MaterialProperty:PhaseChange**Hysteresis**

This object is used to describe the temperature dependent material properties that are used in the Conduction Finite Difference solution algorithm for the material property phase change hysteresis object. This model is initiated when the solution algorithm parameter for the building, surface or construction is set to ConductionFiniteDifference and appropriate materials are specified in a construction and the material property phase change hysteresis object is included. This permits simulating temperature dependent thermal conductivity and phase change materials (PCM’s) in EnergyPlus.

***Field: Name***

This field is a regular name of the material which exhibits variable thermo physical properties associated with it.

***Field: Temperature Coefficient of Thermal Conductivity***

This field is used to enter the temperature dependent coefficient for thermal conductivity of the material. See engineering reference for details.

***Field: Latent Heat of Fusion***

This field is used to specify the latent heat involved during the melting of phase change material. See engineering reference for details.

***Field: Liquid State Specific Heat***

The specific heatof the material in its liquid state is specified in this field.

***Field: Melting Curve High Temperature Difference***

This field is the temperature difference between the high end of melting process and the peak melting temperature. See engineering reference for details.

***Field: Peak Melting Temperature***

This field specifies the temperature at which peak melting of PCM occurs. See engineering reference for details.

***Field: Melting Curve Low Temperature Difference***

This is the temperature range between the low end of the melting process and the peak melting temperature. See engineering reference for details.

***Field: Latent Heat of Solidification***

This field specifies the latent heat involved during the freezing of phase change material.

***Field: Solid State Specific Heat***

The specific heatof the material in its solid state is specified in this field.

***Field: Freezing Curve High Temperature Difference***

This field is the temperature difference between the high end of freezing process and the peak freezing temperature. See engineering reference for details.

***Field: Peak Freezing Temperature***

This field specifies the temperature at which the PCM is at its peak freezing temperature.

***Field: Freezing Curve Low Temperature Difference***

This is the temperature range between the low end of freezing process and the peak freezing temperature. See engineering reference for details.

Note, the following Heat Balance Algorithm is necessary (only specified once).

Also, when using ConductionFiniteDifference, it is more efficient to set the zone timestep shorter than those used for the ConductionTransferFunction solution algorithm. It should be set to 12 timesteps per hour or greater, and can range up to 60.

HeatBalanceAlgorithm,

ConductionFiniteDifference;

Timestep,

20;

Material,

Name PCM\_Q23

Roughness VeryRough

Thickness 0.011176

Conductivity 0.2

Density 235

Specific Heat 1970

Thermal Absorptance 0.9

Solar Absorptance 0.1

Visible Absorptance 0.5

Below is an example input for the Material Property Phase Change Dual Curve object.

MaterialProperty:PhaseChangeDualCurve,

Name PCM\_Q23

Temperature Coefficient for Thermal Conductivity 0

Latent Heat of Fusion 200000

Liquid State Specific Heat 2000

High Temperature Difference of Melting Curve 1

Peak Melting Temperature 24

Low Temperature Difference of Melting Curve 1

Latent Heat of Solidification 200000

Solid State Specific Heat 2000

High Temperature Difference of Freezing Curve 1

Peak Freezing Temperature 22

Low Temperature Difference of Freezing Curve 1

Output variables:

***CondFD Surface Heat Flux [W/m2]***

Sum of Heat flows at the surface to air interface, heat flux density of the entire surfaces being simulated with ConductionFiniteDifference. The value is the sum of convection, radiation and conduction of the surface to the conditioned space in the direction of the inward normal. A Positive value indicates the surface heat gain contribution to the zone and a negative value indicates the surface heat removal from the zone.

***CondFD Surface Temperature Node <X> [C]***

This will output temperatures for a node in the surfaces being simulated with ConductionFiniteDifference. The key values for this output variable are the surface name. The nodes are numbered from outside to inside of the surface. Full numbered node listing available in RDD file after a simulation has been run.

***CondFD Surface Phase Change State Node <X> []***

This is an Integer variable that reports the five potential values of; -2, -1, 0, 1 and 2, representing the physical state of the PCM averaged for the reporting frequency. Results are most useful in hourly or detailed reporting frequencies. The key values for this output variable are the surface name. The nodes are numbered from outside to inside of the surface. Full numbered node listing available in RDD file after a simulation has been run.

Each number stands for the following specific processes:

-2: Completely liquid

-1: Melting Process in progress

0: Transition process is in progress between freezing and melting or vice versa.

1: Freezing process in progress

2: Completely solid

Below is an RDD example of output variables.

Zone,Average,Variable,\*,CondFD Surface Temperature Node <X>; [C]

Zone,Average,Variable,\*,CondFD Surface Phase Change State Node <X>; []

The following shows the Input Data Dictionary description of Material Property Phase Change Hysteresis object.

MaterialProperty:PhaseChangeHysteresis,

\memo Additional properties for temperature dependent thermal conductivity

\memo and enthalpy for Phase Change Materials (PCM) using a dual curve modelling method.

\memo HeatBalanceAlgorithm = CondFD(ConductionFiniteDifference) solution algorithm only.

\memo Constructions with this should use the detailed CondFD process.

\memo Has no effect with other HeatBalanceAlgorithm solution algorithms.

\unique-object

\format singleLine

A1, \field Name

\required-field

\type object-list

\object-list MaterialName

\note Regular Material Name to which the additional properties will be added.

\note this the material name for the basic material properties.

N1 , \field Temperature Coefficient for Thermal Conductivity

\note The base temperature is 20C.

\note This is the thermal conductivity change per degree excursion from 20C.

\note This variable conductivity function is overridden by the VariableThermalConductivity object, if present.

\units W/m-K2

\type real

\default 0.0

N2 , \field Latent Heat of Fusion

\required-field

\units J/kg

\type real

N3 , \field Liquid State Specific Heat

\required-field

\units J/kg-K

\type real

N4 , \field High Temperature Difference of Melting Curve

\note The total melting range of the material is the sum of low and high temperature difference of melting curve.

\required-field

\units deltaC

\type real

N5 , \field Peak Melting Temperature

\required-field

\units C

\type real

\note Must be different than Peak Freezing Temperature for hysteresis functions

N6 , \field Low Temperature Difference of Melting Curve

\note Note: The total melting range of the material is the sum of low and high temperature difference of melting curve.

\required-field

\units deltaC

\type real

N7 , \field Latent Heat of Solidification

\required-field

\units J/kg

\type real

N8 , \field Solid State Specific Heat

\required-field

\units J/kg-K

\type real

N9 , \field High Temperature Difference of Freezing Curve

\note The total freezing range of the material is the sum of low and high temperature difference of freezing curve.

\required-field

\units deltaC

\type real

N10 , \field Peak Freezing Temperature

\required-field

\units C

\type real

\note Must be different than Peak Melting Temperature for hysteresis functions

N11 ; \field Low Temperature Difference of Freezing Curve

\note The total freezing range of the material is the sum of low and high temperature difference of freezing curve.

\required-field

\units deltaC

\type real