Temperature Cycling Due to Water Spray in Laboratory Weathering Devices

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Purpose of the Study

IEC TC82/WG2 “experts” are nearing consensus on steady state weathering conditions for exposures of backsheet materials. Some experts want to adopt water spray to add moisture and temperature cycling to the test. A set of conditions has been proposed. This study looks at the effect on temperature of the proposed spray cycles and estimated specimen temperature in the proposed cycles.

Steady State Conditions

There is preliminary agreement among the working group experts on the following conditions, although temperature evaluations continue. There is ongoing discussion on the duration and construction of test specimens.

Xenon Arc: Optical filter defined in ASTM D7869 (Atlas Right Light™ and Q-Lab Daylight-F)

Irradiance:	0.80 W/(m^2·nm) @ 340 nm
Black Panel Temperature:	95°C
Chamber Air Temperature:	70°C
Relative Humidity:	20%

Fluorescent UV: UVA-340 Lamps

Irradiance:	0.80 W/(m^2·nm) @ 340 nm
Black Panel Temperature:	75°C

Proposed Cyclic Exposures

Xenon Arc (ASTM D7869 optical filter)

Irradiance: 0.80 W/(m^2·nm) @ 340 nm

Chamber Air Temperature: 70°C

Uninsulated Black Panel: 95°C

Relative Humidity: 20%

Cycle:

102 Minutes Light only

18 Minutes Light + Front Water Spray

Proposed Cyclic Exposures

Fluorescent UV (UVA-340 Lamps)

Irradiance:	0.83 W/(m^2·nm) @ 340 nm
Uninsulated Black Panel:	75°C
Relative Humidity:	Not controlled (Typically <10%)

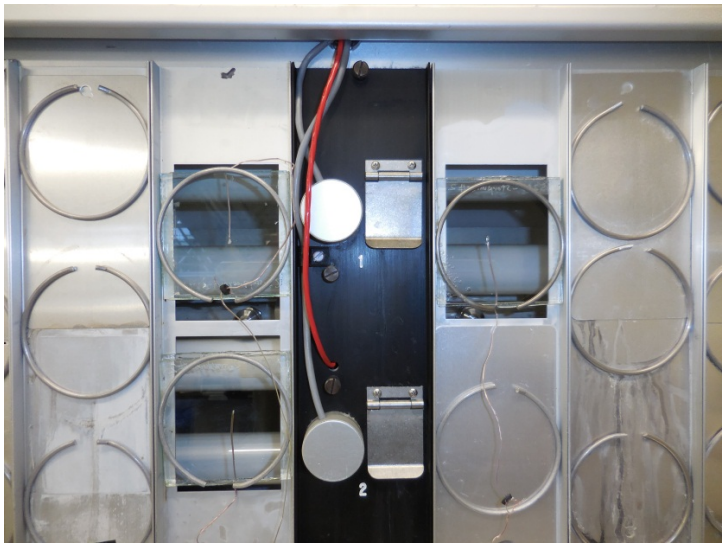
Cycle:
3:50 Lamps On
0:10 Water Spray, Lamps Off (no temp spec)

* 4% Irradiance increase to compensate for 4% of cycle in dark condition

Experiment

- Determine effect of proposed spray cycles on black panel temperature.
- During steady state conditions, measure temperature of NREL coupons and compare to black panel and/or chamber air temperature

Photos of specimens



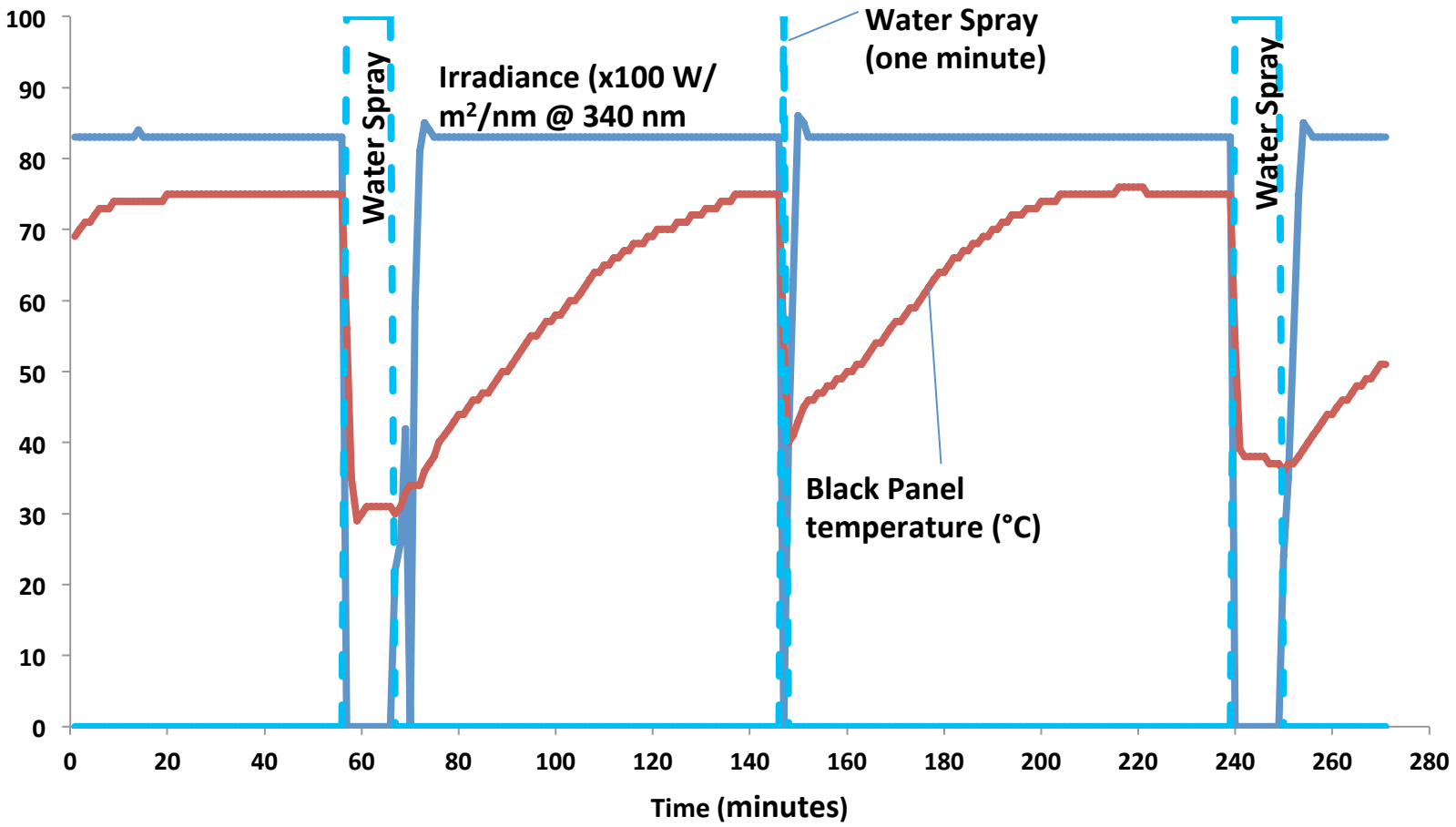
Fluorescent UV (QUV)

Xenon Arc (Q-SUN)

Results – Fluorescent UV

- Black panel temperature in fluorescent UV test decreased from 75°C to 30°C): this equated to ΔT = 45°C (warmer water resulted in 36°C during second spray phase
- A happy mistake in fluorescent UV program cycle provided useful information.
- Fluorescent UV black panel temperature during 10 minutes of water spray achieved equilibrium with incoming water temperature
- One minute of water spray decreased temperature to 40°C
- NREL specimens averaged 82.3°C

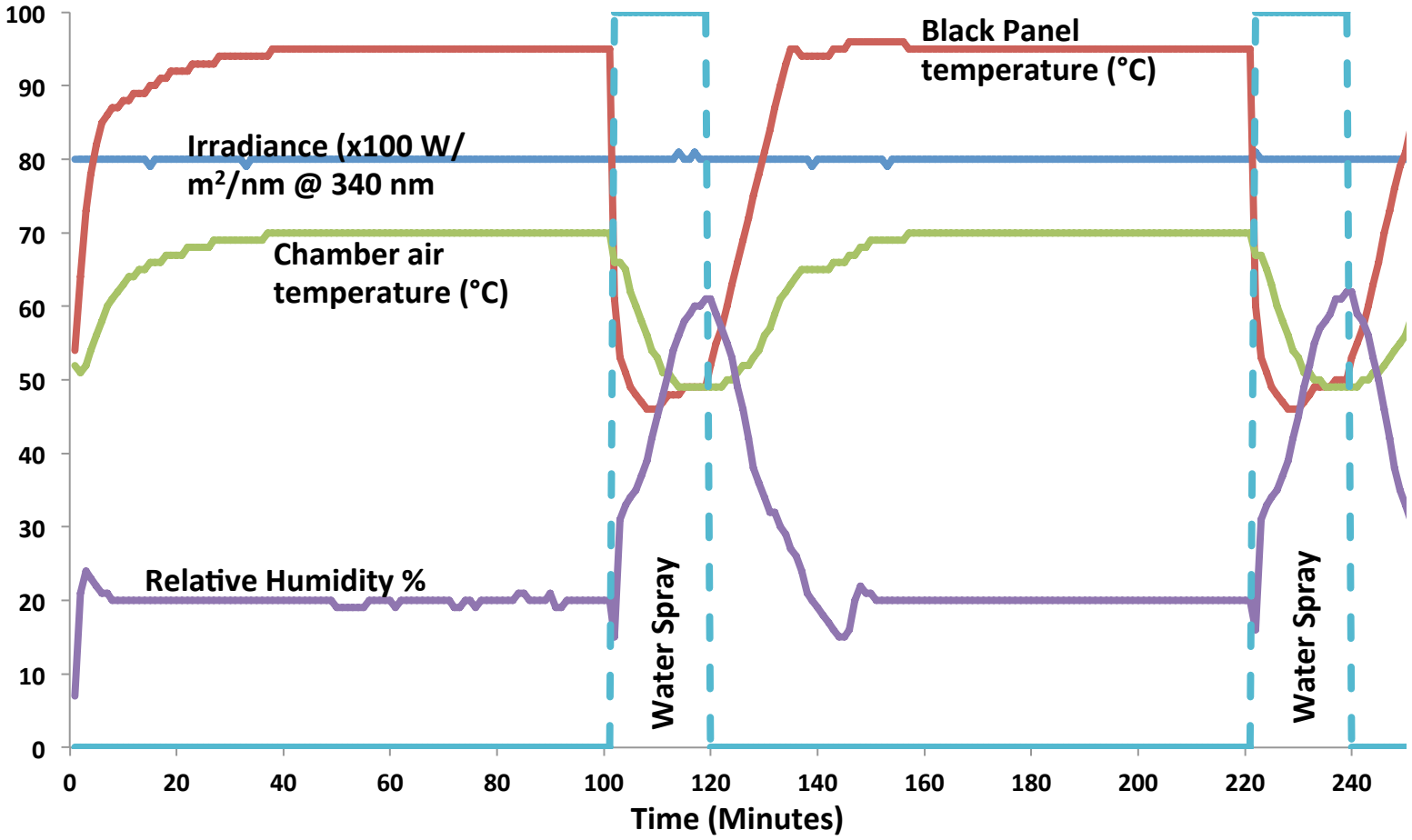
Fluorescent UV



Results – Xenon Arc

- BP temperature decreased from 95°C to 46°C during 18 minute light plus spray cycle($\Delta T = 49°C$)
- NREL specimens averaged 71.6°C during 85°C BP and 60°C chamber air settings; estimated 81.6°C at 95°C/70°C settings
- Fluorescent UV specimen temperature: 82.3°C
- Xenon arc specimen temperature: 81.6°C

Xenon Arc


Black Panel temperature (°C)
Irradiance (x100 W/ m²/nm @ 340 nm
Chamber air temperature (°C)
Relative Humidity %
Water Spray
Water Spray
Time (Minutes)
0
10
20
30
40
50
60
70
80
90
100
0
20
40
60
80
100
120
140
160
180
200
220
240

Spray Contact Time

- Question: Xenon arc spray time is 36 minutes per 4 hours while fluorescent UV is only 10 minutes. Doesn't this mean the xenon is spraying a lot more water?
  - Answer: No. Xenon spray cycles work differently; they are intermittent. In a flat array machine, spray is programmed to pulse in order to mimic rotating rack with fixed nozzles. Specimens are sprayed 5 seconds on, 55 seconds off, every minute (this is adjustable)
  - This equates to 180 seconds of spray during that 36 minutes, compared to continuous 600 seconds during fluorescent UV water spray

Conclusions

- Proposed test conditions achieve very similar specimen temperature in both xenon and fluorescent UV devices:
  - Fluorescent UV specimen temperature: 82.3°C
  - Xenon arc specimen temperature: 81.6°C
- Spray cycle in fluorescent UV could be reduced from 10 minutes (maybe to 5 minutes) and still achieve the same thermal cycling