

# Appendices

## Appendix A

### FDS file: Combination of water spray system and heated plate

```
&HEAD CHID='THESIS_CEDRIC_FINAL_COMBINED_SIMULATION',
TITLE='THESIS_CEDRIC_FINAL_COMBINED_SIMULATION' /

&TIME T_END=600 /

&MESH ID='mesh1', IJK=60,60,10, XB=-0.6,0.6,-0.6,0.6,-0.31,-0.11, MPI_PROCESS=0 / 0.02 m
or 20 mm mesh size
&MESH ID='mesh2', IJK=60,60,10, XB=-0.6,0.6,-0.6,0.6,-0.11,0.09, MPI_PROCESS=1 /
&MESH ID='mesh3', IJK=60,60,10, XB=-0.6,0.6,-0.6,0.6,0.09,0.29, MPI_PROCESS=2 /
&MESH ID='mesh4', IJK=60,60,10, XB=-0.6,0.6,-0.6,0.6,0.29,0.49, MPI_PROCESS=3 /
&MESH ID='mesh5', IJK=60,60,10, XB=-0.6,0.6,-0.6,0.6,0.49,0.69, MPI_PROCESS=4 /

////////// Hot metallic plate part //////////

&RADI NUMBER_RADIATION_ANGLES = 200/

&MISC TMPA=12.75 /

&OBST XB= -0.5, 0.5, -0.5, 0.5, -0.01, 0.01, SURF_ID='Hot metallic plate', COLOR='BLACK'/

&OBST XB= -0.26, 0.26, -0.26, 0.26, -0.23, -0.21, SURF_ID='Radiative panel', COLOR='RED'/

&SPEC ID='METHANE' /

&MATL ID='Steel'
    SPECIFIC_HEAT      = 0.7
    CONDUCTIVITY       = 45.8
    DENSITY             = 7850 / cond in W/m.K ; spec heat in kJ/kg.K; density in
kg/m3;

&MATL ID = 'WATER'
    EMISSIVITY         = 1.0
    DENSITY             = 1000.
    CONDUCTIVITY       = 0.20
    SPECIFIC_HEAT      = 4.184
    N_REACTIONS        = 1
    REFERENCE_TEMPERATURE = 100.
    PYROLYSIS_RANGE    = 10.
```

NU\_SPEC = 1.  
SPEC\_ID = 'METHANE'  
HEAT\_OF\_REACTION = 2500. /

&SURF ID = 'Hot metallic plate'  
MATL\_ID(1,1:2) = 'Steel','WATER'  
MATL\_MASS\_FRACTION(1,1:2) = 0.95,0.05  
THICKNESS = 0.002/

&SURF ID = 'Radiative panel'  
NET\_HEAT\_FLUX = 110  
RAMP\_Q = 'NHFRAMP'  
BACKING = 'INSULATED' /

&RAMP ID='NHFRAMP', T=0.0, F=0.0 /  
&RAMP ID='NHFRAMP', T=32.7, F=0.0 /  
&RAMP ID='NHFRAMP', T=32.8, F=1.0 /  
&RAMP ID='NHFRAMP', T=384.3, F=1.0 /  
&RAMP ID='NHFRAMP', T=384.4, F=0.0 / F is percentage and T is time

////////// Water spray part //////////

&SPEC ID = 'WATER VAPOR' /

&PART ID = 'Watermist', SPEC\_ID='WATER VAPOR', QUANTITIES = 'PARTICLE DIAMETER', 'PARTICLE TEMPERATURE', 'PARTICLE VELOCITY', DIAMETER = 188, GAMMA\_D = 3.3, HEAT\_TRANSFER\_COEFFICIENT\_SOLID = 50000/

&PROP ID='sprinkler',  
PART\_ID = 'Watermist',  
OFFSET = 0.02,  
SPRAY\_ANGLE = 0,21,  
FLOW\_RATE = 4.6,  
PARTICLE\_VELOCITY = 70,  
FLOW\_RAMP = 'SPRAMP',  
PARTICLES\_PER\_SECOND = 5000.0 /

&RAMP ID='SPRAMP', T=0.0, F=0.0 /  
&RAMP ID='SPRAMP', T=1.0, F=1.0 / F is percentage and T is time

&DEVC ID='SPR', XYZ=0.0,0.0,0.51, ORIENTATION=0,0,-1, PROP\_ID='sprinkler', QUANTITY='TIME', SETPOINT=383.4 /

&VENT DB='XMIN', SURF\_ID='OPEN' /  
&VENT DB='XMAX', SURF\_ID='OPEN' /  
&VENT DB='YMIN', SURF\_ID='OPEN' /  
&VENT DB='YMAX', SURF\_ID='OPEN' /  
&VENT DB='ZMIN', SURF\_ID='OPEN' /  
&VENT DB='ZMAX', SURF\_ID='OPEN' /

//////////////////////////////////// Slice files //////////////////////////////////////

&SLCF PBZ= -0.01, QUANTITY='TEMPERATURE' /  
&SLCF PBZ= 0.01, QUANTITY='TEMPERATURE' /  
&SLCF PBX= 0, QUANTITY='TEMPERATURE' /  
&SLCF PBX= 0, QUANTITY='W-VELOCITY' /

//////////////////////////////////// Devices wall temperature //////////////////////////////////////

&DEVC ID='WTHOT', XYZ= 0, 0, -0.01, QUANTITY='WALL TEMPERATURE', IOR = -3 / me grid veranderen  
&DEVC ID='WTCOOL', XYZ= 0, 0, 0.01, QUANTITY='WALL TEMPERATURE', IOR = 3 /

&DEVC ID='WT1', XYZ= -0.25, -0.25, -0.01, QUANTITY='WALL TEMPERATURE', IOR = -3 /  
&DEVC ID='WT2', XYZ= -0.25, 0.25, -0.01, QUANTITY='WALL TEMPERATURE', IOR = -3 /  
&DEVC ID='WT3', XYZ= 0.25, -0.25, -0.01, QUANTITY='WALL TEMPERATURE', IOR = -3 /  
&DEVC ID='WT4', XYZ= 0.25, 0.25, -0.01, QUANTITY='WALL TEMPERATURE', IOR = -3 /  
&DEVC ID='WT5', XYZ= 0.00, 0.00, -0.01, QUANTITY='WALL TEMPERATURE', IOR = -3 /

&DEVC ID='WT6', XYZ= 0, 0.45, 0.01, QUANTITY='WALL TEMPERATURE', IOR = 3 /  
&DEVC ID='WT7', XYZ= 0, 0.35, 0.01, QUANTITY='WALL TEMPERATURE', IOR = 3 /  
&DEVC ID='WT8', XYZ= 0, 0.25, 0.01, QUANTITY='WALL TEMPERATURE', IOR = 3 /  
&DEVC ID='WT9', XYZ= 0, 0.15, 0.01, QUANTITY='WALL TEMPERATURE', IOR = 3 /  
&DEVC ID='WT10', XYZ= 0, 0.05, 0.01, QUANTITY='WALL TEMPERATURE', IOR = 3 /  
&DEVC ID='WT11', XYZ= 0, -0.05, 0.01, QUANTITY='WALL TEMPERATURE', IOR = 3 /  
&DEVC ID='WT12', XYZ= 0, -0.15, 0.01, QUANTITY='WALL TEMPERATURE', IOR = 3 /  
&DEVC ID='WT13', XYZ= 0, -0.25, 0.01, QUANTITY='WALL TEMPERATURE', IOR = 3 /  
&DEVC ID='WT14', XYZ= 0, -0.35, 0.01, QUANTITY='WALL TEMPERATURE', IOR = 3 /  
&DEVC ID='WT15', XYZ= 0, -0.45, 0.01, QUANTITY='WALL TEMPERATURE', IOR = 3 /  
&DEVC ID='WT16', XYZ= -0.45, 0, 0.01, QUANTITY='WALL TEMPERATURE', IOR = 3 /  
&DEVC ID='WT17', XYZ= -0.35, 0, 0.01, QUANTITY='WALL TEMPERATURE', IOR = 3 /  
&DEVC ID='WT18', XYZ= -0.25, 0, 0.01, QUANTITY='WALL TEMPERATURE', IOR = 3 /  
&DEVC ID='WT19', XYZ= -0.15, 0, 0.01, QUANTITY='WALL TEMPERATURE', IOR = 3 /  
&DEVC ID='WT20', XYZ= -0.05, 0, 0.01, QUANTITY='WALL TEMPERATURE', IOR = 3 /

```

&DEVC ID='WTRADPANELSBOTTOM', XYZ= 0, 0, -0.23, QUANTITY='WALL TEMPERATURE', IOR = -3 /
&DEVC ID='WTRADPANELTOP', XYZ= 0, 0, -0.21, QUANTITY='WALL TEMPERATURE', IOR = 3 /
////////// Devices heat flux //////////

&DEVC ID='rhfHeatedSide', XYZ= 0, 0, -0.01, QUANTITY='RADIATIVE HEAT FLUX', IOR = -3 /
&DEVC ID='rhfCooledSide', XYZ= 0, 0, 0.01, QUANTITY='RADIATIVE HEAT FLUX', IOR = 3 /
&DEVC ID='chfHeatedSide', XYZ= 0, 0, -0.01, QUANTITY='CONVECTIVE HEAT FLUX', IOR = -3 /
&DEVC ID='chfCooledSide', XYZ= 0, 0, 0.01, QUANTITY='CONVECTIVE HEAT FLUX', IOR = 3 /
&DEVC ID='thfHeatedSide', XYZ= 0, 0, -0.01, QUANTITY='TOTAL HEAT FLUX', IOR = -3 /
&DEVC ID='thfCooledSide', XYZ= 0, 0, 0.01, QUANTITY='TOTAL HEAT FLUX', IOR = 3 /

&DEVC ID='rhfRadPanelSide', XYZ= 0, 0, -0.21, QUANTITY='RADIATIVE HEAT FLUX', IOR = 3 /
&DEVC ID='chfRadPanelSide', XYZ= 0, 0, -0.21, QUANTITY='CONVECTIVE HEAT FLUX', IOR = 3 /
&DEVC ID='thfRadPanelSide', XYZ= 0, 0, -0.21, QUANTITY='TOTAL HEAT FLUX', IOR = 3 /

////////// Boundary files //////////

&BNDF QUANTITY='RADIATIVE HEAT FLUX'/
&BNDF QUANTITY='CONVECTIVE HEAT FLUX'/
&BNDF QUANTITY='TOTAL HEAT FLUX'/
&BNDF QUANTITY='NET HEAT FLUX'/
&BNDF QUANTITY='WALL TEMPERATURE'/

////////// PDPA devices //////////

////////// first PDPA focuses on the diameter histogram //////////

&PROP ID='pdpa_D',
PART_ID = 'Watermist',
QUANTITY = 'DIAMETER',
HISTOGRAM_CUMULATIVE = T,
PDPA_RADIUS = 0.01,
PDPA_START = 460.0,
PDPA_END = 560.0,
PDPA_M = 1,
HISTOGRAM =T,
HISTOGRAM_NBINS = 20,
HISTOGRAM_LIMITS = 0, 0.0004/

&DEVC XYZ= 0.00,0.0,0.02, QUANTITY='PDPA', PROP_ID='pdpa_D', ID='D1-0' /
&DEVC XYZ= 0.01,0.0,0.02, QUANTITY='PDPA', PROP_ID='pdpa_D', ID='D1-10' /
&DEVC XYZ= 0.02,0.0,0.02, QUANTITY='PDPA', PROP_ID='pdpa_D', ID='D1-20' /

```

```
&DEVC XYZ= 0.03,0.0,0.02, QUANTITY='PDPA', PROP_ID='pdpa_D', ID='D1-30' /
&DEVC XYZ= 0.04,0.0,0.02, QUANTITY='PDPA', PROP_ID='pdpa_D', ID='D1-40' /
&DEVC XYZ= 0.05,0.0,0.02, QUANTITY='PDPA', PROP_ID='pdpa_D', ID='D1-50' /
&DEVC XYZ= 0.06,0.0,0.02, QUANTITY='PDPA', PROP_ID='pdpa_D', ID='D1-60' /
&DEVC XYZ= 0.07,0.0,0.02, QUANTITY='PDPA', PROP_ID='pdpa_D', ID='D1-70' /
&DEVC XYZ= 0.08,0.0,0.02, QUANTITY='PDPA', PROP_ID='pdpa_D', ID='D1-80' /
&DEVC XYZ= 0.09,0.0,0.02, QUANTITY='PDPA', PROP_ID='pdpa_D', ID='D1-90' /
&DEVC XYZ= 0.10,0.0,0.02, QUANTITY='PDPA', PROP_ID='pdpa_D', ID='D1-100' /
&DEVC XYZ= 0.11,0.0,0.02, QUANTITY='PDPA', PROP_ID='pdpa_D', ID='D1-110' /
&DEVC XYZ= 0.12,0.0,0.02, QUANTITY='PDPA', PROP_ID='pdpa_D', ID='D1-120' /
&DEVC XYZ= 0.13,0.0,0.02, QUANTITY='PDPA', PROP_ID='pdpa_D', ID='D1-130' /
&DEVC XYZ= 0.14,0.0,0.02, QUANTITY='PDPA', PROP_ID='pdpa_D', ID='D1-140' /
&DEVC XYZ= 0.15,0.0,0.02, QUANTITY='PDPA', PROP_ID='pdpa_D', ID='D1-150' /
&DEVC XYZ= 0.16,0.0,0.02, QUANTITY='PDPA', PROP_ID='pdpa_D', ID='D1-160' /
&DEVC XYZ= 0.17,0.0,0.02, QUANTITY='PDPA', PROP_ID='pdpa_D', ID='D1-170' /
&DEVC XYZ= 0.18,0.0,0.02, QUANTITY='PDPA', PROP_ID='pdpa_D', ID='D1-180' /
&DEVC XYZ= 0.19,0.0,0.02, QUANTITY='PDPA', PROP_ID='pdpa_D', ID='D1-190' /
&DEVC XYZ= 0.20,0.0,0.02, QUANTITY='PDPA', PROP_ID='pdpa_D', ID='D1-200' /
```

```
////////// second PDPA focuses on the velocity histogram //////////
```

```
&PROP ID='pdpa_vel',
PART_ID = 'Watermist',
QUANTITY = 'VELOCITY',
HISTOGRAM_CUMULATIVE = T,
PDPA_RADIUS = 0.01,
PDPA_START = 460.0,
PDPA_END = 560.0,
PDPA_M = 0,
PDPA_N = 0,
HISTOGRAM = .TRUE.,
HISTOGRAM_NBINS = 20,
HISTOGRAM_LIMITS = 0, 40/
```

```
&DEVC XYZ= 0.00,0.0,0.02, QUANTITY='PDPA', PROP_ID='pdpa_vel', ID='v1-0' /
&DEVC XYZ= 0.01,0.0,0.02, QUANTITY='PDPA', PROP_ID='pdpa_vel', ID='v1-10' /
&DEVC XYZ= 0.02,0.0,0.02, QUANTITY='PDPA', PROP_ID='pdpa_vel', ID='v1-20' /
&DEVC XYZ= 0.03,0.0,0.02, QUANTITY='PDPA', PROP_ID='pdpa_vel', ID='v1-30' /
&DEVC XYZ= 0.04,0.0,0.02, QUANTITY='PDPA', PROP_ID='pdpa_vel', ID='v1-40' /
&DEVC XYZ= 0.05,0.0,0.02, QUANTITY='PDPA', PROP_ID='pdpa_vel', ID='v1-50' /
&DEVC XYZ= 0.06,0.0,0.02, QUANTITY='PDPA', PROP_ID='pdpa_vel', ID='v1-60' /
&DEVC XYZ= 0.07,0.0,0.02, QUANTITY='PDPA', PROP_ID='pdpa_vel', ID='v1-70' /
&DEVC XYZ= 0.08,0.0,0.02, QUANTITY='PDPA', PROP_ID='pdpa_vel', ID='v1-80' /
&DEVC XYZ= 0.09,0.0,0.02, QUANTITY='PDPA', PROP_ID='pdpa_vel', ID='v1-90' /
```

```
&DEVC XYZ= 0.10,0.0,0.02, QUANTITY='PDPA', PROP_ID='pdpa_vel', ID='v1-100' /
&DEVC XYZ= 0.11,0.0,0.02, QUANTITY='PDPA', PROP_ID='pdpa_vel', ID='v1-110' /
&DEVC XYZ= 0.12,0.0,0.02, QUANTITY='PDPA', PROP_ID='pdpa_vel', ID='v1-120' /
&DEVC XYZ= 0.13,0.0,0.02, QUANTITY='PDPA', PROP_ID='pdpa_vel', ID='v1-130' /
&DEVC XYZ= 0.14,0.0,0.02, QUANTITY='PDPA', PROP_ID='pdpa_vel', ID='v1-140' /
&DEVC XYZ= 0.15,0.0,0.02, QUANTITY='PDPA', PROP_ID='pdpa_vel', ID='v1-150' /
&DEVC XYZ= 0.16,0.0,0.02, QUANTITY='PDPA', PROP_ID='pdpa_vel', ID='v1-160' /
&DEVC XYZ= 0.17,0.0,0.02, QUANTITY='PDPA', PROP_ID='pdpa_vel', ID='v1-170' /
&DEVC XYZ= 0.18,0.0,0.02, QUANTITY='PDPA', PROP_ID='pdpa_vel', ID='v1-180' /
&DEVC XYZ= 0.19,0.0,0.02, QUANTITY='PDPA', PROP_ID='pdpa_vel', ID='v1-190' /
&DEVC XYZ= 0.20,0.0,0.02, QUANTITY='PDPA', PROP_ID='pdpa_vel', ID='v1-200' /
```

```
////////// third PDPA focuses on the downwards velocity w histogram //////////
```

```
&PROP ID='pdpa_velw',
PART_ID = 'Watermist',
QUANTITY = 'W-VELOCITY',
HISTOGRAM_CUMULATIVE = T,
PDPA_RADIUS = 0.01,
PDPA_START = 460.0,
PDPA_END = 560.0,
PDPA_M = 0,
PDPA_N = 0,
HISTOGRAM = .TRUE.,
HISTOGRAM_NBINS = 20,
HISTOGRAM_LIMITS = -40, 0/
```

```
&DEVC XYZ= 0.00,0.0,0.02, QUANTITY='PDPA', PROP_ID='pdpa_velw', ID='vw1-0' /
&DEVC XYZ= 0.01,0.0,0.02, QUANTITY='PDPA', PROP_ID='pdpa_velw', ID='vw1-10' /
&DEVC XYZ= 0.02,0.0,0.02, QUANTITY='PDPA', PROP_ID='pdpa_velw', ID='vw1-20' /
&DEVC XYZ= 0.03,0.0,0.02, QUANTITY='PDPA', PROP_ID='pdpa_velw', ID='vw1-30' /
&DEVC XYZ= 0.04,0.0,0.02, QUANTITY='PDPA', PROP_ID='pdpa_velw', ID='vw1-40' /
&DEVC XYZ= 0.05,0.0,0.02, QUANTITY='PDPA', PROP_ID='pdpa_velw', ID='vw1-50' /
&DEVC XYZ= 0.06,0.0,0.02, QUANTITY='PDPA', PROP_ID='pdpa_velw', ID='vw1-60' /
&DEVC XYZ= 0.07,0.0,0.02, QUANTITY='PDPA', PROP_ID='pdpa_velw', ID='vw1-70' /
&DEVC XYZ= 0.08,0.0,0.02, QUANTITY='PDPA', PROP_ID='pdpa_velw', ID='vw1-80' /
&DEVC XYZ= 0.09,0.0,0.02, QUANTITY='PDPA', PROP_ID='pdpa_velw', ID='vw1-90' /
&DEVC XYZ= 0.10,0.0,0.02, QUANTITY='PDPA', PROP_ID='pdpa_velw', ID='vw1-100' /
&DEVC XYZ= 0.11,0.0,0.02, QUANTITY='PDPA', PROP_ID='pdpa_velw', ID='vw1-110' /
&DEVC XYZ= 0.12,0.0,0.02, QUANTITY='PDPA', PROP_ID='pdpa_velw', ID='vw1-120' /
&DEVC XYZ= 0.13,0.0,0.02, QUANTITY='PDPA', PROP_ID='pdpa_velw', ID='vw1-130' /
&DEVC XYZ= 0.14,0.0,0.02, QUANTITY='PDPA', PROP_ID='pdpa_velw', ID='vw1-140' /
&DEVC XYZ= 0.15,0.0,0.02, QUANTITY='PDPA', PROP_ID='pdpa_velw', ID='vw1-150' /
&DEVC XYZ= 0.16,0.0,0.02, QUANTITY='PDPA', PROP_ID='pdpa_velw', ID='vw1-160' /
```

```
&DEVC XYZ= 0.17,0.0,0.02, QUANTITY='PDPA', PROP_ID='pdpa_velw', ID='vw1-170' /
&DEVC XYZ= 0.18,0.0,0.02, QUANTITY='PDPA', PROP_ID='pdpa_velw', ID='vw1-180' /
&DEVC XYZ= 0.19,0.0,0.02, QUANTITY='PDPA', PROP_ID='pdpa_velw', ID='vw1-190' /
&DEVC XYZ= 0.20,0.0,0.02, QUANTITY='PDPA', PROP_ID='pdpa_velw', ID='vw1-200' /
```

```
////////// fourth PDPA focuses on the water mass flux histogram //////////
```

```
&PROP ID='pdpa_massflux',
PART_ID = 'Watermist',
QUANTITY = 'PARTICLE FLUX Z',
HISTOGRAM_CUMULATIVE = T,
PDPA_RADIUS = 0.01,
PDPA_START = 460.0,
PDPA_END = 560.0,
PDPA_M = 1,
HISTOGRAM = .TRUE.,
HISTOGRAM_NBINS = 20,
HISTOGRAM_LIMITS = -0.00001, -0.00000008/
```

```
&DEVC XYZ= 0.00,0.0,0.02, QUANTITY='PDPA', PROP_ID='pdpa_massflux', ID='mf1-0' /
&DEVC XYZ= 0.01,0.0,0.02, QUANTITY='PDPA', PROP_ID='pdpa_massflux', ID='mf1-10' /
&DEVC XYZ= 0.02,0.0,0.02, QUANTITY='PDPA', PROP_ID='pdpa_massflux', ID='mf1-20' /
&DEVC XYZ= 0.03,0.0,0.02, QUANTITY='PDPA', PROP_ID='pdpa_massflux', ID='mf1-30' /
&DEVC XYZ= 0.04,0.0,0.02, QUANTITY='PDPA', PROP_ID='pdpa_massflux', ID='mf1-40' /
&DEVC XYZ= 0.05,0.0,0.02, QUANTITY='PDPA', PROP_ID='pdpa_massflux', ID='mf1-50' /
&DEVC XYZ= 0.06,0.0,0.02, QUANTITY='PDPA', PROP_ID='pdpa_massflux', ID='mf1-60' /
&DEVC XYZ= 0.07,0.0,0.02, QUANTITY='PDPA', PROP_ID='pdpa_massflux', ID='mf1-70' /
&DEVC XYZ= 0.08,0.0,0.02, QUANTITY='PDPA', PROP_ID='pdpa_massflux', ID='mf1-80' /
&DEVC XYZ= 0.09,0.0,0.02, QUANTITY='PDPA', PROP_ID='pdpa_massflux', ID='mf1-90' /
&DEVC XYZ= 0.10,0.0,0.02, QUANTITY='PDPA', PROP_ID='pdpa_massflux', ID='mf1-100' /
&DEVC XYZ= 0.11,0.0,0.02, QUANTITY='PDPA', PROP_ID='pdpa_massflux', ID='mf1-110' /
&DEVC XYZ= 0.12,0.0,0.02, QUANTITY='PDPA', PROP_ID='pdpa_massflux', ID='mf1-120' /
&DEVC XYZ= 0.13,0.0,0.02, QUANTITY='PDPA', PROP_ID='pdpa_massflux', ID='mf1-130' /
&DEVC XYZ= 0.14,0.0,0.02, QUANTITY='PDPA', PROP_ID='pdpa_massflux', ID='mf1-140' /
&DEVC XYZ= 0.15,0.0,0.02, QUANTITY='PDPA', PROP_ID='pdpa_massflux', ID='mf1-150' /
&DEVC XYZ= 0.16,0.0,0.02, QUANTITY='PDPA', PROP_ID='pdpa_massflux', ID='mf1-160' /
&DEVC XYZ= 0.17,0.0,0.02, QUANTITY='PDPA', PROP_ID='pdpa_massflux', ID='mf1-170' /
&DEVC XYZ= 0.18,0.0,0.02, QUANTITY='PDPA', PROP_ID='pdpa_massflux', ID='mf1-180' /
&DEVC XYZ= 0.19,0.0,0.02, QUANTITY='PDPA', PROP_ID='pdpa_massflux', ID='mf1-190' /
&DEVC XYZ= 0.20,0.0,0.02, QUANTITY='PDPA', PROP_ID='pdpa_massflux', ID='mf1-200' /
```

```
////////// fifth PDPA focuses on the water mass flux //////////
```

```
&PROP ID='pdpa_massfluxnor',
```



PART\_ID = 'Watermist',  
QUANTITY = 'PARTICLE FLUX Z',  
PDPA\_RADIUS = 0.01,  
PDPA\_START = 460.0,  
PDPA\_END = 560.0,  
PDPA\_M = 1/

&DEVC XYZ= 0.00,0.0,0.02, QUANTITY='PDPA', PROP\_ID='pdpa\_massfluxnor', ID='mfn1-0' /  
&DEVC XYZ= 0.01,0.0,0.02, QUANTITY='PDPA', PROP\_ID='pdpa\_massfluxnor', ID='mfn1-10' /  
&DEVC XYZ= 0.02,0.0,0.02, QUANTITY='PDPA', PROP\_ID='pdpa\_massfluxnor', ID='mfn1-20' /  
&DEVC XYZ= 0.03,0.0,0.02, QUANTITY='PDPA', PROP\_ID='pdpa\_massfluxnor', ID='mfn1-30' /  
&DEVC XYZ= 0.04,0.0,0.02, QUANTITY='PDPA', PROP\_ID='pdpa\_massfluxnor', ID='mfn1-40' /  
&DEVC XYZ= 0.05,0.0,0.02, QUANTITY='PDPA', PROP\_ID='pdpa\_massfluxnor', ID='mfn1-50' /  
&DEVC XYZ= 0.06,0.0,0.02, QUANTITY='PDPA', PROP\_ID='pdpa\_massfluxnor', ID='mfn1-60' /  
&DEVC XYZ= 0.07,0.0,0.02, QUANTITY='PDPA', PROP\_ID='pdpa\_massfluxnor', ID='mfn1-70' /  
&DEVC XYZ= 0.08,0.0,0.02, QUANTITY='PDPA', PROP\_ID='pdpa\_massfluxnor', ID='mfn1-80' /  
&DEVC XYZ= 0.09,0.0,0.02, QUANTITY='PDPA', PROP\_ID='pdpa\_massfluxnor', ID='mfn1-90' /  
&DEVC XYZ= 0.10,0.0,0.02, QUANTITY='PDPA', PROP\_ID='pdpa\_massfluxnor', ID='mfn1-100' /  
&DEVC XYZ= 0.11,0.0,0.02, QUANTITY='PDPA', PROP\_ID='pdpa\_massfluxnor', ID='mfn1-110' /  
&DEVC XYZ= 0.12,0.0,0.02, QUANTITY='PDPA', PROP\_ID='pdpa\_massfluxnor', ID='mfn1-120' /  
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////////// sixt PDPA focuses on the sauter mean diameter //////////

&PROP ID='pdpa\_d32',  
PART\_ID = 'Watermist',  
PDPA\_M=3,  
PDPA\_N=2,  
PDPA\_RADIUS = 0.01,  
PDPA\_START = 460.0,  
PDPA\_END = 560.0/

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&DEVC XYZ= 0.05,0.0,0.02, QUANTITY='PDPA', PROP\_ID='pdpa\_d32', ID='D32-50' /  
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&DEVC XYZ= 0.07,0.0,0.02, QUANTITY='PDPA', PROP\_ID='pdpa\_d32', ID='D32-70' /  
&DEVC XYZ= 0.08,0.0,0.02, QUANTITY='PDPA', PROP\_ID='pdpa\_d32', ID='D32-80' /  
&DEVC XYZ= 0.09,0.0,0.02, QUANTITY='PDPA', PROP\_ID='pdpa\_d32', ID='D32-90' /  
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&DEVC XYZ= 0.11,0.0,0.02, QUANTITY='PDPA', PROP\_ID='pdpa\_d32', ID='D32-110' /  
&DEVC XYZ= 0.12,0.0,0.02, QUANTITY='PDPA', PROP\_ID='pdpa\_d32', ID='D32-120' /  
&DEVC XYZ= 0.13,0.0,0.02, QUANTITY='PDPA', PROP\_ID='pdpa\_d32', ID='D32-130' /  
&DEVC XYZ= 0.14,0.0,0.02, QUANTITY='PDPA', PROP\_ID='pdpa\_d32', ID='D32-140' /  
&DEVC XYZ= 0.15,0.0,0.02, QUANTITY='PDPA', PROP\_ID='pdpa\_d32', ID='D32-150' /  
&DEVC XYZ= 0.16,0.0,0.02, QUANTITY='PDPA', PROP\_ID='pdpa\_d32', ID='D32-160' /  
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&DEVC XYZ= 0.19,0.0,0.02, QUANTITY='PDPA', PROP\_ID='pdpa\_d32', ID='D32-190' /  
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////////// seventh PDPA focuses on the sauter mean diameter met diameter //////////

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PDPA\_N=2,  
PDPA\_RADIUS = 0.01,  
PDPA\_START = 460.0,  
PDPA\_END = 560.0/

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&DEVC XYZ= 0.03,0.0,0.02, QUANTITY='PDPA', PROP\_ID='pdpa\_d32d', ID='D32d-30' /  
&DEVC XYZ= 0.04,0.0,0.02, QUANTITY='PDPA', PROP\_ID='pdpa\_d32d', ID='D32d-40' /  
&DEVC XYZ= 0.05,0.0,0.02, QUANTITY='PDPA', PROP\_ID='pdpa\_d32d', ID='D32d-50' /  
&DEVC XYZ= 0.06,0.0,0.02, QUANTITY='PDPA', PROP\_ID='pdpa\_d32d', ID='D32d-60' /  
&DEVC XYZ= 0.07,0.0,0.02, QUANTITY='PDPA', PROP\_ID='pdpa\_d32d', ID='D32d-70' /  
&DEVC XYZ= 0.08,0.0,0.02, QUANTITY='PDPA', PROP\_ID='pdpa\_d32d', ID='D32d-80' /  
&DEVC XYZ= 0.09,0.0,0.02, QUANTITY='PDPA', PROP\_ID='pdpa\_d32d', ID='D32d-90' /  
&DEVC XYZ= 0.10,0.0,0.02, QUANTITY='PDPA', PROP\_ID='pdpa\_d32d', ID='D32d-100' /  
&DEVC XYZ= 0.11,0.0,0.02, QUANTITY='PDPA', PROP\_ID='pdpa\_d32d', ID='D32d-110' /  
&DEVC XYZ= 0.12,0.0,0.02, QUANTITY='PDPA', PROP\_ID='pdpa\_d32d', ID='D32d-120' /  
&DEVC XYZ= 0.13,0.0,0.02, QUANTITY='PDPA', PROP\_ID='pdpa\_d32d', ID='D32d-130' /  
&DEVC XYZ= 0.14,0.0,0.02, QUANTITY='PDPA', PROP\_ID='pdpa\_d32d', ID='D32d-140' /  
&DEVC XYZ= 0.15,0.0,0.02, QUANTITY='PDPA', PROP\_ID='pdpa\_d32d', ID='D32d-150' /

&DEVC XYZ= 0.16,0.0,0.02, QUANTITY='PDPA', PROP\_ID='pdpa\_d32d', ID='D32d-160' /  
&DEVC XYZ= 0.17,0.0,0.02, QUANTITY='PDPA', PROP\_ID='pdpa\_d32d', ID='D32d-170' /  
&DEVC XYZ= 0.18,0.0,0.02, QUANTITY='PDPA', PROP\_ID='pdpa\_d32d', ID='D32d-180' /  
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////////// eight PDPA focuses on the number concentration //////////

&PROP ID='pdpa\_NC',  
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QUANTITY = 'NUMBER CONCENTRATION',  
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PDPA\_START = 460.0,  
PDPA\_END = 560.0/

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&DEVC XYZ= 0.03,0.0,0.02, QUANTITY='PDPA', PROP\_ID='pdpa\_NC', ID='NC1-30' /  
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&DEVC XYZ= 0.07,0.0,0.02, QUANTITY='PDPA', PROP\_ID='pdpa\_NC', ID='NC1-70' /  
&DEVC XYZ= 0.08,0.0,0.02, QUANTITY='PDPA', PROP\_ID='pdpa\_NC', ID='NC1-80' /  
&DEVC XYZ= 0.09,0.0,0.02, QUANTITY='PDPA', PROP\_ID='pdpa\_NC', ID='NC1-90' /  
&DEVC XYZ= 0.10,0.0,0.02, QUANTITY='PDPA', PROP\_ID='pdpa\_NC', ID='NC1-100' /  
&DEVC XYZ= 0.11,0.0,0.02, QUANTITY='PDPA', PROP\_ID='pdpa\_NC', ID='NC1-110' /  
&DEVC XYZ= 0.12,0.0,0.02, QUANTITY='PDPA', PROP\_ID='pdpa\_NC', ID='NC1-120' /  
&DEVC XYZ= 0.13,0.0,0.02, QUANTITY='PDPA', PROP\_ID='pdpa\_NC', ID='NC1-130' /  
&DEVC XYZ= 0.14,0.0,0.02, QUANTITY='PDPA', PROP\_ID='pdpa\_NC', ID='NC1-140' /  
&DEVC XYZ= 0.15,0.0,0.02, QUANTITY='PDPA', PROP\_ID='pdpa\_NC', ID='NC1-150' /  
&DEVC XYZ= 0.16,0.0,0.02, QUANTITY='PDPA', PROP\_ID='pdpa\_NC', ID='NC1-160' /  
&DEVC XYZ= 0.17,0.0,0.02, QUANTITY='PDPA', PROP\_ID='pdpa\_NC', ID='NC1-170' /  
&DEVC XYZ= 0.18,0.0,0.02, QUANTITY='PDPA', PROP\_ID='pdpa\_NC', ID='NC1-180' /  
&DEVC XYZ= 0.19,0.0,0.02, QUANTITY='PDPA', PROP\_ID='pdpa\_NC', ID='NC1-190' /  
&DEVC XYZ= 0.20,0.0,0.02, QUANTITY='PDPA', PROP\_ID='pdpa\_NC', ID='NC1-200' /

&TAIL /

## Appendix B

### Extra results sensitivity radiation angles analysis

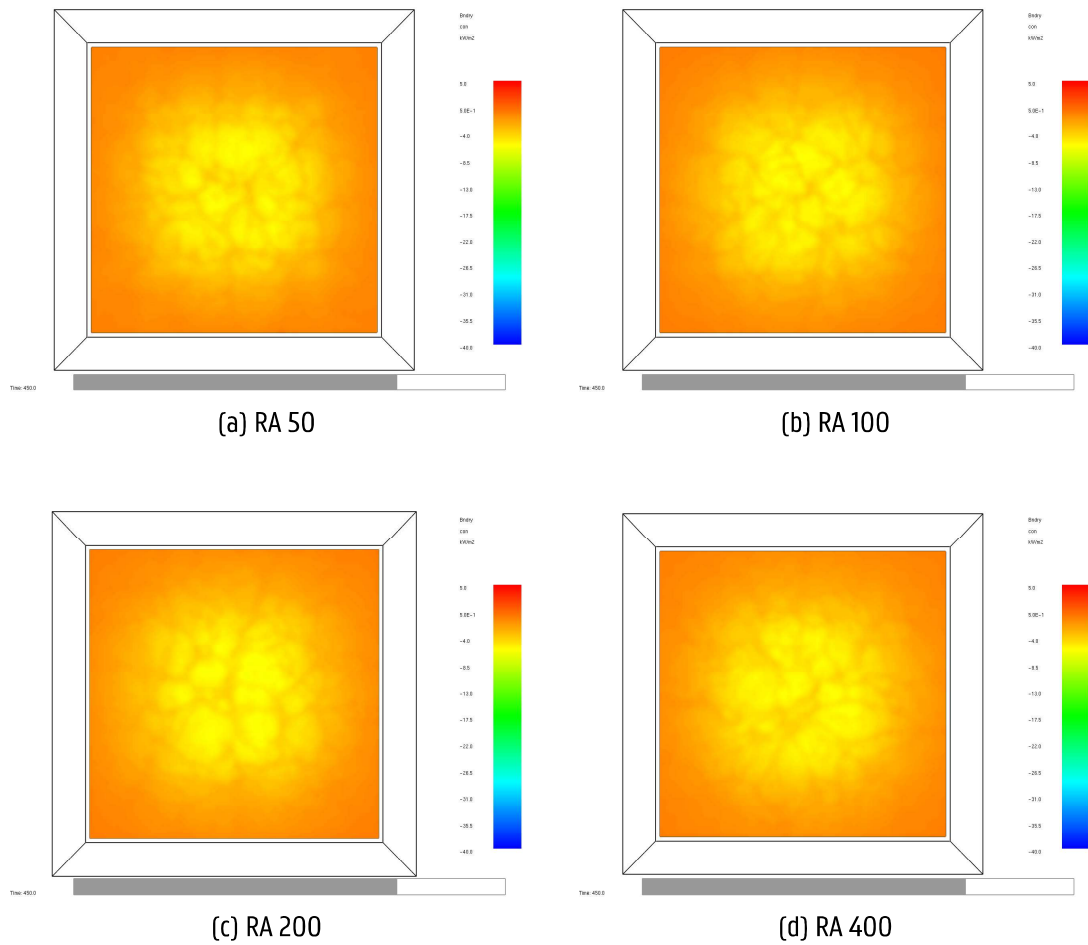


Figure 1: Convective Heat flux, Top view, Cool side, at 450 seconds with different number of radiation angles

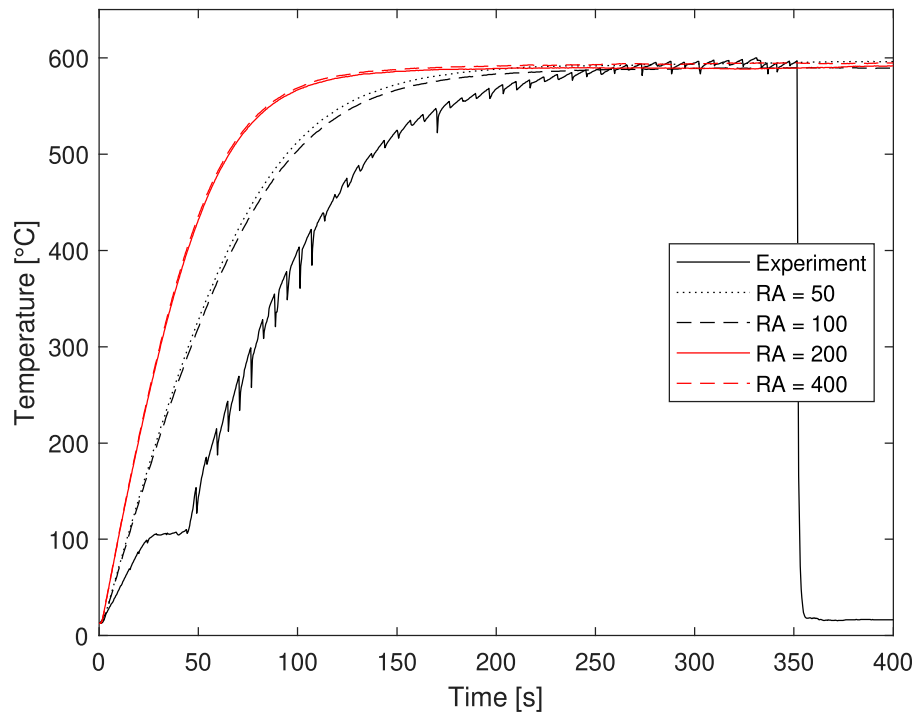


Figure 2: Wall temperature analysis steel plate with different RA values, Cool side

## Appendix C

### Size distribution

#### Matlab file

```
clc
clear
close all
syms D
syms Y
syms X
gamma_D = 3.3
sigma_D = 1.15/gamma_D
D_median = 188 %Dv50
FuncDmedian = 400-D_median
ffirstpart = 1./(sigma_D*(sqrt(2.*pi)))

gamma_and_Dv50 = "Gamma= " + gamma_D + "   Dv50= "+ D_median

f = @(D) (0.5+((ffirstpart)*sqrt(pi/2.)*sigma_D*erf(((log(D)-log(D_median))/(sqrt(2)*sigma_D))))))

g = @(D) 1-exp(-0.693.*((D./D_median).^gamma_D))

for D = 1.0:D_median
    fplot(g, [0 D_median], 'red');
end

hold on

for Y = 1.0:FuncDmedian
    fplot(f, [D_median 400], 'red');
end

xlabel('Droplet size [microm]');
ylabel('Cumulative volume fraction of water');
```

```

rawTable = readtable('MATLAB\dataCVF.xlsx','Sheet','Sheet1');

x = rawTable.Header1; %: get the excel column, Header1 (header name)
y = rawTable.Header2; %: get the excel column, Header2 (header name)

plot(x,y,'--','Color','black');

title('Rosin-Rammler distribution:', gamma_and_Dv50)

xlabel('Droplet size [microm]');
ylabel('Cumulative volume fraction of water');

qw{1} = plot(nan, '-', 'Color', 'red');
qw{2} = plot(nan, '--', 'Color', 'black');
legend([qw{:}], {'Simulation', 'Experiment'}, 'Location', 'northwest')

hold off

```

## Graph size distribution

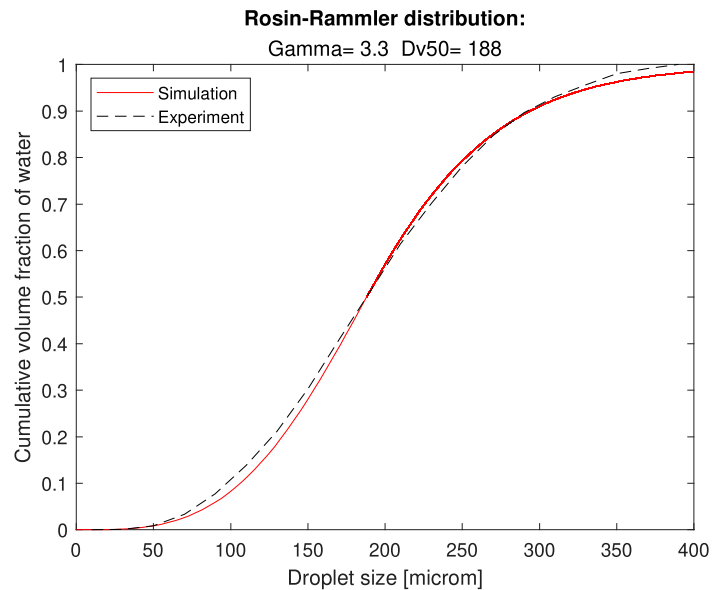


Figure 3: Graph Matlab of CVF Rosin-Rammler-log-normal distribution

## Appendix D

### Different water spray distributions simulated

#### Size distributions

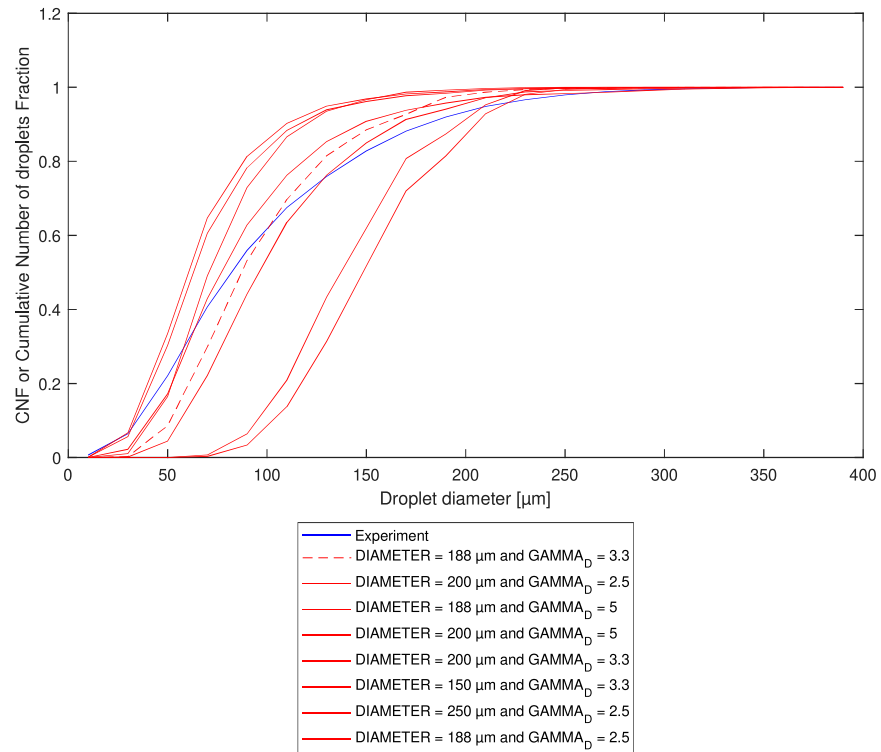


Figure 4: Multiple size distributions measured at 50 cm below the nozzle



## Velocity distributions

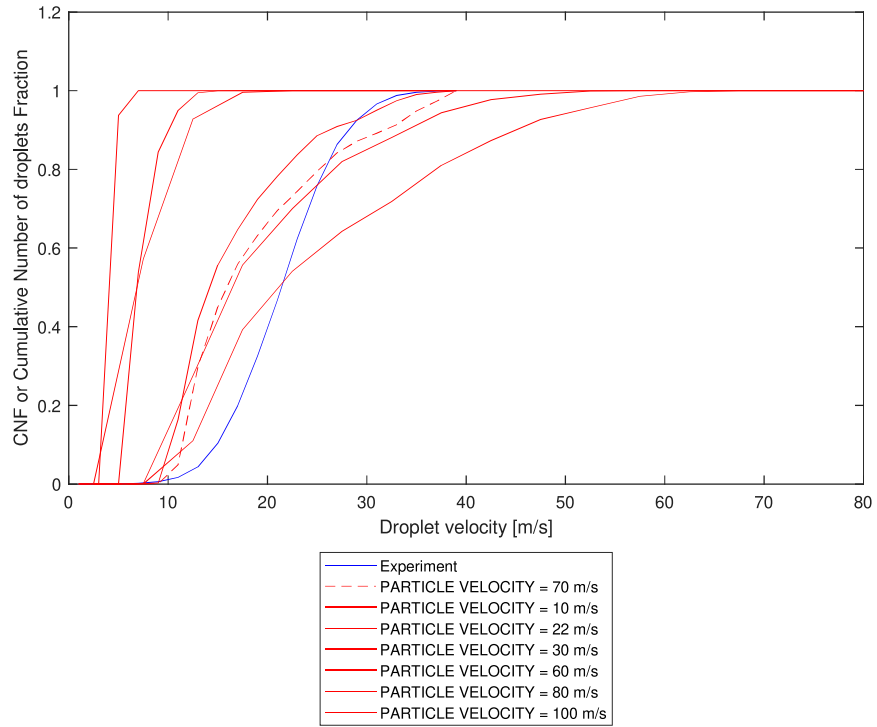


Figure 5: Multiple velocity distributions with different initial velocity out the nozzle measured at 50 cm below the nozzle