Installation and Maintenance Manual IM 827-1

Group: **Applied Air Systems**
Part Number: **IM 827**
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Non-Chemical Water Treatment System

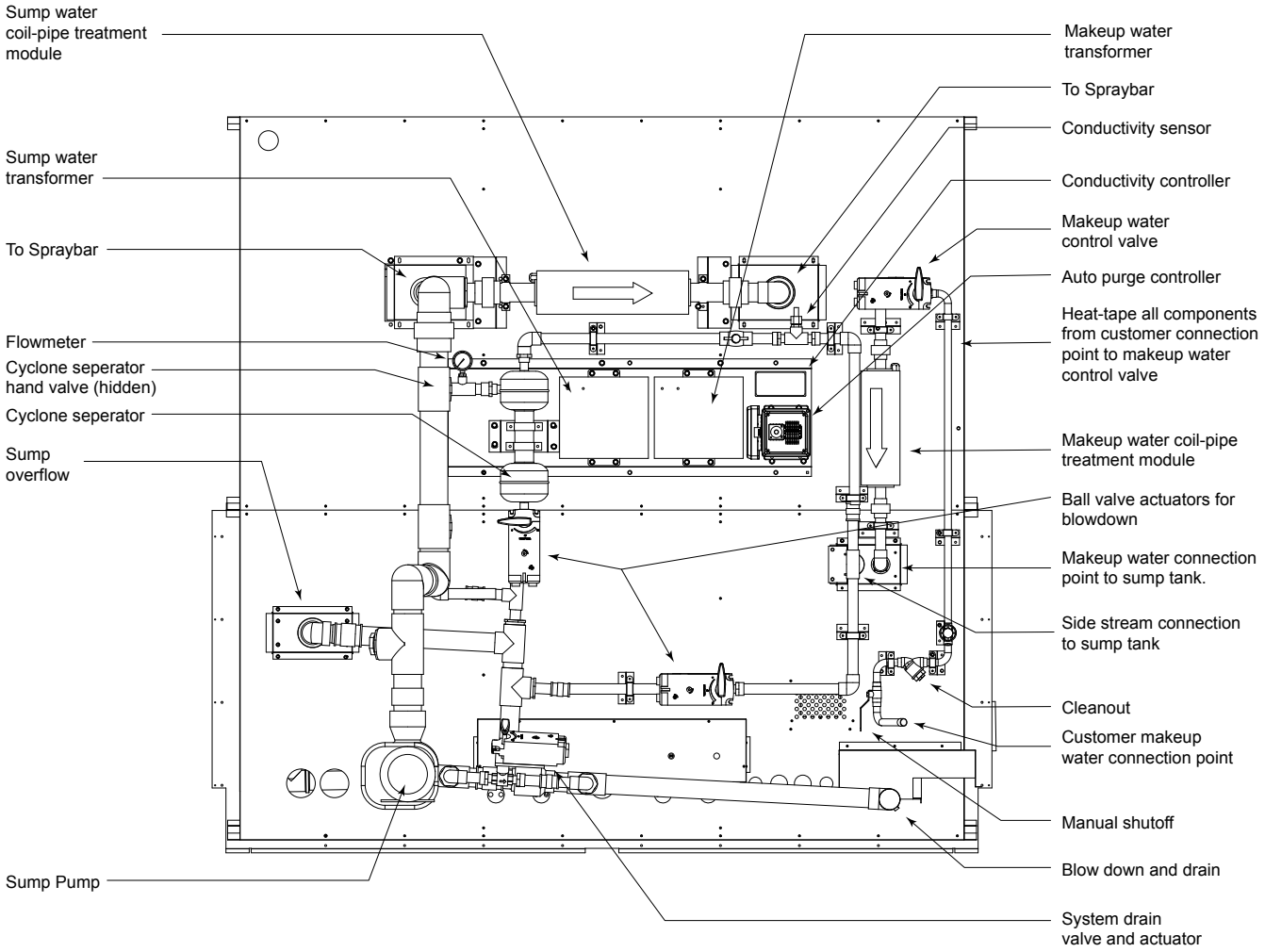
System description and operation

The Daikin Non-Chemical Water Treatment System is designed to prevent scale build-up and microbial growth in the moisture-laden condenser section of Daikin evaporative condenser rooftop units. It has several advantages over traditional chemical treatment systems and functions in the following ways (see ED 9040 for more details):

- Changes precipitate formation from surface nucleation (scale) to colloidal nucleation (bulk-solution powder).
- Keeps systems free from mineral scale on the fill material, pipes, heat exchangers, and other components in the system.
- Controls the population of microorganisms such as bacteria and algae by incorporating them into colloidal precipitates (encapsulation) or damaging them with pulsed electric fields (electroporation).
- Allows system operation at lower blowdown quantity, resulting in water savings.
- Eliminates scaling and slime formation, resulting in energy savings.
- Aids in conforming to discharge regulations since the blowdown contains no added chemicals.

NOTE: Since the non-chemical system operates by forming a powder precipitate, water usage is measured by flow meters on makeup and blowdown or by the ratio of a particular mineral in the makeup and blowdown water, not by the ratio of conductivity of the makeup and blowdown water.

Figure 1: System overview



System Components

The non-chemical system consists of the following components (see Figure 3).

- Transformer panels (2): Provides power to the Coil-pipes. It contains the following (Figure 2):
  - — LED status indicators
  - — Primary fuse assembly
  - — Two over-voltage fuses
  - — Digital printed circuit board
  - — Umbilical cable connection
  - — Power line cord
  - — Dry FORM “C” contact (for building automation system interface)
- Coil-pipes (2): Provides electromagnetic water treatment. One treats the intake water and the other treats the spray water. It contains the following:
  - — PVC Sch80 flow pipe material—full flow with no obstructions.
  - — Specially wound coils and circuitry contained within a closed, larger diameter PVC cylinder with ventilated PVC end caps.
  - — Built-in thermal protection which automatically turns the coil-pipe assembly off if the operating temperature exceeds 200°F for PVC units.
  - — Locking power cable (umbilical cable) between the transformer paned and coil-pipe assembly

NOTE: The thermal protection for PVC units protect internal circuitry from internally generated heat. However, do not use the PVC unit in environments with field temperatures above 140°F due to degradation of PVC’s mechanical properties.

- Blowdown controller: Opens the blowdown solenoid as required to prevent mineral concentrations (measured by water conductivity) from exceeding the setpoint.
- Cyclone separator: Removes precipitates from the water during the blowdown process. Normal flow and gauge pressure drop is about 20 gpm and 12 psi, respectively.

Figure 2: Transformer overview

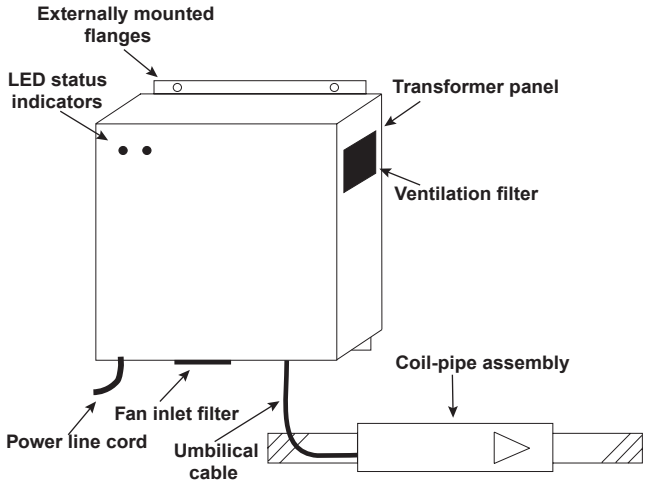
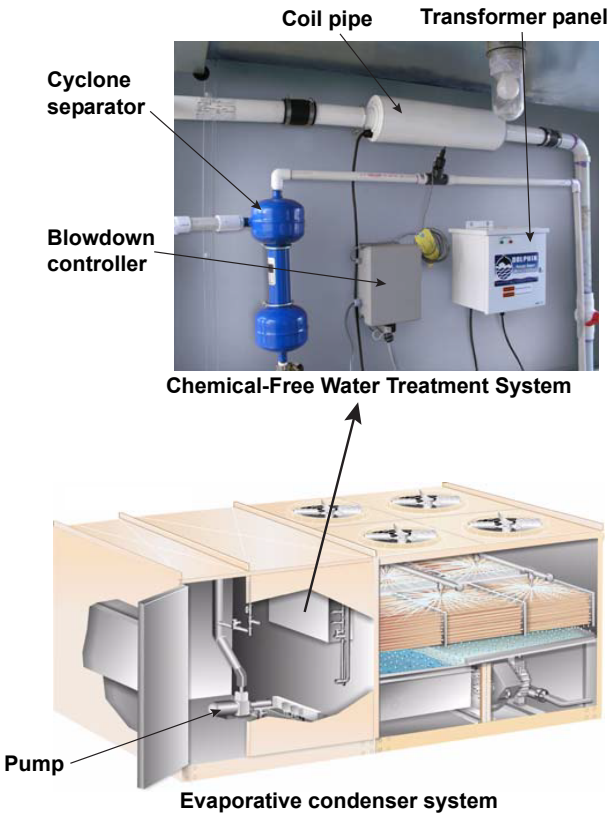


Figure 3: Water treatment system components



Building automation system interface

The interface to building automation systems is through a FORM “C” dry relay contact located on the circuit board in the transformer panel. The interface signals a change in the following operating status conditions.

- Primary power status (e.g., a loss of utility power, tripped circuit breaker, blown fuse, or unit unplugged).
- Secondary power status (e.g., severed or removed umbilical cable connection or a defective transformer).
- Coil-pipe assembly operation status (e.g., coil-pipe assembly overheated).
- Circuit board operation status (e.g., board overheated, electronic failure).

In the event of a change in status (due to any of the anomalies listed above) the supervisory contact will change the relay status. The supervisory contact power rating is as follows:

- 0.6 A at 125 VAC
- 0.6 A at 110 VDC
- 2.0 A at 30 VDC

Initial operation

The Daikin Non-Chemical Water Treatment System should be operated initially under blowdown settings or a protocol specified by Daikin.

At installation, a Daikin representative monitors the performance of the system. This monitoring, provided by Daikin at no additional cost to the customer, includes:

- Inspecting the Non-Chemical Water Treatment System for functionality
- Inspecting the blowdown system for functionality
- Calibrating and cleaning conductivity probes or other instrumentation related to blowdown
- Visually inspecting the overall system condition Stabilization period

For the first 90 days after installation, a Daikin representative makes periodic visits to continue monitoring the performance of the system. This monitoring, provided by Daikin at no additional cost to the customer, includes:

- Inspecting the Non-Chemical Water Treatment System for functionality
- Inspecting the blowdown system for functionality
- Calibrating and cleaning conductivity probes or other instrumentation related to blowdown
- Visually inspecting the overall system condition

During this period, a water chemistry analysis, which includes the following, is performed:

- Heterotrophic plate count
- Conductivity
- PH
- Chloride
- Other evaluations as required by a particular installation

Normal operation

When your rooftop unit is equipped with a Daikin Non-Chemical Water Treatment System, no new adherent scale is deposited. Dissolved $CaCO_3$ precipitates out of solution as free-flowing, microscopic, bulk-solution precipitate. As the bulk-solution precipitate particles grow, they encapsulate the vast majority of microscopic life—of all species present. This particle encapsulating principle is how the Non-Chemical Water Treatment System keeps the population of bacteria and other microbes exceedingly low.

Key parameters

The parameters of pH, specific conductivity, and total bacteria count (TBC) are essential to help ensure good operation. Typically, the Non-Chemical Water Treatment System should keep values within these ranges:

- A PH range of 7.5 to 9.0 and operation in the regime of calcium carbonate precipitation.
- Conductivity in the range of 600 to 2,000 µS/cm.
- TBC, as measured by SMEWW 9215B, of less than 10,000 colony-forming units per milliliter (CFU/ml) and routinely at 1,000 to 2,000 CFU/ml.
- There is no odor from the sump and only a slight amount of algae may form on areas intermittently wetted by spray. Periodic algae blooms may be unavoidable in immersed areas under conditions of high nutrient load, blown-in sediment, and direct sunlight. The blooms, which are infrequent, die off and should be cleaned as soon as is practical. In general, the water is impressively clear with little biological debris and no calcite scale forms.

These parameters are adjusted by changing the blowdown setpoint. (See Blowdown setpoint during lay-up on page 7). Daikin sets the initial blowdown so the water chemistry is in the regime of calcium carbonate precipitation. How far into the regime it is set depends on the capability of the system to remove suspended particles and the precipitation of other minerals from the makeup water. Daikin will determine the appropriate setpoint for conductivity based on the makeup water chemistry.

NOTE: The makeup water must have some hardness. Distilled or de-ionized water hampers the system's effectiveness since bacteria are controlled by the precipitation of the non adherent bulk-solution precipitate particles. Likewise, water softening, which basically replaces each Ca^{++} ion with two Na^{+} ions, is neither necessary nor desirable with this system.

Wintertime practices

Wintertime practices may vary by the requirements of each cooling system. The operator must determine appropriate practice for the particular situation.

If there is no need for cooling over a period of time, some operators drain the system and leave it dry. Provided good operational practices are followed, this practice is an excellent way to lay up the evaporative condenser. Since there is no water in the system, there is no requirement for water treatment. In these situations, de-energize the Non-Chemical Water Treatment System while the system is empty.

Many cooling systems are kept in a standby situation. In this mode, the open loop is either partially or completely filled with water, and the system is ready to be started under short notice. Since there is water in these systems, water treatment must be addressed.

Water treatment during lay-up

In periods of no load, there is little or no water loss through evaporation, which means there is no concentration of minerals, and concern with general scaling is minimal. There are stagnant water concerns with corrosion, microbial growth, particulate fouling, and some localized scaling from dissimilar metals.

Stagnant water issues

Stagnant water can cause problems of corrosion, microbial growth, and localized scale formation, as follows.

- Stagnant water allows non-uniform levels of oxygen to develop near metal surfaces. This non-uniformity can give rise to differential oxygen cell corrosion. The somewhat protective oxide film on steel can become depleted beneath oxygen-poor regions of water, and the metal surface in that region will be anodic to the metal in oxygen-rich areas.
- Stagnant water may allow large, loose masses of biofilm to form. When water circulation resumes, these masses can cause operational problems. The biocidal affect of the Non-Chemical Water Treatment System is active only when water is passing through the unit. Daikin control sequences dump the water if the spray pump and the Non-Chemical Water Treatment System are not operated for 72 hours. The automatic fill valve does not refill the system until there is a call for spray pump operation. The maximum water charge of the evaporative condenser is only 150 gallons, so occasionally dumping the water is far better than risking microbial problems.

Blowdown setpoint during lay-up

When there is almost no load on the system, there is almost no water use. The blowdown setpoint can be set to a lower water conductivity setting than when operating at normal full load levels to minimize particulate formation and growth without affecting water use of the system.

Relationship between conductivity, blowdown and mineral content

A conductivity controller is used to control blowdown and mineral content in the spray water. Its setpoint is determined by Daikin and depends on both water chemistry and the components in the spray system. Several concerns are evaluated by Daikin to determine the initial setpoint. They are described in brief below. This information is not intended to be in depth nor to be used to change the setting. Contact Daikin if you feel a setting change is required.

Makeup water analysis

Prior to installation, Daikin performs the following analyses on makeup water sources:

- Calcium hardness (as ppm $CaCO_3$)
- Total hardness (as ppm $CaCO_3$)
- Total alkalinity (as ppm $CaCO_3$)
- PH
- Silica (as SiO_2)
- Specific conductivity (µS/cm)
- Sulfate (as SO_4)
- Chloride (as Cl^-)
- Phosphate (as PO_4)

Saturation of calcium carbonate

The corrosion protection afforded by using the Non-Chemical Water Treatment System comes by operating the recirculating water close to the saturation of calcium carbonate. This point becomes the minimum level of cycles that the system should operate for extended periods of time. Saturation of calcium carbonate is the point where precipitation is at equilibrium with dissolution. This point is generally a function of calcium concentration, alkalinity, temperature, PH, and conductivity.

Daikin recommends calculating this saturation point by an iterative process of cycling up the makeup water. There are a variety of formulae used to determine this point. Daikin uses the Pukorius Scaling Index (PSI) and a saturation of about 6.2. If the system cycles above this point, the additional calcium and carbonate form a bulk solution precipitate.

Estimation of powder formation

Once the saturation point of the calcium carbonate is known, cycling above that point causes precipitation in the bulk solution of calcium carbonate. Daikin typically aims for about 100 ppm of precipitate to assure that normal fluctuations in makeup water in the conductivity controller do not drop the actual water chemistry too far below saturation.

Conductivity setpoint

Daikin will adjust the conductivity controller setpoint at startup, based on water analysis and the following procedure:

1. The desired cycles of concentration (and the amount of blowdown) is determined, based on the saturation of calcium carbonate, as described.
2. The resulting spray water concentration of silica, sulfate, chloride, phosphate, and calcium is calculated and adjustments are made, as needed, to the cycles of concentration.
3. The conductivity controller setpoint is established based on desired levels of concentration.

⚠ DANGER

ELECTRICAL SHOCK HAZARD

Failure to disconnect or turn off power can result in electric shock, equipment damage, severe personal injury, or death. Before opening the transformer panel door, performing any maintenance, or cleaning the cables and connectors of the coil-pipe assembly, disconnect or turn off power to the Non-Chemical Water Treatment System.

⚠ WARNING

Reduced water levels can cause equipment damage.

Disconnect or turn off power to the water treatment system before performing any maintenance, cleaning, or draining of the system that reduces water levels to the point where a dry pipe condition occurs in the coil-pipe assembly,

The Non-Chemical Water Treatment System requires little routine maintenance beyond occasionally inspecting the umbilical cable and power cord and cleaning the filters on the ventilation openings on the coil-pipe assembly. If necessary, clean the rooftop unit's sump filter and sump basin. See IM 791 for details.

Other maintenance includes:

- Periodically checking the cooling vents and fan (if fan equipped) to help ensure proper airflow.
- Removing all foreign matter that might inhibit proper airflow through the Non-Chemical Water Treatment System.
- Cleaning the transformer panel filters and the coil-pipe assembly ventilation openings.

Periodic monitoring

Daikin strongly recommends establishing and maintaining a periodic monitoring regime per Table 1 on page 9. Monitoring should include PH, conductivity (TDS) measurement, and TBC. Annual inspections should include a thorough clean out of debris.

Periodic inspection by trained service personnel

In addition to regular inspections by maintenance staff, a trained service person must check operation of the system one to two times per quarter. This must be provided by others and is NOT included in Daikin pricing or in the factory start up. This is available through a Daikin authorized non-chemical system service expert. This inspection includes the following:

- Double checking the regular inspections detailed in IM 827.
- Verifying proper blow-down control and the controller's conductivity reading with a proper meter.

TBC testing

A trained service person must test the TBC of the water once or twice a year. Testing is provided by others and is NOT included in Daikin pricing or in the factory start-up. It is available through a Daikin authorized non-chemical system service expert. There are two types of TBC tests available:

- A local lab sample analysis, which is relatively inexpensive and very accurately measures typical TBC levels (usually below 2000 CFU/ml).
- Dip slides, which are even less expensive than lab analysis and can determine if TBC is less than 10,000 CFU/ml. This is sufficiently low for most applications.

Table 1: Maintenance/monitoring schedule

Action	Person Responsible	Date Performed	Recommended Frequency
Treatment system equipment			
Check LED indicators to determine that the system is operating correctly.			Daily
Check coil-pipe assembly ventilation filters and clean if required.			Quarterly
Touch the coil-pipe. It should vibrate slightly during operation.			Daily
Check transformer panel fan screens, louvers, and fans. Remove all dirt and debris. Clean as required.			Quarterly
Visually inspect all wetted condenser system components for mineral deposits, algae, corrosion, discoloration of water, or odors associated with biological contamination.			Weekly
Blowdown system			
Check water in system for proper pH and conductivity or TDS (total dissolved solids).			Weekly
Check for proper operation of blowdown system.			Monthly
Clean all sensors and probes associated with the blowdown system.			Quarterly
Calibrate automatic blowdown system using pH probe or conductivity probe.			Quarterly
Check water in system for proper TBC.			Once or twice/ year
Good general practices			
Flush debris from basin and dispersion pan.			Quarterly
Clean entire system.			Annually
After extended system shutdown periods, clean all debris from system, including condenser, drain pan, system piping, and sump holding tanks. Drain system and refill with fresh, clean water.			After extended shutdowns

Before calling for service, review the following related solutions. If a problem persists or is intermittent, call troubleshooting table for potential operating problems and your local Daikin representative.

Table 2: Troubleshooting chart

Problem	Possible cause	Solution
The system does not turn on.	Power cord not firmly connected.	Reconnect the power cord.
	Tripped unit control breaker.	Check the circuit breaker; reset if necessary
	Fuse located in the transformer panel is loose, missing, or blown.	Check the fuses in the transformer panel; replace if necessary.
Both status LEDs fail to light.	Power cord not firmly connected.	Reconnect the power cord.
	Tripped unit control breaker.	Check the circuit breaker; reset if necessary
	Fuse located in the transformer panel is loose, missing, or blown.	Check the fuses in the transformer panel; replace if necessary.
Fault LED is lit.	Umbilical cable is not plugged into the transformer panel firmly.	Reinsert the umbilical cable plug into the connector located on the bottom of the transformer panel. Make certain the plug locks into position.
	Umbilical cable is not firmly connected.	Check the serial numbers located on the transformer panel and the coil-pipe assembly to make sure they match.
	Operating temperature of the water flowing through the coil-pipe assembly exceeds maximum allowable temperature. The thermal safety switch is open	Reduce the operating temperature of the water flowing through the coil-pipe assemble. The thermal safety switch automatically resets.
	LED failure or printed circuit board fault.	Call for service.
Fault and operating LEDs blink intermittently.	The coil-pipe assembly is approaching maximum operating temperature, causing the thermal safety switch to open and close.	Reduce the operating temperature of water flowing through the coil-pipe assembly.
	The umbilical cable connector is loose.	Reinsert the umbilical cable plug into the connector located on the bottom of the transformer panel. Make certain that the plug locks into position.
Blown fuse	Defective or weak fuse.	Replace the fuse and restart the system.
	Power surge.	
	System exceeds its electrical design parameters.	
	Lightning strikes related equipment.	
	Water in the electronics.	Contact your local Daikin representative. Pinched wire or cable.
	Short circuit in transformer or coils.	

Daikin Applied Training and Development

Now that you have made an investment in modern, efficient Daikin equipment, its care should be a high priority. For training information on all Daikin HVAC products, please visit us at www.DaikinApplied.com and click on Training, or call 540-248-9646 and ask for the Training Department.

Warranty

All Daikin equipment is sold pursuant to its standard terms and conditions of sale, including Limited Product Warranty. Consult your local Daikin Applied Representative for warranty details. To find your local Daikin Applied Representative, go to www.DaikinApplied.com.

Aftermarket Services

To find your local parts office, visit www.DaikinApplied.com or call 800-37PARTS (800-377-2787). To find your local service office, visit www.DaikinApplied.com or call 800-432-1342.

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