Application Note

Improving FAN Control on Cooling Towers

VLT® 6000 HVAC

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■ The Application

Cooling Tower Fans are used to cool condenser water in water cooled chiller systems. Water cooled chillers provide the most efficient means of creating chilled water. They are as much as 20% more efficient than air cooled chillers. Depending on climate, Cooling towers are often the most energy efficient method of cooling the condenser water from chillers.
They cool the condenser water by evaporation.

The condenser water is sprayed into the cooling tower onto the cooling towers “fill” to increase its surface area. The tower fan blows air through the fill and sprayed water to aid in the evaporation. Evaporation removes energy from the water dropping its temperature. The cooled water collects in the cooling towers basin where it is pumped back into the chillers condenser and the cycle is repeated.

■ The Design

In an attempt to conserve energy and improve control, the traditional systems utilized On/Off control, two speed motors, and sometimes adjustable pitch blade fans. On/Off control can be used with one cell or tower, or with multiple cells. Based on the temperature of the condenser water leaving the cooling tower, fans can be turned on or off. To limit the number of times the fan motors are cycled on and off, wide temperature bands are established. When the temperature exceeds the high limit, a fan is staged on, and then staged off upon reaching the low temperature limit.
The systems load on the chiller and the outside wetbulb temperature determine the cooling towers operation profile. As the wetbulb temperature or system load decreases, the required speed of the cooling tower fan also decreases.

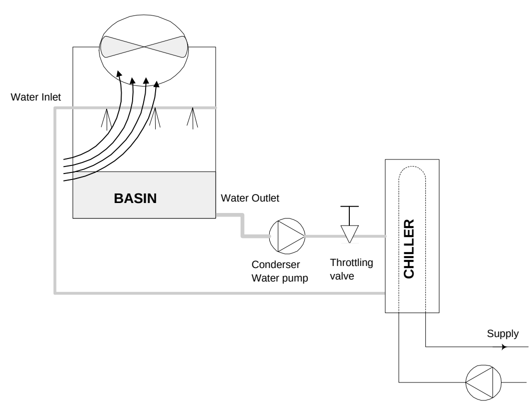

Fig. 1

■ The new standard

With a VLT frequency converter, the cooling towers fans can be controlled to the required speed to maintain the condenser water temperature. VLT frequency converters can also be used to turn the fan on and off as needed.

Several features of Danfoss' HVAC dedicated drive, the VLT 6000 HVAC can be utilized to improve the performance of your cooling tower fans application. As the cooling tower fans drop below a certain speed, the effect the fan has on cooling the water becomes small. Also, when utilizing a gear-box to VLT frequency converter the tower fan, a minimum speed of 40-50% may be required.

The customer programmable minimum frequency seting of the VLT is available tol maintain this minimum frequency even as the feedback or speed reference calls for lower speeds.

Also as a standard feature, you can program the VLT frequency converter to enter a “sleep” mode and stop the fan until a higher speed is required. Additionally, some cooling tower fans have undesireable frequencies that may cause vibrations. These frequencies can easily be avoided by programming the bypass frequency ranges in the VLT frequency converter.

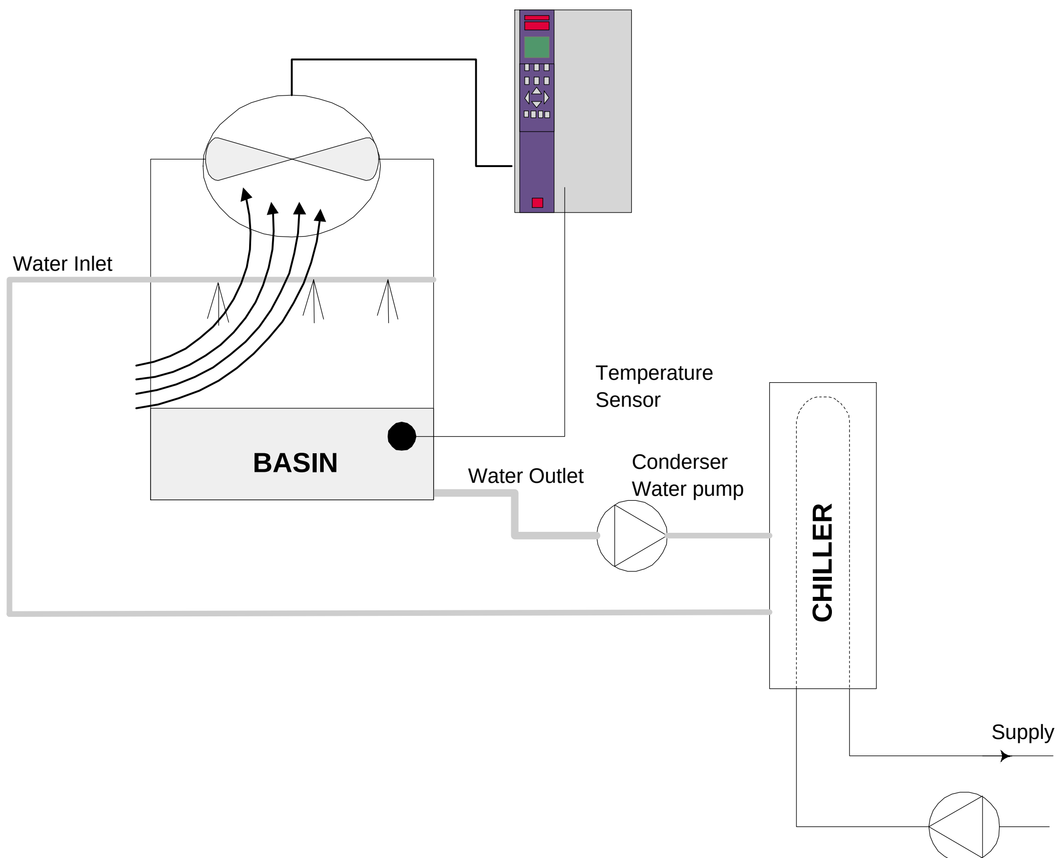

Fig. 2
Cooling Tower system with VLT frequency converters

■ Annual operation load profile

To calculate your potential savings, one must look at the actual load profile.
The load profile indicates the amount of flow the system requires to satisfy its loads during the typical day or time period under study. Figure 3 shows a typical load profile for a cooling tower. This profile will vary depending on the specific needs of each system due to location and other factors, but is representative of normal systems.

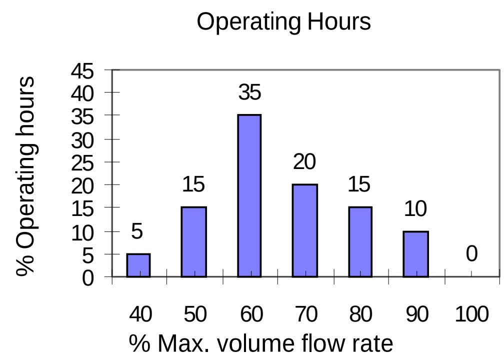

Fig. 3 Load Profile

■ Energy saving calculation example

In the following calculation example a 30 kW fan is operated according to the load profile shown in fig. 3. The energy consumption during one year running time is calculated for a cooling tower fan either with 2-speed motor (2/3, full speed) or a VLT frequency converter. The comparison shows energy savings of over 86%.

Flow (%)	Hours (%)	Hours run	Power Consumption (kW)		Energy input for 30 kW Pump motor	
			2-speed motor	VLT 6000 HVAC	2-speed motor	VLT 6000 HVAC
40	5	438	12,80	2,67	5606	1169
50	15	1314	12,80	4,83	16819	6347
60	35	3066	12,80	7,85	39245	24068
70	20	1752	30,00	11,93	52560	20901
80	15	1314	30,00	17,27	39420	22693
90	10	876	30,00	24,16	26280	21164
100	0	0	0,00	0,00	0	0
	100%	8760 Hours			179930 kWh	96342 kWh

■ Sensor Type And Placement

The energy savings capabilities of a properly installed VLT frequency converter system is well known. In the case of cooling towers, the sensor placement and control is simple in normal systems. A temperature sensor should be located in the towers basin or the condenser pumps return line.
The ideal temperature varies with each installation and should be calculated. The efficiency of a water cooled chiller varies with the condenser water return temperature; the cooler the return temperature, the more efficient the chiller. However, the energy consumption of the chiller needs to be compared to the energy consumption of the tower fans and condenser pumps required to optimize system efficiency.

Once the optimum temperature has been determined, the drive can be used to maintain this temperature as the systems load and conditions modulate.

■ Comparison of installation and maintenance costs

The 2-speed motor system requires a pole changing motor (Dahlander motor or with separate windings), a suitable switchgear, 6-wire motor cable and power factor correction. A controller is necessary to switch the motor poles. Frequent switching from one speed to another must be avoided.

Utilizing a Danfoss VLT frequency converter makes the controller, power factor corrections and extensive cablework superfluous. A simple voltage (0...10V) or current (0/4...20 mA) feedback from a temperature sensor is sufficient to vary the flow.

High starting currents and peaks, like when switching poles, disappear from your energy bill and the stress on motor, bearings and beltdrives is reduced considerably. Maintenance is limited to a minimum and installation costs and space can be saved.
Falling expenses for electronic equipment and increasing costs for labour have brought the investments for both regulation methods to a similar level. The comparison of energy consumption shows why the utilization of VLT frequency converters is doubtless the better choice.

MN.60.C1.02 - VLT is a registered Danfoss trademark

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