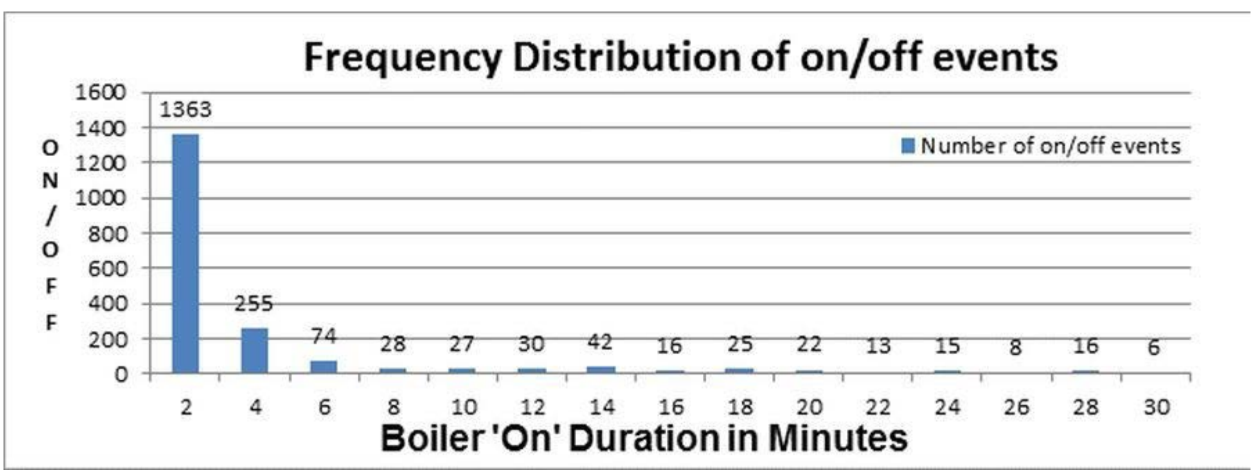
Identify Energy Savings by Monitoring Closed Loop Control System Cycles

Increasing Energy Efficiency with an Accsense Electrocorder

Frequent on/off cycling can waste money and reduce system life in many closed loop control systems, including:

- Thermostatically-controlled heating systems
- Pressure-controlled compressor systems
- Luminescence-controlled lighting systems

For example, CAS DataLoggers supplied an Accsense Electrocorder EC-1V data logger to monitor a customer's oil-fired central heating system for their office building over a period of 6 months. After collecting the data, users graphed the following astonishing results:



This data shows that over the recording period the thermostat requested 1363 instances where the boiler came on for 2 minutes or less, and 255 events 2 to 4 minutes in length. Adding up the cumulative time that the boiler ran, our customer found that for 33% of the time, the boiler was only on for a period of 10 minutes or less.

This data is significant because for the short duration 'on' cycles the boiler does not add much heat to the building environment. Most of the fuel is used to start the boiler and the energy bleeds of as heat loss before it can be transferred to the environment. Analyzing the data shows that if these short duration events lasting less than 10 minutes can be eliminated, an estimated minimum savings of 30% should be realized.

Q. How do you solve this problem?
A. Use a delay 'on' timer.

We subsequently developed a 10-minute delay between the thermostat activation and the boiler trigger event being transmitted which will eliminate all cycling that is less than 10 minutes. The closed loop control systems cycle requests that last less than 10 minutes are false requests for heat.

The customer used two Accsense Electrocorder EC-1V Single Phase Voltage data loggers to monitor their new system over a defined period and found:

Cumulative demanded boiler 'On' Time: **21:02 hours**

Cumulative actual boiler 'On' Time: **9:57 hours**

Savings (demanded 'on' time but not given): **11:05 hours = 52% energy reduction!**

Number of ‘on’ events demanded: **184 on events**

Actual number of ‘on’ events: **25 on events**

Savings (demanded ‘on’ event but not given): **159 on events = 86% reduction in ‘on’ cycles!**

Average number of demanded ‘on’ cycles per year: **8,375**

Average number of actual ‘on’ cycles per year: **1,156**

Saving (demanded ‘on’ event but not given): **7,219 = 86% reduction in ‘on’ cycles!**

Conclusion

Since the demand signal is subject to a 10-minute delay, when the demand is a real temperature demand, the temperature continues to fall slightly during the 10-minute delay. That means that when the boiler comes on, it takes slightly longer to bring the office building up to the set point of 70°F, therefore using more energy. However, even accounting for this, our customer still achieved an energy savings of 52%!

The obvious disadvantage with this setup would be a delay between the demand and the supply for heat. However, the data shows that 56% of the demands for energy were not real temperature demands but were just the result of the thermostat oscillating (on/off) around the temperature set point. The customer saw no noticeable effect on internal office temperature during the trial of the timer. As an added benefit, this reduction in run time and in the number of ‘on’ cycles by has increased the effective boiler life.

The Accsense Electrocorder EC-1V data logger is widely used to monitor voltage variations on site, allowing voltage problems to be highlighted quickly for further investigation using traditional recorders. When recording, the Electrocorder will store the average voltage over the period chosen (1 sec to 60 min), and also records the highest (max) & lowest (min) cycle values during that period.

The EC-1V was designed for cycle analysis in many different applications:

Compressor cycling can be an issue in [pneumatic] compressor systems, where the set point is a pressure level and the system tries to maintain that set point. A better method of control can be to use a dead band system, that is, where minimum and maximum pressures are defined separately. The minimum pressure (say 10 bar) activates the 'on' signal and the maximum pressure (say 15 bar) activates the 'off' signal.

With pumps and compressors the reduction of the number on on/off cycles has a major effect on the life of the system. If you have a system with a single defined pressure setpoint, then the introduction of a timer delay can help reduce cycling. For pneumatic systems it is important to look at the minimum working pressures of the items fed from the compressor reservoir and also the maximum air demand before setting the delay times. It's important that the delay not be so long that the air reservoir is depleted by air demand before the timer allows the compressor to start.

Controlled Lighting is also prone to cycling. In this application, the set point is a lux level, and the system turns on the lighting whenever that minimum level is observed. Some systems use a dead band system where a minimum lux level turns the lights on and a maximum level turns the system off again. Cycling normally only happens at dawn or dusk due to the low light level as opposed to throughout the day. The improvements are limited by the fact that light levels normally continue to increase at dawn and decrease at dusk rather than maintaining at a given level.

For more information on Electrocorder Data Loggers, closed-loop control systems, or to find the ideal solution for your application-specific needs, contact a CAS DataLogger Application Specialist at **(800) 956-4437** or www.DataLoggerInc.com.