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Condenser Short Cycling

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One common application problem with air-cooled condensers is short-cycling of condenser fans.

At its best, short-cycling is usually an indication of an unstable head pressure control. At its worst, short-cycling can shorten the life of the condenser and may cause fan motor or fan blade failure, refrigerant leaks or failure of other components.

Condensers operate most efficiently at a steady state condition. Multi-fan condensers have a large thermal mass and internal (refrigerant) volume. They need time to adjust to changes in the refrigerant load or ambient condition. When fans cycle too rapidly, the condenser does not have sufficient time to stabilize and often, the controls overshoot the setpoints and do not adequately maintain head pressure control.

The lack of proper head pressure control may cause problems in the rest of the the refrigeration system. If the head pressure is erratic or cycling improperly, it may cause excessive wear on other pressure regulators in the system. Cycling head pressure may also cause poor expansion valve control and liquid flood back to the compressor.

Refrigerant flow through the expansion valve is a function of the refrigerant pressure differential across the valve. If the head pressure is unstable, then so is the pressure differential and refrigerant flow through the valve. If the cycling is excessive, the valve may lose control of its superheat and allow liquid to flood back to the compressor.

What causes condenser fan short-cycling? There are several reasons. The most common is too close of a differential on the control setpoints. When this happens, the control differential is smaller than the normal result of cycling the fan.

For example, consider a multi-fan condenser with pressure fan cycling. The setpoint on one of the fans is 165 psig with a 2 psig differential. When the head pressure falls below the 163 psig (setpoint-differential), the fan cycles off. This reduces the condenser capacity and causes the head pressure to increase, assume a value of 8 psig. The head pressure quickly exceeds the 165 psig setpoint and the condenser fan cycles back on and short cycling is initiated.

Another cause of short-cycling is too close a difference between stages of fan cycling. Using the same multi-fan condenser example, assume the setpoints on the fan cycle controls were only 2 psig apart — 165, 163 and 161 psig.

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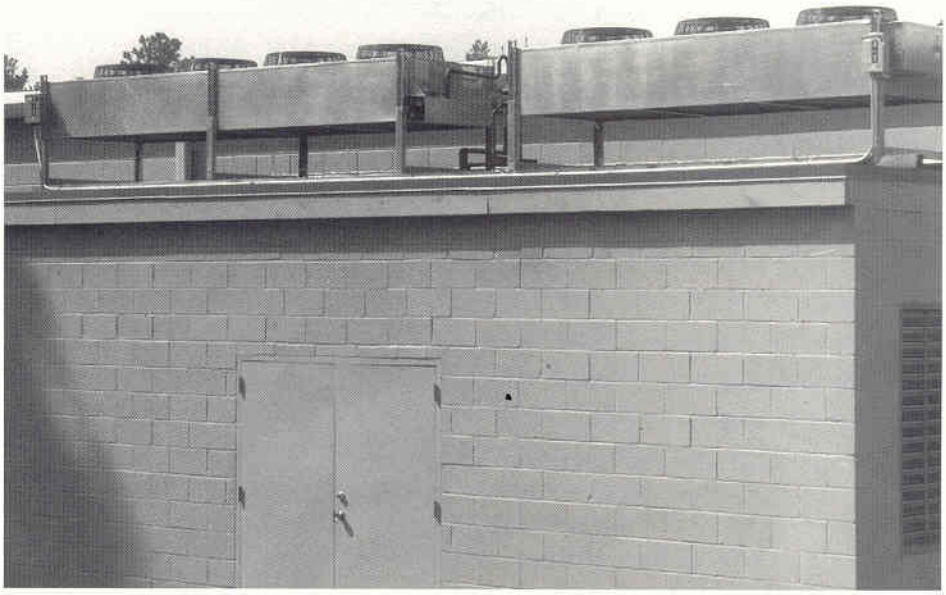

Supermarket applications typically use multiple air-cooled condensers which are piped to the store's mechanical room. Maintenance personnel should pay special attention to the control settings so fan short cycling can be prevented.

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The condenser is operating with all of these fans on. There is a reduction in the condenser load caused by cylinder unloading or some other means. Under normal operating conditions, this reduction in condenser load would only cause one fan to cycle off.

When the head pressure falls below the 163 psig (165 setpoint – 2 psig differential), the first fan cycles off. When this happens, the condenser capacity is reduced and normally the head pressure rises. But due to the thermal inertia (mass of condenser and internal volume), the head pressure will continue to fall for short periods of time until the condenser can stabilize. But because the setpoints are too close together, the thermal inertia drives the condensing pressure down below 161 psig (163 setpoint - 2 psig differential) and the second fan cycles off. In a similar manner, the thermal inertia is usually sufficient to cause the third fan to cycle off as well.

The condenser now has cycled three fans off instead of the required single fan. The reduction in condenser capacity has now overcome the thermal inertia and the head pressure stops falling. But because too many fans have cycled off, there is insufficient condenser capacity and the head pressure starts to go up. The process now repeats itself, but in reverse, causing all three fans to come on in rapid sequence. The "stair-stepping" is similar to expansion valve hunt caused by a poor superheat adjustment.

This cycling or stair-stepping is often exaggerated if all of the condenser fans are cycled off. For this reason, cycling off all of the condenser fans is not recommended.

Another common cause of rapid fan cycling is conflicting head pressure controls. It is often common practice to combine more than one style of head pressure control on the same refrigeration system, such as fan cycling and flooded head pressure control. If the fan cycling setpoints are below the flooded control setpoints, the controls will "fight" each other. In this case, the fan controls will cycle the fans off, energizing the flooding control and cycling the fans back on — causing short-cycling. The fan cycle controls' setpoints should always be higher than the flooding control setpoint.

Fan cycling in excess of three minutes is considered excessive. An initial recommendation for fan cycling should be a 5° F differential for ambient fan cycle and a 20 psig minimum differential for pressure controls. These settings may have to be adjusted if cycling occurs more often than every three minutes.

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