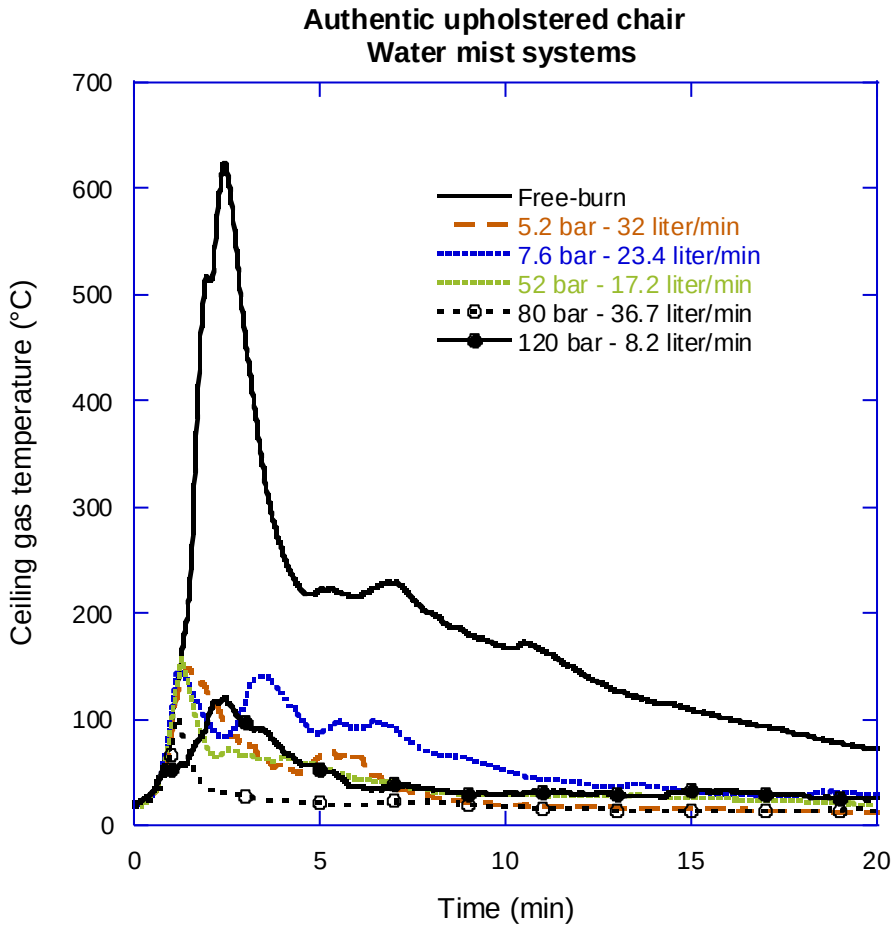
Ceiling gas temperature



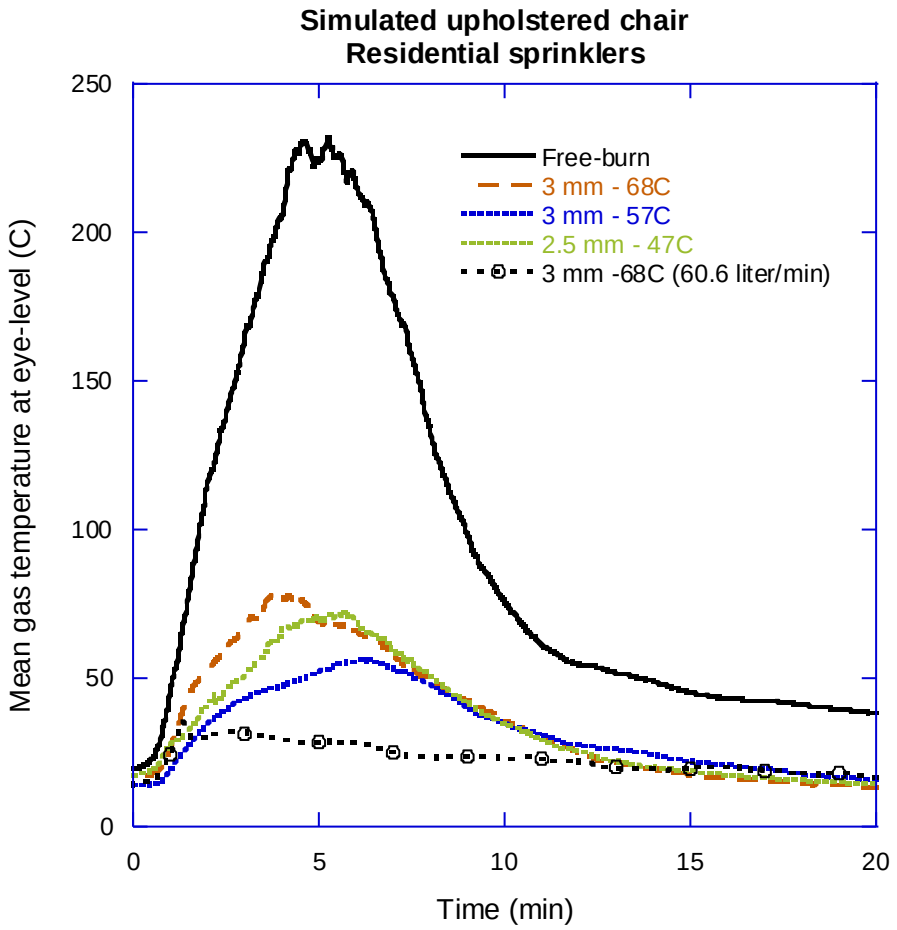


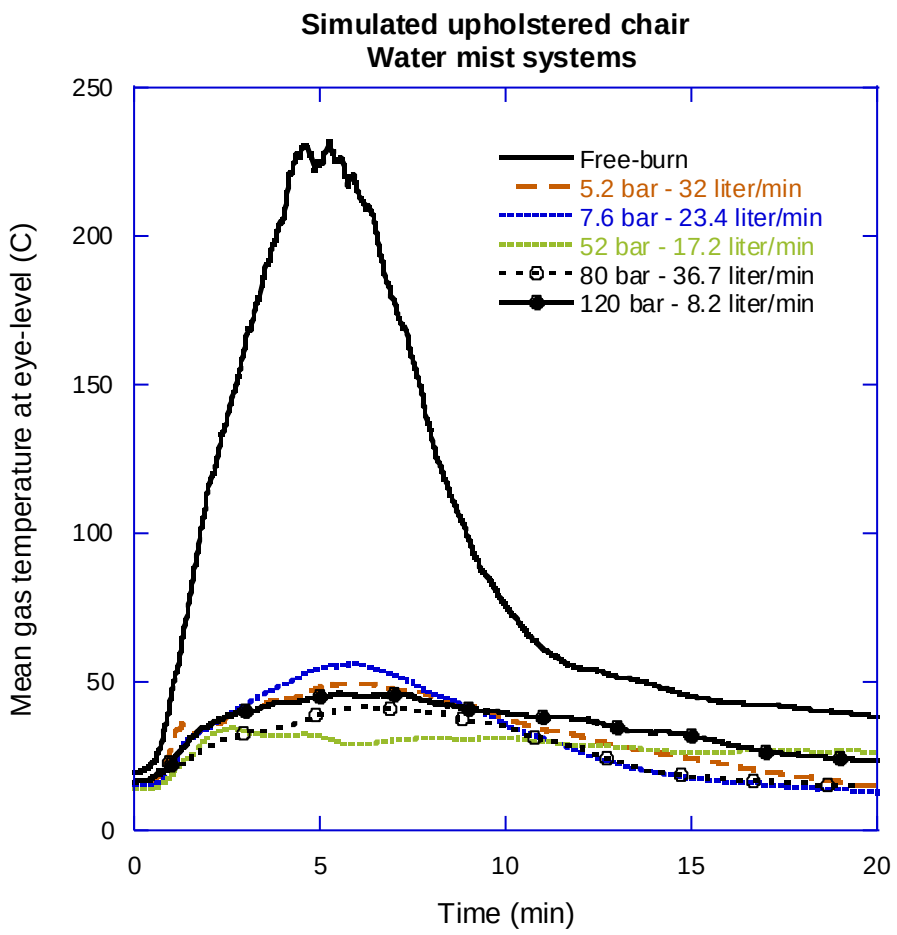
Ceiling gas temperature





Gas temperature at eye-level (mean from three points)





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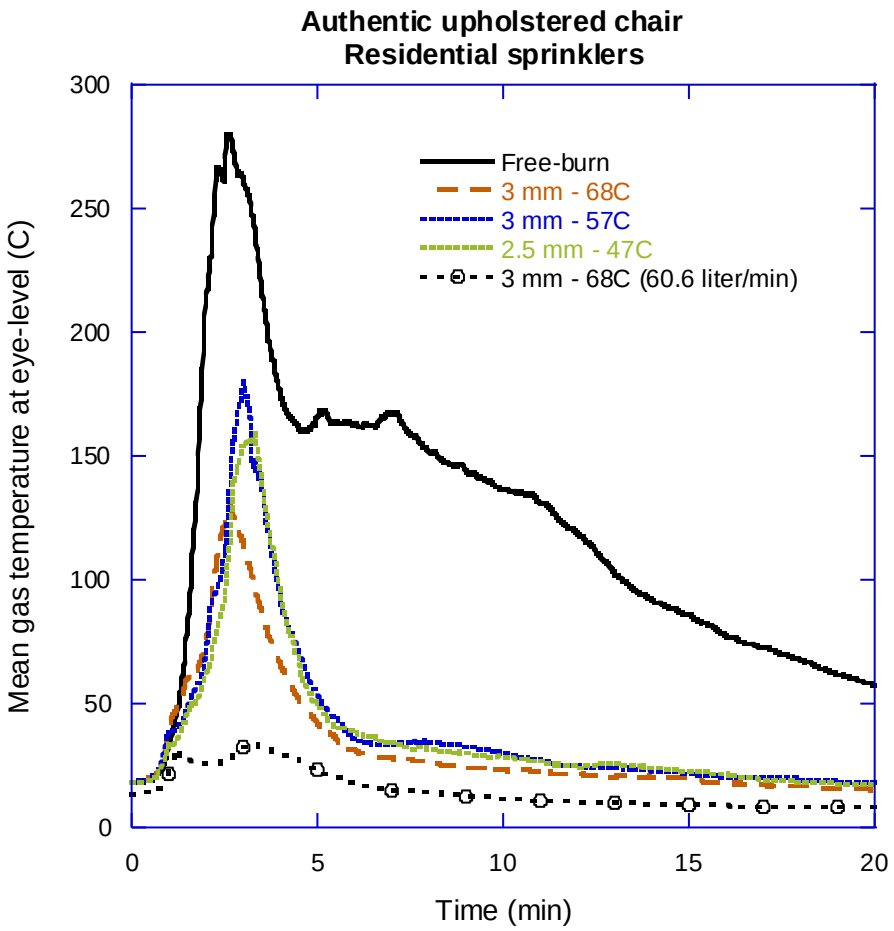
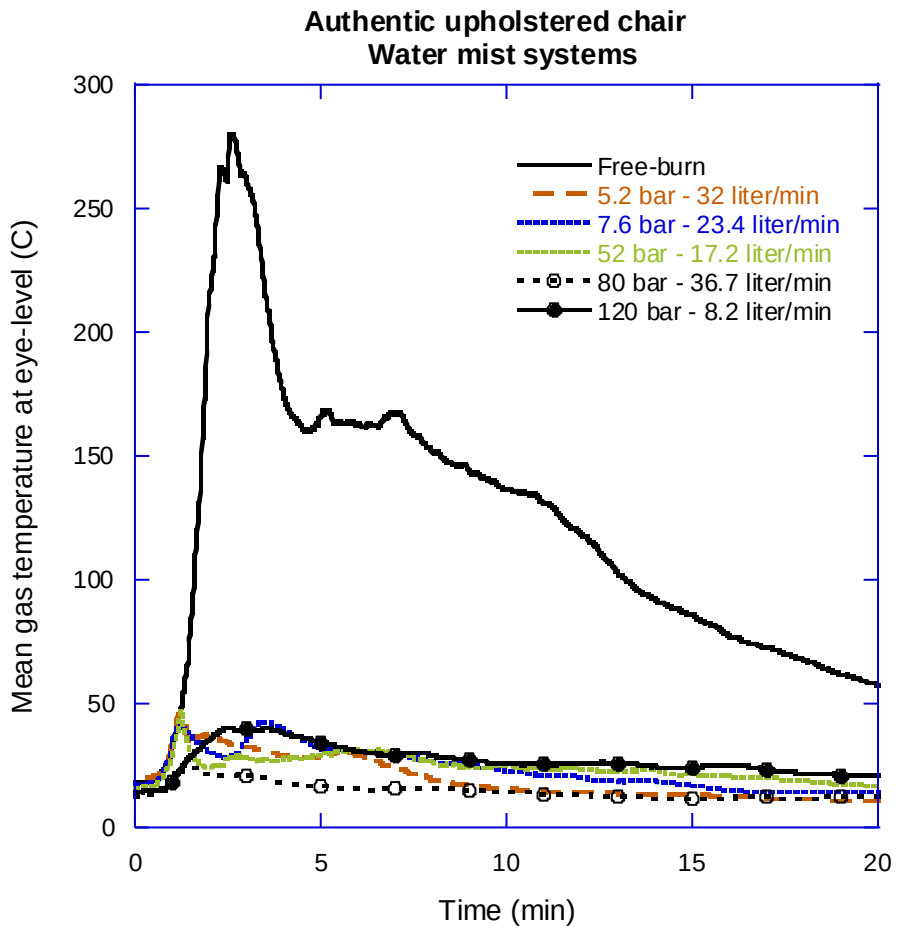




Conclusions

Residential sprinklers

- Some improvement with earlier activation for the simulated chair scenario, but not with the authentic chair scenario.
- Survivable environment in the compartment with reservation for relatively high gas temperatures at eye-level for the authentic chair scenario.
- Significantly improved performance with 60.6 liter/min (4.1 mm/min) as compared to 30.3 liter/min (2.05 mm/min).
- Human in direct contact with the fire unlikely to survive or will suffer severe injuries*.
- The data indicate that the authentic upholstered chair represented a more challenging fire scenario than the simulated upholstered chair for the residential sprinklers.

*) Not expected, the performance objectives of residential sprinklers are to prevent flashover in the room of origin and allow a safe escape of people.

Conclusions

Water mist nozzles

- Improvement performance compared to the residential sprinkler flowing 30.3 liter/min (2.05 mm/min).
- Comparable performance compared to the residential sprinkler flowing 60.6 liter/min (4.1 mm/min) with about a quarter to half the flow rate.
- Survivable environment in the compartment.
- Human in direct contact with the fire unlikely to survive or will suffer severe injuries.
- The simulated upholstered chair scenario was more challenging for the water mist nozzles than the authentic upholstered chair scenario.

Conclusions

Stand-alone high-pressure system

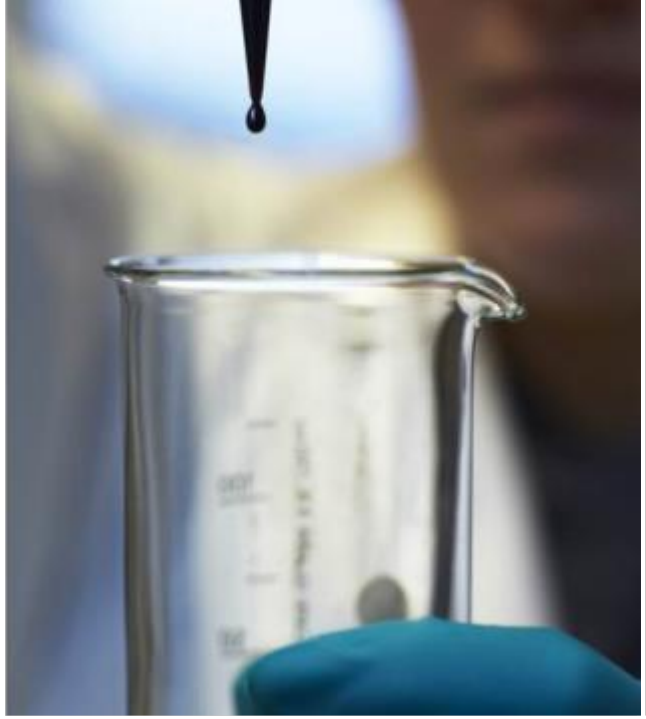
- The earlier activation did not contribute to any noticeable reduction in temperatures (as compared to the water mist nozzles) measured with the Plate Thermometers.
- Survivable environment in the compartment.
- Human in direct contact with the fire unlikely to survive or will suffer severe injuries.
- The fire did not re-develop in any of the fire tests at the end of the discharge of the system, although the fires were not completely extinguished.
- The simulated upholstered chair scenario was more challenging for the system than the authentic upholstered chair scenario.
- The effect of the fire's location was not investigated. However, a thoughtful position of the unit can be applied in practical applications.

The sponsors of the tests

- The tests were financed by MSB, the Swedish Civil Contingencies Agency.
- The tests were a part of the project “Analysis of fire safety physical determinants and technical measures to decrease the number of casualties in residential fires”.
- The companies that provides the sprinklers and nozzles.

The sponsors are gratefully acknowledged.

The results are published in RISE Report 2017:40.



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