Aeration management

by Dave Crompton

When it comes to aerating grain, less runtime can mean more dollars saved

Ever-tightening energy supplies coupled with increasing global demand means high energy prices have become an unwanted fact of life. Agricultural facilities, in particular, are feeling the pinch.

"Although electrical costs and consumption rates vary by customer, agriculture consumers have experienced a 50% rise in electrical prices, from approximately 8¢ to 12¢ per kilowatt hour during the past five years," said Brian Heithoff, chief executive officer (CEO) and general manager of Consumers Energy in Marshalltown, Iowa, U.S.

Heithoff anticipates that energy demands will continue to grow and speculates that an additional 10% to 15% energy price increase is likely in the foreseeable future.

"Being a member-owned energy delivery and management cooperative, Consumers Energy strives to assist our agriculture-based customers in adopting strategies and programs that reduce consumption and make energy use more efficient," Heithoff said.

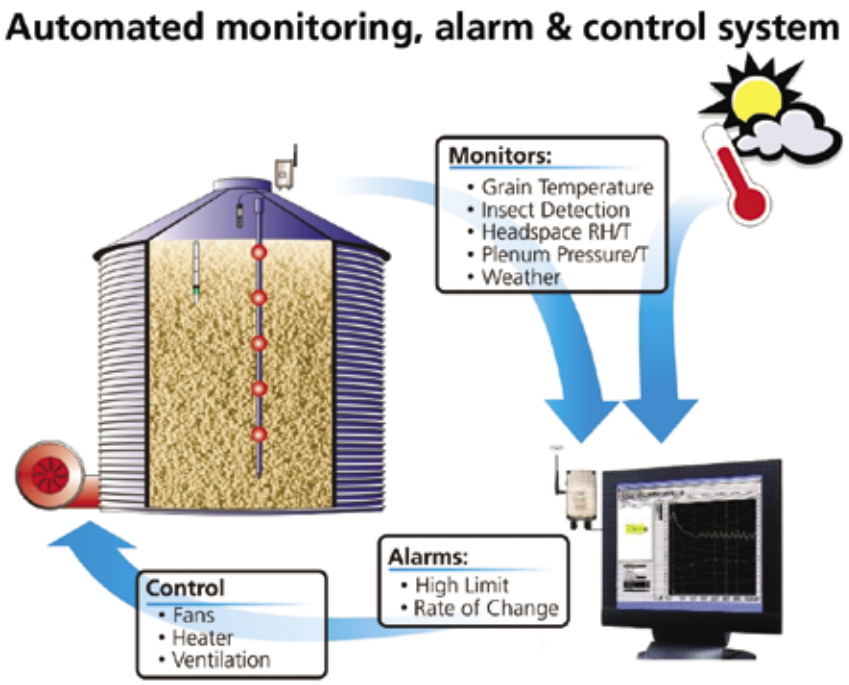
Aside from seasonal activities such as handling and drying grain, aeration consumes a significant share of the monthly utility bill for many grain storage facilities.

AVOID OVER-AERATION

When reviewing existing grain storage practices, the most common tendency is to over-aerate. "Without a good understanding of what is happening inside the bin, fans are often run on a regular and sometimes continuous basis 'just to be safe'," said Dr. Dirk E. Maier, extension agricultural engineer with Purdue University, West Lafayette, Indiana, U.S.

These practices do little to enhance grain quality. Instead, they often create temperature differences leading to condensation and potential spoilage. Over-aeration also incurs other costs, such as over-drying (shrink), which can significantly impact a company's bottom line.

Think of the grain as a massive energy sink: when fans run continuously, heat energy is cycled out of and then back into the grain, creating a "layer-cake" of varying temperatures. The better approach is to achieve consistent temperatures from bottom to top, with grain as cool as possible, to a minimum of 5 degrees C (so as not to freeze the grain) and a range no greater than



Components of an automated monitoring, alarm and control system. Illustration courtesy of OPIsystems.

+/-3 degrees C. According to Dr. Fuji Jian, entomologist with OPIsystems Inc. out of Calgary, Alberta, Canada, "Below 10 degrees C (50 degrees F), microorganism and insect activity is slowed to where the chance of grain damage is greatly reduced."

To understand how many fan runtime hours are required to make a complete temperature change, a simple formula called a seasonal factor is used. The seasonal factor (15 in winter, 12 in spring, or 10 in fall) is divided by the airflow rate to arrive at the minimum number of hours required to make a complete temperature change from the bottom to the top of the bin. The example in the above Fan Runtime Summary table is based on a seasonal factor of 12 and an airflow rate of 0.1 cubic feet per minute per bushel, it would take a minimum of 120 hours to make a complete temperature change in spring.

The challenge is in picking the "right" 120 hours when outside temperature and humidity are such that the grain is cooled toward the intended target, without a resulting loss in moisture content.

Selecting only the right mix of temperature and relative humidity air will generate the safest storage environment with the least possible number of runtime hours. The good news is that the technology exists today in the form of automated monitoring and control systems that can perform this very task.

Using these systems (see illustration, page 76), key storage parameters such as grain temperatures (as well as headspace humidity and temperature in bins with roof ventilation fans) and outside weather conditions are monitored on a continuous basis. As a function of user-established grain temperature and moisture content targets, the computer automatically turns conditioning equipment such as aeration fans, roof ventilation and heaters on and off, on an as-needed basis, until the target is achieved. At that time, conditioning equipment will not run again unless required to keep the grain in the optimum condition.

Fan Runtime Summary

	Time				Temperature		Moisture		
Year	Start Date	End Date	Run Hrs	Fan %	Start Temp	End Temp	Start MC%	End MC%	Run EMC%
1997	1/Oct/97	10/Jan/98	147	6	80.0	44.5	14.5	14.5	14.9
1998	1/Oct/98	09/Dec/98	137	8	80.0	44.9	14.5	14.6	15.2
1999	1/Oct/99	02/Nov/99	141	18	80.0	44.9	14.5	14.5	14.4
2000	1/Oct/00	18/Dec/00	112	6	80.0	44.5	14.5	14.5	14.7
2001	1/Oct/01	09/Dec/01	140	8	80.0	44.9	14.5	14.5	14.7
2002	1/Oct/02	22/Nov/02	136	11	80.0	44.7	14.5	14.5	15.0
2003	1/Oct/03	12/Nov/03	133	13	80.0	44.7	14.5	14.5	14.8
2004	1/Oct/04	12/Dec/04	125	7	80.0	44.7	14.5	14.5	14.9
2005	1/Oct/05	23/Nov/05	123	10	80.0	44.2	14.5	14.5	14.8
Minimum		02/Nov/99	112	6		44.5		14.5	14.4
Average		4/Dec	134	10		44.7		14.5	14.8
Maximum		10/Jan/98	147	18		44.9		14.6	15.2

This table shows fan runtimes from the modeling program based on automated aeration control for a Marshalltown, Iowa, U.S., grain storage facility from 1997 to 2005. Table courtesy of OPIsystems.

AUTOMATION ADVANTAGE

Automation can reduce runtime by as much as 80% over conventional techniques. To quantify the potential savings, a modeling program can be run to simulate automated "best practice" based on your grain type, airflow, location and target objectives. The example in the above table is based on a 90-foot-diameter bin storing 8,000 tonnes (400,000 bushels) of maize. With four 40 horsepower (hp) fans, power consumption is 120 kilowatts (KW) per hour (0.747 KW/HP). At a base rate of 12¢/KWH (not factoring in demand charges), it costs U.S.$14.40 per hour to run fans on this bin.

Automation can reduce aeration runtime by as much as 80% over conventional techniques

This doesn't seem too bad until we go back to the original example of manual operation, which based on a cumulative run-time of 30 days (720 hours) over the six-months storage period, ends up costing U.S.$10,370. By comparison, the model indicates that an optimum storage environment can be achieved with 134 hours of selective runtime. This 80% reduction in runtime over the conventional technique translates into a direct savings of U.S.$8,300 per year. Based on these savings and the average cost of an automated system, return on investment can be realized in the first one or two years of operation.

Automation generates further electrical savings by pushing fan runtime into "off-peak" periods. This is accomplished by setting "block outs" in the automated control program so that fans cannot operate so as to incur additional demand charges. These block-out periods are typically during daytime hours when electrical demand is otherwise at its highest level. Fortunately, daytime often provides sub-optimal conditions for the less time-critical activity of aeration. Elimination of demand charges compounds your savings in that reduced hours are multiplied by lower rates.

Aeration optimization provides one of the most effective and simple ways to cut your electrical bill. And, if an improved bottom line isn't enough of an incentive, reducing energy consumption means you will be doing your part to improve the health of our planet. WG

Dave Crompton is president of OPIsystems, Inc. He can be reached at dave@opisystems.com.

We want to hear from you — Send comments and inquiries to worldgrain@sosland.com.
For reprints of *WG* articles, e-mail reprints@sosland.com.