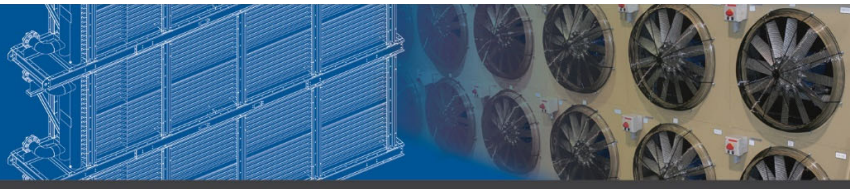
COLMAC COIL
Manufacturing Inc.



Technical Bulletin

By Grant Brookover

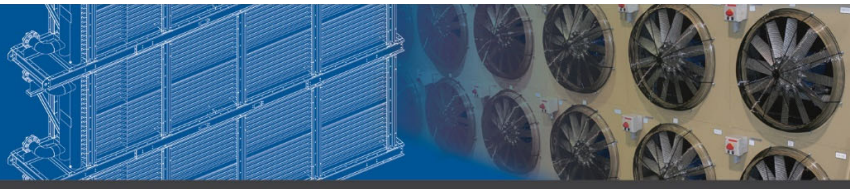
Demand Defrost Sensor

Background

Evaporator efficiency is critical to energy savings for any cold storage facility. During operation at temperatures below freezing, evaporator surfaces accumulate frost which reduces cooling capacity and energy efficiency. To remove the frost and restore capacity and efficiency, evaporators must be defrosted. The process of defrosting involves warming the evaporator surfaces to melt and remove the frost. This warming process adds some heat to the refrigerated space which must then be removed again by the refrigeration system. Reducing the frequency and duration of defrosts is a simple and effective way to increase the refrigeration system efficiency and reduce power consumption. The new demand defrost sensor available from Colmac Coil functions to initiate the defrost cycle only when a defrost is required and then terminates the defrost cycle as soon as the frost is melted and the unit is ready to return to service.

The frost load on evaporators in cold storage applications changes throughout the year as outdoor climate conditions change. Traditionally, evaporator defrosts have been initiated based on a fixed schedule, that is, set to some number of defrosts per day regardless of whether a defrost is needed. During periods of the year where the outdoor air dew point temperature is low (usually in the winter months) frost accumulates on evaporator surfaces much more slowly and fewer defrosts are needed. Depending on system temperatures and the cost of power, a single 30-minute defrost will cost between $0.15 and $0.20 per defrost per TR. For example, a 300 TR cold store with evaporators defrosting 3 times per day will cost as much as $65,700 per year to defrost. Using the new Demand Defrost Sensor on Colmac A+Series™ air coolers reduces the number of defrosts to match the frost load throughout the year. By determining the amount of ice build-up on evaporator fins, this sensor ensures that the defrost system is activated only when necessary. Typically, use of the Demand Defrost Sensor will reduce the number of defrosts per year by at least 50% compared to a set time-initiated defrost schedule. For the 300 TR cold store mentioned earlier, installation of Demand Defrost Sensors offers the potential to save as much as $32,850 per year.

It has been shown (Cole 1989, Vestergaard 2018) that a properly designed and piped evaporator operating with hot gas defrost will be completely clear of frost in only 10 minutes (hot gas on time). This is compared to the typical 30 minute defrost duration for a time-terminated defrost control. The Demand Defrost Sensor includes a temperature sensor which is mounted to sense the temperature of the defrost condensate as it leaves the evaporator. Using this defrost termination feature in combination with the sensor's demand defrost initiation function offers the potential to save even more energy by shortening the duration of each defrost. In conclusion, using the new Demand Defrost Sensor will reduce the frequency and duration of hot gas defrosts in a typical cold store. The Demand Defrost Sensor is simple in design and operation, making it easy to install and use. The Demand Defrost Sensor can be provided as a factory installed option or for retrofit on existing Colmac A+Series™ coolers.



Capacitive Measuring Method

To determine frost accumulation levels, the sensor measures a change in capacitance as the frost is formed. The coated steel cable attached to the sensor acts as one conductor and the evaporator fins each act as the second conductor. As frost begins to accumulate on the fins after a defrost, the fin and cable act as dielectric elements. In this way, the steel cable, fin, and frost work together to create a capacitor. Increases in frost build-up changes the capacitance which is monitored by the sensor. The device sends an "ON" digital signal to the defrost control system to initiate the defrost cycle when the current reaches a designated setpoint (signifying max frost build-up).

Temperature-activated Termination

Typically, the defrost cycle is terminated using a timer function in the control system. This method of defrost termination is not energy efficient because the defrost process inevitably runs longer than is necessary. The Demand Defrost Sensor, however, eliminates this problem by sending an "OFF" digital signal to the defrost control system when the temperature of the defrost condensate reaches the setpoint temperature that corresponds to sufficient ice-removal. In most situations, this setpoint termination temperature is around 5-10 degrees Celsius (40-50 degrees Fahrenheit).

Easy Installation and Setup

The Demand Defrost Sensor is mounted by four fasteners to either the evaporator's tube sheet or a bracket on the tube sheet. The coated steel measuring cable is passed between the evaporator fins and held securely by plastic clips that snap onto evaporator tubes. The temperature termination sensor bulb is fastened to the defrost condensate return connection using a bulb strap and insulation. To calibrate the sensor, use the configuration software tool supplied with the Sensor, which runs on your PC.

Bibliography

Cole, R.A. 1989. "Refrigeration Loads in a Freezer Due to Hot Gas Defrost and Their Associated Costs." *ASHRAE Transactions*, V.95, Pt.2.

Vestergaard, N., Skovrup, M.J. 2018. "Energy and Function Analysis of Hot Gas Defrost in Ammonia Refrigeration Systems." IIAR Alexandria, VA. Proceedings 2018 IIAR Natural Refrigeration Conference, Colorado Springs, CO. Technical Paper #8.

For more information contact Colmac Coil Manufacturing, Inc.
www.colmaccoil.com | P: 800.845.6778 or 509.684.2595
PO Box 571 | Colville WA 99114-0571