Chilled Water Coil Freeze Protection via Internal Drying

Using system air to blow-dry the tubes of chilled water coils provides a fail-safe winterizing method

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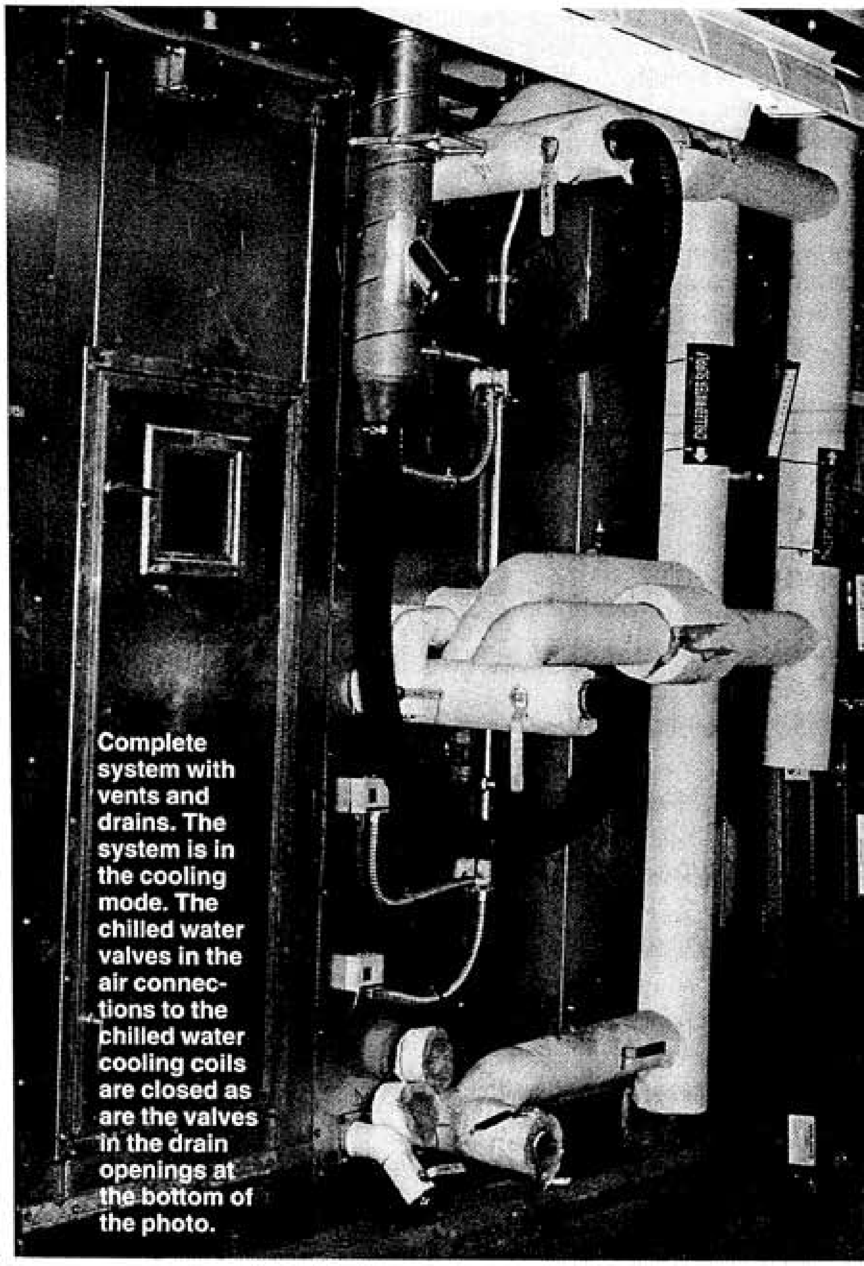


Complete system with vents and drains. The system is in the cooling mode. The chilled water valves in the air connections to the chilled water cooling coils are closed as are the valves in the drain openings at the bottom of the photo.

Winter lay-up for chilled water coils has been a problem for as long as there has been air conditioning. A frozen coil may be so seriously damaged that it must be replaced. Also, as the coil thaws, significant flooding of adjacent areas may result.

Over the years, various methods of freeze protection have been used. These methods include using a glycol solution to lower the freezing point, blowing the coil clear with compressed air, or installing coils that incorporate freeze plugs in the coil design. Each of these methods has one or more significant drawbacks.

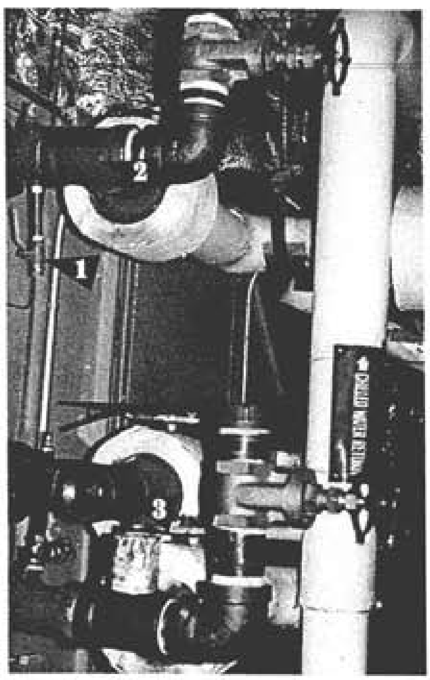
- Using glycol has several disadvantages, including:
  - The cost of the glycol.
  - The labor involved in handling, mixing, and disposing of the glycol.
  - The environmental aspects of glycol disposal.

- The human safety factor and associated workers compensation costs.
- The inability to place a cooling coil quickly back in service if the weather warms up unexpectedly.
- Blowing coils clear with compressed air requires an expensive equipment investment. It is also labor intensive, requiring moving the air compressor from coil to coil and connecting and disconnecting it at each location.
- Installing new coils having freeze plugs does not protect the thousands of existing coils presently in service.

The LaRocca Solution

A new approach, nicknamed "The LaRocca Solution" by my coworkers, is a simple procedure. Air is blown continuously through the coils to ensure that they become completely dry and remain so. Instead of using a separate

continued on page 70



AHU in the process of modification. Arrow 1 shows the original 1/2-in. drain. Arrow 2 shows a 2-in. tee, installed in place of original 90 deg ell, for a vent line connection. Arrow 3 shows a 2-in. tee installed for a drain and awaiting installation of a valve.

New method of winterizing cooling coils without using ethylene glycol

Traditionally during winter operation, the cooling coils in air handling units would be drained and filled with ethylene glycol to guard against freezing. Ethylene glycol is an environmental hazard, and our goal was to reduce the amount of ethylene glycol used or eliminate its use completely. This newly devised method prevents cooling coils from freezing by using air from the supply fan to blow dry the coil chambers continually, thus eliminating the use of ethylene glycol. Following is the sequence of operation (Figs. 1 and 2).

General procedure

During the summer, the chilled water (12 and 13) is circulating through the cooling coils (11), cooling the air (24), which will be delivered to the spaces via the main supply duct (10):

- Volume dampers (21) are closed.
- Valves (14) on piping (15, 16, and 23) are closed.
- Valves (14) on chilled water piping (12 and 13) are open.

In preparation for the winter season, the chilled water is pumped out of the cooling coils (11):

- The cooling coils (11) are vented and drained by opening valves (14) on piping (15 and 16).
- Valves (14) on piping (12 and 13) are closed.
- Valves (14) on piping (15, 16, and 23) are open.

Using the conventional method

During the winter season:

- Valves (14) on the return pipes (22) are closed.
- Valves (14) on the supply pipes (22) are open, and ethylene glycol is pumped into the cooling coils (11) where it remains throughout the season.

In preparation for the summer season:

- Valves (14) on the supply pipes are closed.
- Valves (14) on the discharge pipes (22) are open, and ethylene glycol is pumped into the cooling coils (11) to be stored or discharged into the city waste line.
- Proceed with Item 1 from the general procedure section of this sequence.

Using the new method

During the winter season:

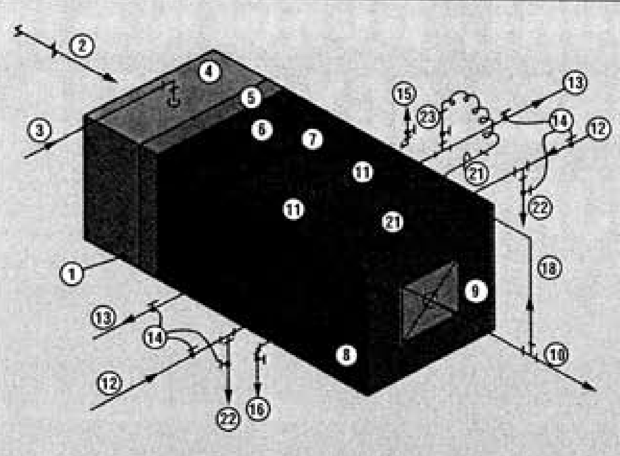
- Volume dampers (21) on supply air branches (19) and valves (14) on piping (22 and 23) are open, allowing the supply air to circulate through the cooling coils (11), preventing freeze-up.

In preparation for the summer season:

- Proceed with Item 1 from the general procedure section of this sequence.

The new method provides savings for the following:

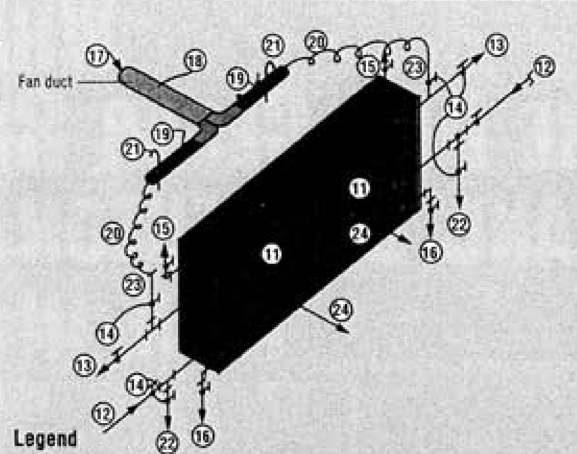
- Obtaining of ethylene glycol (approximately 1800 gal of glycol used to fill all the cooling coils).
- Storing of the ethylene glycol in barrels during the summer season.
- Discharging of the ethylene glycol to the city waste pipes.
- Man-hours and energy for pumping ethylene glycol into and out of the 92 air handling units yearly.
- Obtaining permits and permissions on a yearly basis from city officials.



Legend

1) Air handling unit (AHU) housing
2) Outside air entering the AHU
3) Return air from the spaces
4) Mixing box for the outside and return air
5) Filters
6) Heating coils
7) Humidifiers
8) Supply fan section
9) Discharge from the AHU
10) Main supply air duct from the AHU to the air conditioned spaces
11) Cooling coils with piping (see Fig. 2)

1 Typical AHU arrangement with added ducts, piping, and drains. (See Fig. 2 for continuation of the legend.)



Legend

11) Cooling coil—two typical, located inside the air handling unit
12) Chilled water supply piping to the cooling coils (2 in. diameter for this sketch)
13) Chilled water return piping from the cooling coils (2 in. diameter for this sketch)
14) Shutoff valves for the cooling coils piping (12 typical for this sketch)
15) 1/2 in. diameter vent pipe with valve (one per coil, two typical for this sketch)
16) 2 in. diameter maximum drain pipe with the valve from the cooling coil housing (one per coil, two typical)
17) Direction of the supply air inside the supply air duct
18) 6 in. diameter supply air duct from the main supply duct out of the air handling unit
19) 4 in. diameter supply air branches to the cooling coils (two typical)
20) 3 in. diameter flexible ducts (two typical, one per coil)
21) Volume damper-type "blast gate" (two typically located on the 4 in. supply air branches)
22) 2 in. discharge pipe with the valve (two typical, one per coil)
23) 2 in. diameter pipe for the supply air (or glycol) to the cooling coil (two typical, one per coil)
24) Direction of the conditioned air through the coils

2 Detail of coil piping and valving with the air ducts for blowing out the coil during winterizing, piping, and drains.

continued from page 68

blower or air compressor to blow out the water, the supply fan itself is used. On most medium- and high-pressure HVAC systems, the static pressure produced by the supply fan is sufficient to overcome the internal resistance of the coil tubes. We simply configure the chilled water piping in a manner that permits the coils to be drained by gravity and then purged by the discharge of the fan. The fan does all the work.

Each system has its own characteristics, but the procedure is generally the same. Usually, there are chilled water supply and return mains. There are also supply and return headers for each coil. Both headers should have drains and/or vents, depending on the position of the coil inlet and outlet.

Each branch line connecting the mains to the headers must have a full-size drain or vent pipe and valve on the coil side of the main isolation valves. It is these branch valves that are connected to the discharge ductwork of the fan. The main isolation valves are closed. Then, after the coils are gravity drained, the branch valves to the fan discharge are opened. The fan pushes out any water that did not drain by gravity. After a few days of "gurgling," the coil is bone dry.

To begin the winter lay-up process using this method, one must first isolate and completely drain the cooling coil. Allow enough time to make sure the main isolation valves are not leaking. (This is a critical step in all winter lay-up methods.) After proving that the main isolation valves are not leaking, connect the supply fan discharge to the newly installed branch valve on the chilled water return header (Fig. 1). Water should start running out of the newly installed valves on the chilled water supply header (Fig. 2). It may take up to three days before the water stops draining. After a week or so, the coil is dry. Self-draining coils aid the process.

We have successfully used this method on a small pilot basis over the past two years. One air handling unit (AHU) was thus winterized for one winter, another for two. As this article was being prepared for publication (October 1997), many of the 97 AHUs in our facility were scheduled to be laid-up for winter in this manner. Table 1 shows the cost/benefit analysis. We expect to realize an annual saving of $32,880 ultimately. This is from a one-time investment totaling $153,000 when all AHUs are modified so that their cooling coils will be drained and dry during the winter.

Summary

This new winterizing method saves time and money. First and foremost, by eliminating the use

continued on page 72

TABLE 1—Cost-benefit analysis for modified cooling coil freeze protection, comparing a "traditional method" (using glycol solution) with a "new method" (without glycol solution).

Task	Time to complete task, man-hr: Small AHU	Time to complete task, man-hr: Large AHU	Labor cost, $ per man-hr: Any size AHU	Cost per AHU per year, traditional method, $: Small AHU	Cost per AHU per year, traditional method, $: Large AHU	Cost per AHU in first year, new method, $: Small AHU	Cost per AHU in first year, new method, $: Large AHU	Cost per AHU in subsequent years, new method, $: Small AHU	Cost per AHU in subsequent years, new method, $: Large AHU	Total cost per year, assuming 56 large AHUs (>10 gal) and 41 small AHUs, $: Traditional method	Total cost per year, New method: First year	Total cost per year, New method: Subsequent years
Preparation for winter (traditional and new method)—drain chilled water out of the cooling coils:	1	2	40	40	80	40	80	40	80	6,120	6,120	6,120
Purchase and storage of 1800 gal of glycol:				40	150					10,040		
Pump glycol solution into the cooling coils in the fall:	2	6	40	80	240					16,720		
Preparation for summer (traditional method)—pump out glycol solution from the cooling coils and slowly discharge it into the city sewer:	2	6	40	80	240					16,720		
Preparation for summer (new method)—close air valves and open chilled water valves:	1	4	40			40	160	40	160		10,600	10,600
Tools and equipment used for the different tasks:				10	15	10	15	10	15	1,250	1,250	1,250
Modifications for the new method:						1,000	2,000				153,000	
			Cost per year:	**250**	**725**	**1,090**	**2,255**	**90**	**255**	**50,850**	**170,970**	**17,970**

Advantages of using the new method:

- Preservation of the environment by complete elimination of the glycol use.
- Freeing the labor needed for other physical plant operations.
- A quick switchover from free cooling to mechanical cooling operation when necessary.
- A saving of $32,880 per year after less than 5 years of the payback period (based on $50,850 – $17,970).

continued from page 70

of glycol, there is no need to buy the product. Disposal issues and costs are therefore completely avoided. Next, labor costs are significantly reduced. There is no handling, measuring, or mixing. The seemingly endless hours of pumping (to ensure a good mix of glycol and water) are eliminated. Workers compensation costs are reduced as well. There is the added benefit of being able to place cooling coils back into service quickly should the weather turn unseasonably warm. Finally, while the intangible "good will" value in the minds of your clients is hard to measure, it is real as well. The LaRocca Solution is clearly a win-win situation all around. Good luck this winter! **HPAC**

Close-up view of a supply air duct-to-coil connection.

Questions or comments about this article may be directed to the author by phone at 203-785-6690.

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