TYPE 666: WATER COOLED CHILLER

General Description

Type666 models a vapor compression style water cooled chiller. It relies on catalog data provided as external text files to determine chiller performance. Example data files and information on data file format are provided.

Nomenclature

COP_{nom}	[-]	Chiller nominal Coefficient of Performance at current conditions.
COP_{rated}	[-]	Chiller rated Coefficient of Performance at current conditions.
COP_{ratio}	[-]	Chiller COP at current conditions divided by the rated COP.
$Capacity$	[kJ/hr]	Chiller capacity at current conditions.
$Capacity_{rated}$	[kJ/hr]	Chiller rated capacity.
$Capacity_{ratio}$	[kJ/hr]	Chiller capacity at current conditions divided by the rated capacity.
$\dot{Q}_{load}$	[kJ/hr]	Current load on the chiller.
$\dot{Q}_{met}$	[kJ/hr]	Load met by the chiller.
$\dot{Q}_{rejected}$	[kJ/hr]	Energy rejected by the chiller to the ambient.
$\dot{m}_{chw}$	[kg/hr]	Flow rate of fluid entering the chilled fluid stream.
Cp_{chw}	[kJ/kg.K]	Specific heat of fluid entering the chilled fluid stream.
$\dot{m}_{cw}$	[kg/hr]	Flow rate of fluid entering the cooling fluid stream.
Cp_{cw}	[kJ/kg.K]	Specific heat of fluid entering the cooling fluid stream.
$T_{chw,set}$	[ºC]	Desired outlet temperature of fluid in the chilled fluid stream.
$T_{chw,in}$	[ºC]	Temperature of fluid entering the chilled fluid stream.
$T_{chw,out}$	[ºC]	Temperature of fluid exiting the chilled fluid stream.
PLR	[0..1]	Chiller Part Load Ratio (the ratio of the current load to the rated load).
P	[kJ/hr]	Power drawn by the chiller at current conditions.
$FFLP$	[0..1]	Fraction of full load power.

Detailed Description

Type666 relies on a catalog data lookup method to predict the performance of a vapor compression style water cooled chiller. These devices cool a fluid stream on the evaporator side while rejecting heat to a second fluid stream on the condenser side. The fluid stream being cooled is referred to as the chilled water stream while the stream to which energy is rejected is referred to as the cooling fluid stream. Because of the data lookup approach, this component may be equally well used to model single and multi stage chillers. To set up the model, the user must provide two text based data files in the standard TRNSYS data file format[1]. The first of these files provides the chiller's capacity ratio (dimensionless)

[1] Please see Appendix 1 of the TESS Component Library Manual for more information on the standard TRNSYS data format.

and the chiller's COP ratio (dimensionless) for varying values of chilled water set point temperature (in ºC), and for varying entering cooling water temperatures (in ºC). The second data file provides values of the chiller's fraction of full load power for varying values of part load ratio. A schematic diagram showing a single stage water cooled chiller is shown in Figure 1.

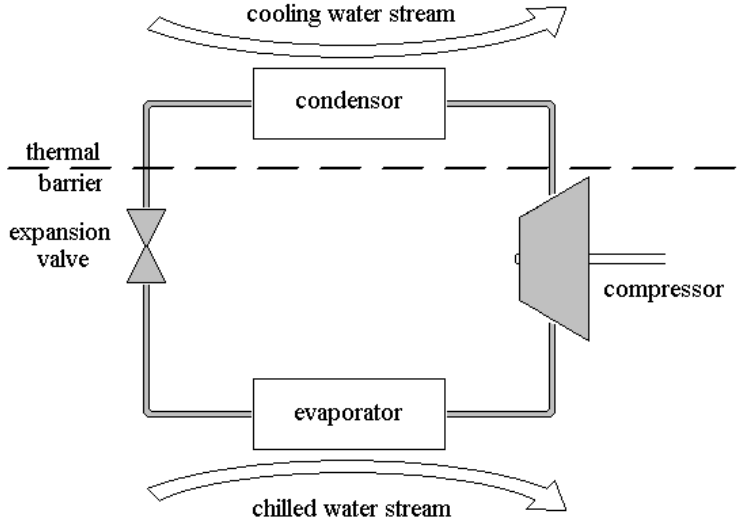


Figure 1: Schematic Diagram of a Single Stage Water Cooled Chiller

At a given time step, Type666 first performs a call to the TRNSYS DynamicData routine with the current cooling water (sink) temperature and the chilled water set point temperature, obtaining in return the COP ratio and capacity ratio for those conditions. The chiller's nominal COP is calculated using Equation 666.1 and the capacity at current conditions is calculated using Equation 666.2. The implicit assumption in the first call to DynamicData is that the chiller is running at full load.

$$COP_{nom} = COP_{rated} * COP_{ratio} \quad \text{(Eq. 666.1)}$$

$$Capacity = Capacity_{rated} * Capacity_{ratio} \quad \text{(Eq. 666.2)}$$

The chiller load is calculated by equation 666.3.

$$\dot{Q}_{load} = \dot{m}_{chw} * Cp_{chw}\left(T_{chw,in} - T_{chw,set}\right) \quad \text{(Eq. 666.3)}$$

The PLR (part load ratio) is therefore:

$$PLR = \frac{\dot{Q}_{load}}{Capacity} \quad \text{(Eq. 666.4)}$$

If the calculated PLR is greater than unity, Type666 automatically limits the load met by the chiller to the capacity of the machine. With a valid PLR calculated (between 0 and 1), the DynamicData routine is called again, this time specifying the second data file. The resulting value is the fraction of full load capacity for the current conditions. The chiller's power draw is given by

$$P = \frac{Capacity}{COP_{nom}} FFLP \qquad \text{(Eq. 666.5)}$$

A corrected COP is then calculated as:

$$COP = \frac{\dot{Q}_{met}}{P} \qquad \text{(Eq. 666.6)}$$

The energy rejected to the cooling fluid stream by the device is therefore:

$$\dot{Q}_{rejected} = \dot{Q}_{met} + P \qquad \text{(Eq. 666.7)}$$

and the outlet temperature of the chilled fluid stream is:

$$T_{chw,out} = T_{chw,in} - \frac{\dot{Q}_{met}}{\dot{m}_{chw} Cp_{chw}} \qquad \text{(Eq. 666.8)}$$

while the outlet temperature of the cooling fluid stream is

$$T_{chw,out} = T_{cw,in} - \frac{\dot{Q}_{rejectedt}}{\dot{m}_{cw} Cp_{cw}} \qquad \text{(Eq. 666.9)}$$

Example data files are provided in the Catalog_Data\WCCs\Sample directory. The format of the data files is shown below for reference.

Example Capacity Ratio and COP Ratio Data File

```
4.44    5.56    6.67    7.78    8.89    10.              ! Chilled Water Temperatures (C)
15.56   21.11   26.67   29.44   35      40.56            ! Cooling Water Inlet Temperatures (C)
 1.0292          1.3000                          ! Capacity Ratio and COP (All Power) Ratio at 4.44/15.56
 1.0599          1.3313                          ! Capacity Ratio and COP (All Power) Ratio at 4.44/21.11
 1.0898          1.3614                          ! Capacity Ratio and COP (All Power) Ratio at 4.44/26.67
 1.1065          1.3777                          ! Capacity Ratio and COP (All Power) Ratio at 4.44/29.44
 1.1309          1.4019                          ! Capacity Ratio and COP (All Power) Ratio at 4.44/35
 1.1553          1.4274                          ! Capacity Ratio and COP (All Power) Ratio at 4.44/40.56
 1.0070          1.1701                          ! Capacity Ratio and COP (All Power) Ratio at 5.56/15.56
 1.0383          1.2016                          ! Capacity Ratio and COP (All Power) Ratio at 5.56/21.11
 1.0696          1.2329                          ! Capacity Ratio and COP (All Power) Ratio at 5.56/26.67
 1.0857          1.2475                          ! Capacity Ratio and COP (All Power) Ratio at 5.56/29.44
 1.1093          1.2709                          ! Capacity Ratio and COP (All Power) Ratio at 5.56/35
 1.1337          1.2948                          ! Capacity Ratio and COP (All Power) Ratio at 5.56/40.56
 0.9742          1.0463                          ! Capacity Ratio and COP (All Power) Ratio at 6.67/15.56
 1.0063          1.0776                          ! Capacity Ratio and COP (All Power) Ratio at 6.67/21.11
 1.0376          1.1070                          ! Capacity Ratio and COP (All Power) Ratio at 6.67/26.67
 1.0536          1.1230                          ! Capacity Ratio and COP (All Power) Ratio at 6.67/29.44
 1.0766          1.1443                          ! Capacity Ratio and COP (All Power) Ratio at 6.67/35
 1.1003          1.1662                          ! Capacity Ratio and COP (All Power) Ratio at 6.67/40.56
 0.9380          0.9422                          ! Capacity Ratio and COP (All Power) Ratio at 7.78/15.56
 0.9694          0.9711                          ! Capacity Ratio and COP (All Power) Ratio at 7.78/21.11
 1.0000          1.0000                          ! Capacity Ratio and COP (All Power) Ratio at 7.78/26.67
 1.0188          1.0188                          ! Capacity Ratio and COP (All Power) Ratio at 7.78/29.44
 1.0425          1.0416                          ! Capacity Ratio and COP (All Power) Ratio at 7.78/35
 1.0669          1.0650                          ! Capacity Ratio and COP (All Power) Ratio at 7.78/40.56
 0.9150          0.8456                          ! Capacity Ratio and COP (All Power) Ratio at 8.89/15.56
 0.9464          0.8717                          ! Capacity Ratio and COP (All Power) Ratio at 8.89/21.11
 0.9784          0.8991                          ! Capacity Ratio and COP (All Power) Ratio at 8.89/26.67
 0.9958          0.9136                          ! Capacity Ratio and COP (All Power) Ratio at 8.89/29.44
 1.0195          0.9345                          ! Capacity Ratio and COP (All Power) Ratio at 8.89/35
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 1.0432          0.9547                    ! Capacity Ratio and COP (All Power) Ratio at 8.89/40.56
 0.8809          0.7493                    ! Capacity Ratio and COP (All Power) Ratio at 10/15.56
 0.9130          0.7737                    ! Capacity Ratio and COP (All Power) Ratio at 10/21.11
 0.9457          0.7990                    ! Capacity Ratio and COP (All Power) Ratio at 10/26.67
 0.9624          0.8125                    ! Capacity Ratio and COP (All Power) Ratio at 10/29.44
 0.9854          0.8301                    ! Capacity Ratio and COP (All Power) Ratio at 10/35
 1.0084          0.8475                    ! Capacity Ratio and COP (All Power) Ratio at 10/40.56
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Example PLR Data File

```
0.0  0.25  0.50  0.75  1.00                          ! Part Load Ratio
0.0000                                  ! Fraction of Full Load Power at PLR=0.00
0.2497                                  ! Fraction of Full Load Power at PLR=0.25
0.4956                                  ! Fraction of Full Load Power at PLR=0.50
0.6902                                  ! Fraction of Full Load Power at PLR=0.75
1.0000                                  ! Fraction of Full Load Power at PLR=1.00
```