Drying Laundry in a Bathroom

Dew condensation and evaporation analysis is performed with consideration on moisture absorption and desorption properties of solid

Setting of Absorption and Desorption Properties

Absorption/desorption properties are...

Amount of moisture to change humidity (absolute humidity) of a solid and amount of moisture to change temperature of a solid.
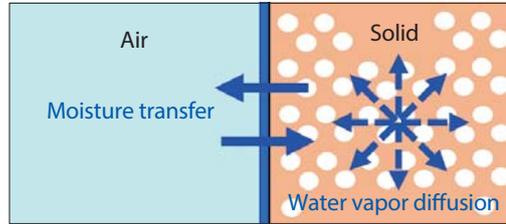

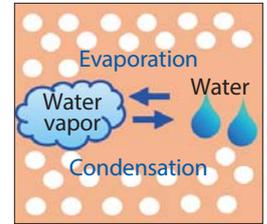Figure 1: Humidity in a solid

Figure 2: Moisture absorption and desorption in a solid

As shown in Figure 1, assume a solid in a dry state with voids (porous medium). Moisture in solid transfers when water permeates in the solid and water vapor diffuses. At the same time, a phase change between water vapor and water occurs inside the solid as shown in Figure 2. Since heat generation and absorption corresponding to latent heat due to the phase change affects the phenomenon, transfer of moisture and heat in the solid requires to be simulated in a coupled analysis. The setting of absorption/desorption properties of solid is needed to perform this coupled analysis.

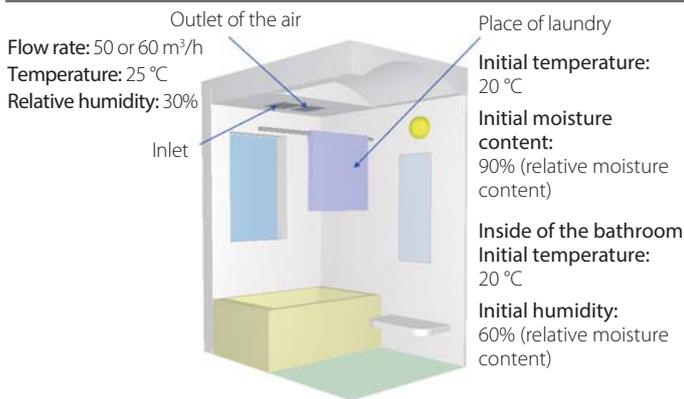## Analysis of Laundry Drying System in a Bathroom

Analysis Model

Outlet of the air

Place of laundry

Flow rate: 50 or 60 m³/h
Temperature: 25 ℃
Relative humidity: 30%

Inlet

Initial temperature:
20 ℃

Initial moisture content:
90% (relative moisture content)

Inside of the bathroom
Initial temperature:
20 ℃

Initial humidity:
60% (relative moisture content)

Figure 3: Laundry drying system in the bathroom

Laundry	126 cm long × 60 cm wide × 1cm thick, hung from the horizontal bar near ceiling
Porosity	0.4 (dry state)
Density	1.30 kg/m³
Specific heat	1.15 kJ/(kg•K)
Thermal conductivity	0.086 W/(m•K)
Moisture conductivity	$5.0×10^{-6}$ kg/(m•s (kg/kgDA))[*1]
Amount of moisture to change absolute humidity	$5.0×10^{3}$ kg/(m³ (kg/kgDA))[*1]
Amount of moisture to change temperature	2.5 kg/(m³ K)

[*1]   DA: Short for Dry Air
kg/kgDA: Unit of absolute humidity

Analysis Resuts

Temperature distribution on laundry surface and the middle cross section

Relative humidity distribution on laundry surface

Air flow rate at outlet 50m³/h
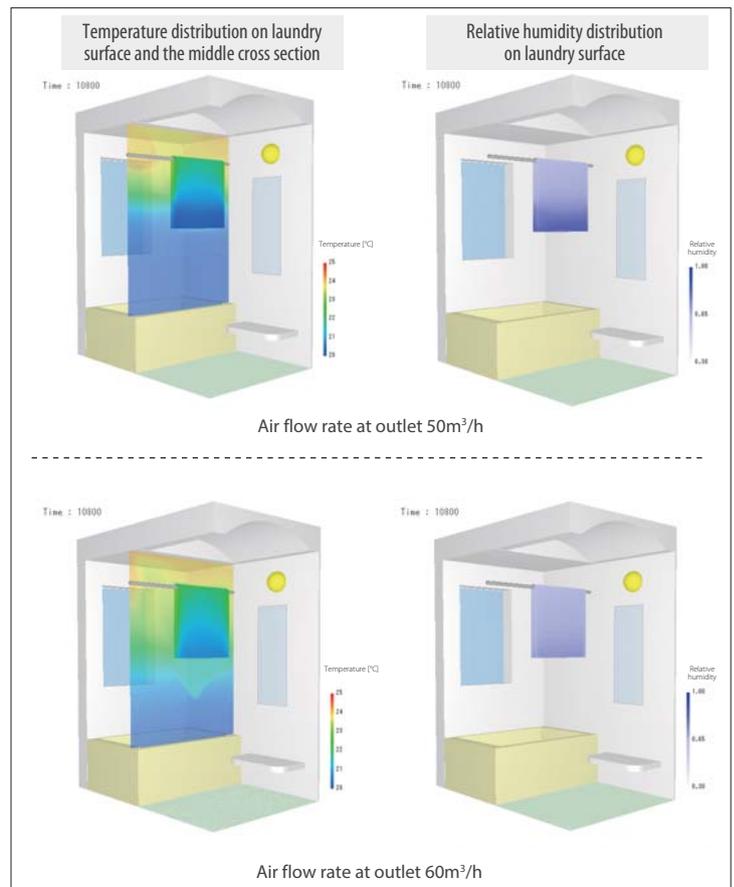
Air flow rate at outlet 60m³/h

Figure 4: Analysis results (1.5 hour). Air flow rate at outlet50m³/h (top), 60m³/h (bottom)

Notes

Laundry dried by the drying system in a bathroom is well simulated. A larger flow rate of the air helps the laundry dry faster.