TYPE 643: SIMPLE FURNACE / AIR HEATER

General Description

Much like Type6 does for fluids, Type643 represents an air heating device that can be controlled either externally, or set to automatically try and attain a set point temperature. The furnace is bound by a heating capacity and an efficiency. Thermal losses from the furnace are based on the average air temperature. The outlet state of the air is determined by an enthalpy based energy balance that takes pressure effects into account.

Nomenclature

$h_{air,in}$	[kJ/kg.K]	Enthalpy of air entering the furnace.
$h_{air,out}$	[kJ/kg.K]	Enthalpy of air exiting the furnace.
$\dot{m}_{air}$	[kg/hr]	Mass flow rate of air (entering mass flow rate = exiting mass flow rate)
$\dot{q}_{\max}$	[kJ/hr]	Capacity of the furnace
$\dot{q}_{\eta}$	[kJ/hr]	Maximum heating rate of the furnace (accounting for efficiency effects)
UA	[kJ/K]	Overall thermal loss coefficient for the furnace.
$\overline{T}$	[C]	Average temperature of air in the furnace.
T_{env}	[C]	Temperature of the air surrounding the furnace (for loss calculations)

Detailed Description

The operation of Type643 is governed by the energy balance shown in Figure 1.

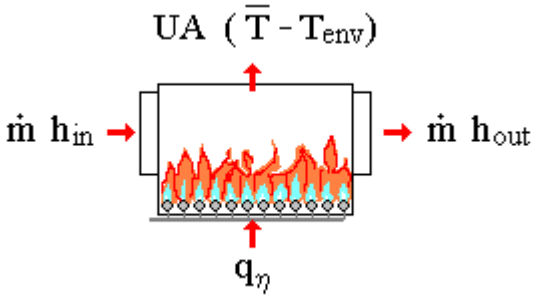


Figure 1: Furnace Energy Balance

Where h_{in} and h_{out} refer to the enthalpy of air entering and exiting the furnace, respectively. Thermal loss calculations are made based on the average temperature of air in the furnace and q_η is the capacity of the furnace multiplied by its overall efficiency. In other words, q_η is the amount of energy actually transferred from the fuel to the air in the furnace. The energy balance is written as shown in equation 643.1 so as to solve for the enthalpy of air exiting the furnace..

$$h_{air,out} = h_{air,in} + \frac{q_\eta}{\dot{m}} - \frac{UA}{\dot{m}}\left(\overline{T} - T_{env}\right) \qquad \text{(Eq. 643.1)}$$

Because the outlet temperature of the air is not initially known, Type643 uses an iterative process to arrive at the exiting air condition. The enthalpy of entering air is calculated and returned by the TRNSYS PSYCHROMETRICS routine whereupon the equation 643.1 energy balance is solved first guessing that the inlet and outlet air temperatures are equal. The resulting outlet enthalpy is passed back to the PSYCHROMETRICS routine, which in turn returns a new outlet air temperature. The new outlet air temperature is used to modify the energy balance, affecting both the thermal loss term and the energy exiting through the air stream. Iteration continues until the temperature of outlet air returned from PSYCHROMETRICS changes less than 0.01 ºC. This default tolerance may be modified in the Type643 source code if desired.

Type643 also accounts for air pressure drop across the furnace. The pressure drop is applied to the air outlet conditions whether or not the furnace is in operation and whether or not air is flowing. The assumption that pressure drop occurs without regard to flow is made so that TRNSYS is better able to converge upon a solution when a system starts up. Users wishing to ignore pressure effects should simply set the pressure drop parameter to zero.