ENGINEERING TOMORROW

Case story

Danfoss AB-QM™ Valves in Biofuel Heating System Raise Profits for Organic Poultry Farmer

Poultry and livestock products are big business in Pennsylvania, responsible for $4.5 billion in annual agricultural sales. Organic poultry farmer Earl Ray Zimmerman is adding to that number, thanks to an innovative heating system utilizing Danfoss AB-QM™ pressure independent temperature control and system balancing valves to maintain the precise temperatures chickens need to keep gaining weight to go to market as fast as possible.

"Chickens are affected by temperature," observes Matt Aungst, co-owner of Total Energy Solutions, a Willow Street, Pa.-based firm that engineered the heating system. "A change of just a few degrees affects the birds' eating habits. And if they don't eat, they don't put on weight. Missing the growth schedule for thousands of birds for just one day stretches a farmer's time to market and cash flow, something poultry producers want to avoid at all costs."
Precise temperature balancing is critical in each of the 45 x 500-foot houses Zimmerman uses for broilers — chickens specifically raised for meat production. "Each building is wide open," Aungst describes. "So each area has a different heat loss profile depending on the location in the building. The goal is to keep the entire building at 93 degrees Fahrenheit at the beginning of every flock."

To hit that goal, Aungst and his partner John Albright offer an air handler designed specifically for chicken houses. Called the CUBO series air mixer, the system uses a centrifugal fan to circulate air through the mixer's coil into the chicken house to maintain even temperature throughout the living area. Each building employs eight CUBO units suspended from the ceiling. A heating coil in each unit is supplied by a hot water circuit regulated by its own Danfoss AB-QM™ valve.

AB-QM™ valve enables precise temperature control

"The AB-QM™ valve is a pressure independent control valve (PICV) that provides just the right flow of hot water to satisfy temperature requirements exactly, which is ideal for our system," says Aungst.

On warm days, the CUBO mixer pulls hot air from the ceiling level and expels it in a 360-degree circular flow just above the floor to eliminate stratification.

On cold days, a boiler supplies hot water to the internal heat exchanger inside each CUBO unit. The system engineered by Total Energy Solutions uses an unusual fuel source — dried chicken waste — to fire the 1.5 million BTU boiler, which can handle 100 percent of the heat load.

"The water flow to each coil is based on the heat load," explains

Aungst. "At full load, the system supplies 180 degree F water at 11 gallons per minute (GPM) to each CUBO unit. But conditions seldom call for that much heat."

That's why Aungst is using Danfoss AB-QM™ valves. Eight AB-QM™ valves are located along the main piping circuit that runs near the peak of the roof in each building. One valve is used to control the water flow to one coil. The valve increases or reduces the flow of hot water supplied to the coil depending on whether the zone temperature sensors call for more or less heat. Because 100 percent flow is usually not needed, a Danfoss variable frequency drive (VFD) incorporated into the circulating pump motor can reduce pump speed as flow is reduced, which cuts electricity consumption.

However, changing the flow also changes pressures, which creates problems for the system. Aungst realized that alternatives to the AB-QM™ valves' PICV design — traditional temperature control valves along with manual balancing valves — would not provide sufficient stability or controllability at low loads.

According to Danfoss' William Boss, who worked with Aungst to determine the best solution, "manual balancing valves don't work with variable-flow systems. They are meant for constant flow systems designed for maximum heat load using fixed-speed pumps, which in the CUBO application is the wrong choice."

"But traditional temperature control valves used with manual balancing valves adjust to changing flow only after a change in temperature has been measured by the room or zone thermostat or sensor, so there is a delayed reaction," Boss continues. "For example, at low-load conditions when only a small amount of hot supply water is required, the actuator in the temperature control valve will partially close to limit flow to that specific CUBO unit. Consequently, the pressure in the rest of the system increases, which increases flow to the other units. The standard temperature control valve compensates to decrease flow, which increases system differential pressure to start the cycle over again. The back-and-forth cycling behavior of overflow and underflow – known as "valve hunting" — decreases system efficiency and stability, while increasing temperature swings. The frequent open-closed cycling also reduces the valve's lifespan."

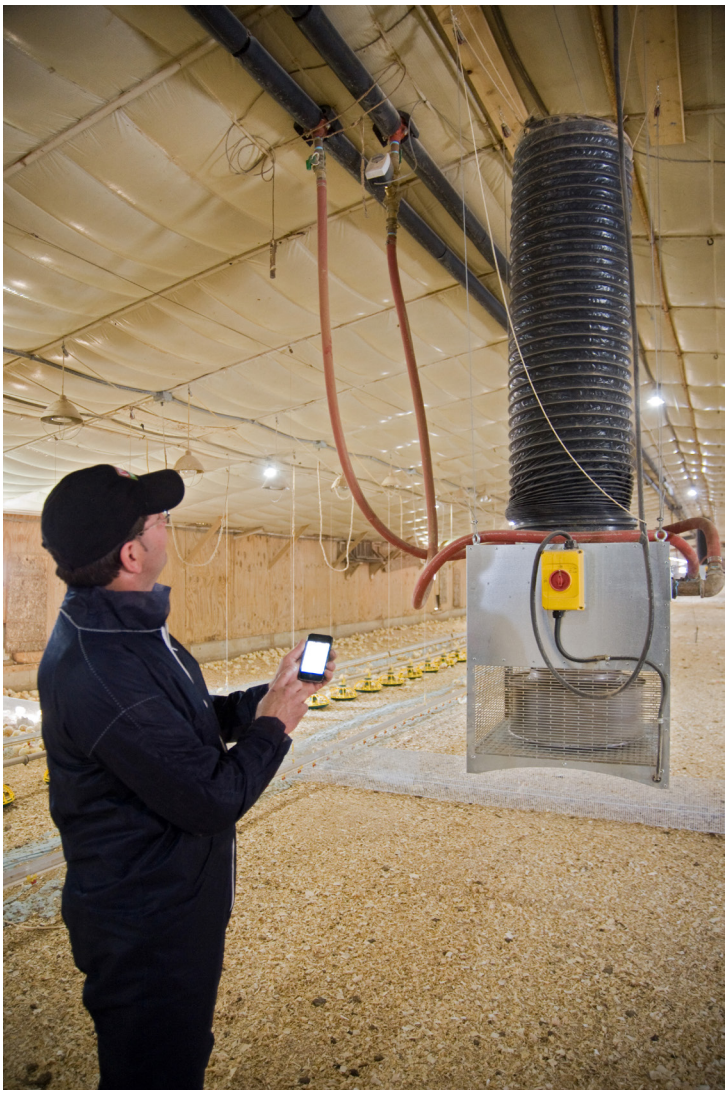
Tweaking manual balancing valves in the field to balance the system cannot compensate for constant differential pressure fluctuations. "You need PICV function that can absorb system pressure fluctuations to maintain the desired flow rate to the coil at all times," Boss notes. "The AB-QM™ valve in itself does the balancing dynamically to prevent cycling and hunting. It exactly matches flow to load regardless of pressure changes. You always get the proper flow rate."

True PICV function performs precisely at low loads and flow

The AB-QM™ valve combines the best of two technologies in one unit: it acts as a modulating temperature control valve and as a differential pressure controller containing an integrated membrane. This enables the control valve to do double duty: to provide water at the required flow rate to the CUBO coil and to maintain that exact flow by eliminating the effects of pressure fluctuations on the valve as system loads change.

Regardless of how much flow each temperature control actuator is calling for, the differential pressure within the AB-QM™ valve remains stable. When a temperature control valve is unaffected by system differential pressure changes throughout its entire range, it is said to have "100 percent valve authority," something that was only possible in laboratory conditions until recently.

Aungst notes that "with the AB-QM™ valve, neither pressure nor balancing affects the individual circuits. In other words, each AB-QM™ valve lets



each single CUBO circuit act independently of the system. It's practically a plug-and-play solution."

The AB-QM™ valves and the variable speed drive pump work in perfect harmony. Redundant pumps powered by Danfoss drives simply circulate the hot water to the circuits. The AB-QM™ valve matches the flow to the exact load. And at lower loads, the pump reduces speed to save electricity. The pump only needs to produce the minimum required differential pressure for the valves to operate.

Each AB-QM™ valve is outfitted with an optional 4-20ma actuator. The actuator is controlled by a proportional-integral-derivative (PID) loop in a programmable logic control (PLC) system configured by Total Energy Solutions that uses inputs from a thermistor located in each zone. The control network runs over Ethernet. Local control can be done on the PLC's color touch-screen. The system can also be monitored remotely from the comfort of Zimmerman's home, combining convenience and reliability.

Precise temperature/flow solution for CUBO systems

"The full PICV function of the AB-QM™ valve is perfect for our CUBO system," Aungst emphasizes. "The area zones are PID controlled, so every zone is at a different state of modulation. The valves moderate water flow precisely compared to the surging that can occur with open-close type controls. Any one valve may be wide open, closed or partly closed to match the exact flow required for that individual coil. They operate independently and smoothly through the entire range regardless of system pressure. Plus, they are self flushing, so they also operate cleanly."

"The AB-QM™ valve is very precise," concludes Aungst. "Across a 22,500-square-foot floor area, the readouts on the eight thermistors are all within one degree F."

For Earl Ray Zimmerman, getting temperatures that consistent over an area about half the size of a football field is impressive. "I know Matt put a lot of thought into the components he selected," says Zimmerman. "These valves modulate — opening halfway or three-quarters — whatever is needed. Some days require just a little heat. The chicks like an even temperature. So the valves open a little to provide heat without temperature swings. I'm very happy with how things are working."

Aungst agrees: "The AB-QM™ valve's precision gives our CUBO mixers and biofuel heating system a big advantage in maintaining constant temperature inside the chicken house. This is going to make a huge difference in Pennsylvania and anywhere else where poultry farmers want to pay less for fuel and electricity while raising broiler weights on schedule."