COMMON QUESTIONS CONCERNING EVAPORATOR FAN VFD CONTROL

Introduction

This document is intended as an introduction to common design and operational issues associated with the use of variable frequency drives (VFDs) on evaporator coils in refrigerated warehouses. See the accompanying document "VFDs in Industrial Refrigeration" for specifics details about VFD functionality and additional application opportunities (e.g., condenser fans and compressors).

Common Questions

1. **How many VFDs will be installed?** In general, one VFD is installed per evaporator coil, typically driving two to six fan motors simultaneously. In some instances, multiple coils can be driven by a single VFD, particularly if the coils are all part of one refrigeration "zone".

2. **Where are the VFDs located?** For large-scale installations, VFDs are typically placed in the main electrical room, near a MCC, or in the engine room. Multiple drives are usually placed in a single Hoffman-style enclosure, along with all supporting hardware (reactors, filters, bypasses, fuses, disconnects, etc.). For smaller projects, or where the applications are far apart, the VFDs are commonly ordered with a factory NEMA enclosure, and mounted on the wall.

3. **How will the VFDs be controlled?** In general, a refrigeration computer control system manages the VFDs. Without VFDs, liquid solenoids or back-pressure regulators are used to control zone temperature. The VFD will operate in series with the existing control. VFD speed will be reduced from maximum (typically 80% to 100% speed) to minimum speed (typically 40% to 50%). If additional coil capacity reduction is required, the solenoid or BPR can then be utilized.

4. **Is a computer control system necessary?** In some cases, VFDs can be installed without a control system. If the coil is a flooded design, then the VFD can utilize the existing 4-20 mA control signal used by the back-pressure regulator. In controlled atmosphere storage, VFDs are often operated manually, with fan speed reduced following pull down. Another option is a simple UDC-style controller, that manages VFD speed by monitoring and controlling space temperature. Finally, in simple applications, a temperature probe (and associated signal transmitter) can be directly wired to the VFD. Internal programming within the VFD can often provide PID control to control temperature.

5. **Why set the minimum fan speed at 40% to 50%?** Fan shaft horsepower is reduced as the cube of fan speed. For example, at 50% speed, the fan shaft horsepower is reduced to $50\%^3$, or 12.5%. (In reality, with VFD and motor losses, the cubic law exponent is usually closer to 2.5-2.7.) Thus, reducing fan speed below 40% to 50% yields minimal additional energy savings.

6. **Will I get warm spots in the room?** No. Proper application of VFDs to evaporator coils includes proper placement of, or additional, temperature probes. Many system are designed with a single return-air probe for a zone, or even entire room. Often, additional temperature probes are placed opposite the evaporator coil, in locations of concern. The control system

will automatically speed up the fans to increase cooling in response to the temperature probes, preventing warm spots.

7. **Why can't I just cycle the fans?** Fan cycling is frequently an option. However, VFD control will always save more energy. In addition, cycling fans completely shuts off air flow to a zone. With no air movement and minimal probes, the control system may not be able to accurately assess the need for cooling. With VFD control, some air movement is always occurring.

8. **Will my coils ice up?** No. It is true that as air flow is reduced across the evaporator coil, the air and coil remain in contact longer. The result is increased coil "effectiveness". More moisture is drawn from the air stream and frozen to the coil surface. However, this is more than offset by the reduction in total air (and moisture) drawn through the coil.

9. **Will my fan motors burn up?** With proper design and application, no. Virtually all motor manufacturers have created motor lines that are intended for inverter-applications. These motors have improved insulation systems and other features that are designed specifically for this application. On retrofit projects or where inverter-rated motors are not available, the VFD will be installed with an output filter to provide an acceptable voltage waveform to the motor.

10. **What if the VFD fails?** VFDs are solid-state devices with no substantial mechanical movement. The failure rate on properly selected and installed VFDs is very low. A mechanical bypass can be installed on key equipment (e.g., condenser fans, compressors), but is seldom required for evaporator fans.

11. **Can VFDs be used on direct expansion coils?** Some ammonia systems and many CFC or HCFC-based system utilize direct expansion evaporator coils. On these systems, the thermal expansion (TX) valve is designed for a particular range of refrigerant flow rate. At reduced air flow, the concern is that the TX valve cannot close enough to maintain proper superheat at the coil exit, resulting in flood back. With careful, prudent application, VFDs can work properly on these systems. Several examples are currently in operation.

12. **Are there any non-energy benefits?** Fan noise is dramatically reduced at low speed. In areas where employees are exposed to the evaporator coils (e.g., processing areas or docks), the environment is much more pleasant.

    In controlled atmosphere tests with apples, apple mass loss has been shown to be reduced. In many cases, the value of this reduced mass loss is greater than the energy savings.

13. **What will the VFD installation look like?** Several sample installations are shown in the following images:

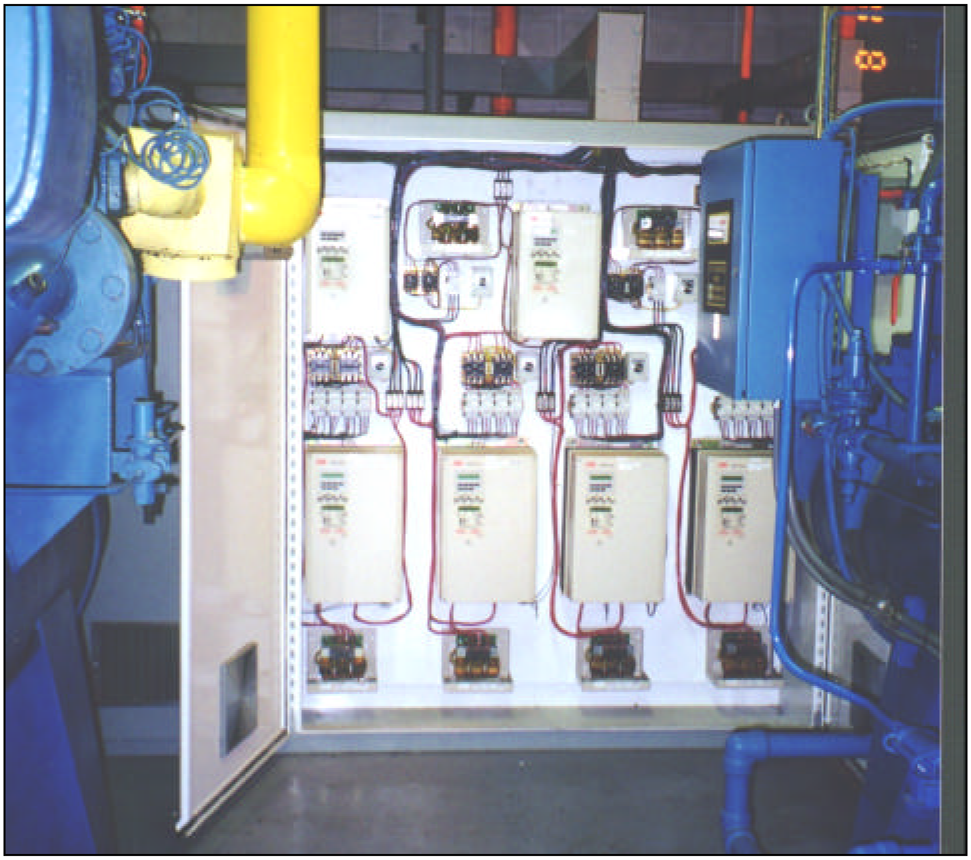

Figure 1: Kenyon Zero Storage VFDs

Figure 2: Darigold Dairy Milk Cooler VFDs

14. **Who is currently using VFDs on evaporator fans?** There are approximately 50 facilities in the Pacific Northwest utilizing evaporator fan VFD control. The following example references are offered:

Distribution Centers & Public Refrigerated Warehouses			
Company	**Contact**	**Title**	**Phone**
Fred Meyer	Kevin Merrick	Facilities Manager	503-557-2674
Sysco Food Services	Larry Powers	Facilities Manager	503-682-8700
	Dave Reichel	Corporate Engineer	281-584-1343
Associated Grocers	Ray Gooding	Facilities Manager	206-764-7802
Henningsen	Pete Lepschat	Chief Operator	503-359-1100
	Paul Henningsen	Corporate Engineer	503-531-5400
Columbia Colstor	Joel Sandburg	Corporate Engineer	509-765-3343
Kenyon Zero Storage	Scott Wingert	General Manager	509-813-1103
Americold	Dave Fisher	Corporate Engineer	503-624-8585
Seafreeze	Marty Houck	Maintenance Super.	206-767-7350
Darigold	Don Eaton	Maintenance Super.	800-310-2239 x2742
Tillamook Creamery	Jim Hefernen	Chief Operator	503-815-1377

Fruit Storage & Controlled Atmosphere			
Company	**Contact**	**Title**	**Phone**
Broetje Orchards	Multiple Facilties		
Clasen Fruit	Todd Clasen	Plant Manager	509-452-9891
CPC Partnership	Peter Hancock	President	509-673-3113
Double Diamond	Rex Morgan	Plant Manager	509-787-4644
Duckwall-Pooley Fruit	Bob Baskins	Maintenance Super.	503-354-1694
Naumes	Dave Briggs	Plant Manager	503-773-6805
Stadelman Fruit	Multiple Facilities		
Washington Fruit	Tommy Hanses	Plant Manager	509-457-5177