

AUTOMATION OF OPEN RECIRCULATING COOLING SYSTEMS

ONGUARD® FR SERIES CONTROLLER

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ABSTRACT

Improvements in cooling performance can be obtained through automation of process controls. Successful implementation of automation will improve performance, reliability, safety and operating costs. With constraints on capital budgets and available manpower, automation of cooling systems has taken a back seat to the rest of the plant. Loss or reduction in cooling capabilities usually results in reduced product throughput, off product specification, or plant shutdown. It is for this reason that automation of cooling systems must be brought in-line with the rest of the operating plant. The ONGUARD® FR Series Controller is a cost effective means to meet your current and future control needs. Combining the expertise of Drew Industrial Division and Fisher Rosemount, the modular designed ONGUARD® FR Series Controller provides complete cooling water management. Process variable control, performance monitoring, remote surveillance, inventory management, and man machine interface (MMI) are all included. *End of Abstract*

COOLING PROCESS AUTOMATION

Cooling tower technology is one of the oldest unit operations found in manufacturing facilities. Considering the age of this technology, automation of these systems have been left behind. Millions of dollars are spent every year to automate manufacturing processes with only a small portion designated to plant cooling systems. Cooling systems are all too often unattended and uncontrolled; until production is stopped due to poor cooling performance.

Cooling towers are needed to remove waste heat (BTU's), this waste heat must be restored to the environment without causing ecological damage. Ecological and monetary costs for waste heat removal must be optimized.

Improvements in cooling performance can be obtained through automation of process controls. Whether or not a new control package is utilized, or the current plant control system; automation will improve performance, reliability, safety and operating costs.

Successfully implemented automation systems relieve plant operators of tedious and repetitive tasks of monitoring and adjusting process parameters manually and allow more time for inspecting the operating condition of the equipment, performing maintenance tasks, and assisting in the overall optimizing of the plant operation. Specifically, the advantages to automatic control include:

- I. Elimination and/or reduction of human error while operating plant. This includes minimizing the risk of accidents related to chemical handling, exposure, etc.
- II. Reduced labor and associated costs.

- III. Minimization of energy consumption
- IV. Improve product quality, consistency, and throughput.
- V. Better control of plant emissions and discharges thereby minimizing risk of non-compliance violations.
- VI. Efficient and rapid communication of system upsets and operating data to appropriate personnel.
- VII. Reduction of raw material usage including:
 - A. Water savings via minimized demand and/or utilization of alternate water sources (water re-use)
 - B. Chemical Usage.

In the case of a cooling system the ultimate goal is to efficiently transfer heat from the process to cooling water and ultimately to the atmosphere.

- Corrosion inhibitor involves the feeding of the product into the system where it will ultimately react to yield corrosion inhibiting films on metal surfaces.
- Dispersants are delivered to the system to maintain target concentrations and ultimately react with hardness salts and/or suspended solids to ultimately be flushed from the system.
- pH control is accomplished by feeding acid and/or caustic materials to maintain the target concentration of hydrogen ions, alkalinity, and solubility indices of the system.
- Cycles of concentration control involves the removal of both total dissolved and suspended solids to maintain the system's target mineral solubility index.
- Microbiocides are fed to the system to maintain target concentrations but

more specifically to kill the microorganism population via the rupture of cell walls (oxidizing biocides) or inhibiting metabolic activity (non-oxidizing biocides).

There are four basic automation elements to each of the processes above:

- 1) Measure Variables (pH, ORP, conductivity, tank levels, etc.)
- 2) Manipulated Variable (pumps, valves, etc.)
- 3) Controller device (FR-Controller, DCS, etc.)
- 4) Control Logic (time feed, material balance, proportional, etc.)

Lack of capital money and manpower availability has limited the automation of the processes above. The Ashland Chemical Company - Drew Industrial Division ONGUARD® FR controller is the answer to these needs. The ONGUARD® FR controller is a reliable, field proven technology from a supplier alliance with Drew Industrial Division and Fisher-Rosemount services division, the world's largest supplier of process management equipment and systems. The FR controller will produce significant savings when used for water treatment by reducing the following:

- Makeup water usage
- Bleed water
- Labor requirements
- Chemical Usage
- Loss of heat transfer due to fouling
- Corrosion rates
- Risk of chemical handling accidents
- Risk of environmental non-compliance violations

The ONGUARD® FR controller will/can control the feed of corrosion inhibitor, microbiocide, oxidants, dispersant and antiscalent products as well as control pH and cycles of concentration of cooling systems. The system can be set up to monitor product inventories, corrosion rates, and system fouling factors. Automation of key control parameters will allow for continuous cooling tower operation at maximum cycles of concentration (the ratio between the total dissolved solids, TDS, in the cooling tower water and the TDS in the systems makeup supply). As cycles of concentration increase, cooling tower operation costs decrease. The costs associated with each change in cycles of concentration are significant, as seen in Figure 1. In addition, labor saving costs are incurred by reducing the time required by operations to attend the cooling system after the ONGUARD® FR controller has been installed.

The ONGUARD® FR controller provides a plants cooling system with flexibility, expandability, functionality, and connectivity. The ONGUARD® FR control system:

- Controls and monitors up to 64 different points
- Interfaces with performance-based monitors such as fouling monitors and CORRATORS®¹
- Utilizes standard communication languages which allow for communication to most commercially available Distributed Control Systems(DCS), providing connectivity to many types of communicating devices. Broad connectivity means more choices when planning new automation systems, and greater ability to

communicate with intelligent field devices.

- Utilizes feedforward "smart" control strategies which incorporate Drew Industrial Division's expertise in water treatment technology.
- Stores and analyzes historical and operating data.
- Features modularity in hardware, firmware, and software design. Modularity makes it easy, and cost effective, to size the ONGUARD® FR controller to both your current and future needs.
- Functionality to fit the need. The ONGUARD® FR series controller has the capability to efficiently implement simple or complex measurement and control strategies.
- Technology that is advanced, yet proven in hundreds of installations. The ONGUARD® FR series controller meets or exceeds typical field-performance requirements for temperature, low-power, ruggedness, and reliability.

The ONGUARD® FR series controller consists of these major components: a master control unit, one to four module racks, one to 64 input/output (I/O) modules, a memory module, and one or two expansion RAM modules. The master controller unit can house one or two plug-in communications cards and a 12 to 24 volt dc I/O power converter.

The plug-in, single-point I/O modules contains its own signal conditioning and conversion circuits, allowing modules to be used in any combination and location in the module racks. I/O modules are available for interfacing to analog, discrete, and pulse devices of various types and voltage/current ranges.

The ONGUARD® FR series controller operating system firmware resides in a plug-in module called a Memory Module. Upgrading the firmware is easy --- it is only necessary to remove and replace the MEMORY module.

Modularity also extends to memory capacity. Random-access memory (RAM) size can be increased to meet the storage requirements for data, application programs, and communication protocols by using one or two plug-in RAM expansion modules.

As a stand-alone unit, the ONGUARD® FR series controller can be configured and operated onsite using a PC-compatible laptop or palmtop computer. Information can be gathered and archived for up to 35 days and then retrieved by an operator using the laptop computer or automatically gathered by the ONGUARD® Remote Surveillance software.

The ONGUARD® FR series controller is easily integrated into to an automation system either through direct connection, telephone line, or radio link. The ONGUARD® FR series controller uses any of several available communication protocols including MODBUS², Hewlett-Packard 48000 RTU, or ONGUARD® FR series controller protocol. These communications drivers are certified to communicate with PROVOX³, ROSEMOUNT SYSTEM^{3,4}, INTELLUTION DMACS⁵, WONDERWARE IN-TOUCH⁶, FACTORY LINKS IV⁷ and countless other Distributed Control Systems(DCS) and Man Machine Interface(MMI) software and hardware platforms.

The ONGUARD® FR series controller offers application capability derived from industrial process control such as proportional integral and derivative (PID), On/Off, Feedforward and tank level management. This functionality lets the ONGUARD® FR series controller grow with your needs. In addition, customized control strategies specifically targeting water treatment applications represent state of the art *smart* control and were designed to enhance the performance and cost effectiveness of a comprehensive water treatment program.

The MAGELLAN™ Controller MMI module provides a PC-based workstation for operators which provides on-line viewing and control of multiple controllers installed on site. We are presently using IN-TOUCH 5.0 from WONDERWARE as the platform in which MAGELLAN software is programmed. The software operates under WINDOWS⁸ and is recognized widely throughout the chemical processing, utility, food and beverage, plastics, pulp and paper, pharmaceutical, and primary metals markets as one of the leading packages available. The Magellan MMI controller software features:

- **Object oriented graphics** which allows for development of easy to interpret screen design.
- **Animation links** which enable animated representation of process changes.
- **Standard user interface** enabling anyone familiar with Windows to navigate through the application.
- **Dynamic Data Exchange(DDE)** which allows sharing data with other WINDOWS software programs.

- **Real-time and Historical Trend Graphs** which can simultaneously display up to four pens. The software displays the measured parameter at the cursor location and supports scrolling, zoom and centering capabilities.
- **Extensive Alarming capabilities.**
- **Calculation and recipe capabilities** which enable implementation of complex *feedforward* control schemes.
- **Password protection** which assures that only authorized personnel have access to functions such as set point and alarm programming.

ONGUARD® Remote Surveillance Data Services are included. Systems installed in the field are automatically polled remotely for further graphing and analysis. This system is continuously on stand by to receive phone calls from systems when alarms are detected. In response to an alarm one or all of the following will happen:

- Send an e-mail to an Ashland Representative
- Notify the local Drew Industrial representative via pager
- Dispatch a Rosemount service technician.

The ONGUARD® FR series controller is designed to be technologically sophisticated, yet operate reliably under tough conditions. Power consumption is low, which makes the ONGUARD® FR series controller ideal for solar powered installations, because solar panel and battery costs can be reduced.

Performance specifications cover a wide temperature range, reducing the need for

temperature-controlled enclosures. Built-in self-test diagnostics and watchdog timers help in troubleshooting and protect the application from erroneous outputs.

Ruggedness is apparent in the design and construction of the ONGUARD® FR series controller. The heavy gauge steel chassis and doors use corrosion resistant epoxy and zinc-chromate finishes: Circuit boards are mil-spec quality; connectors use gold plated sockets and pins; and I/O module circuitry is encased in solvent resistant thermoplastic.

A variety of packaging options for the ONGUARD® FR series controller are available to meet most installation requirements. Included is a rugged, freestanding enclosure that also accommodates radio and solar equipment, making it the ideal package for harsh or remote environments.

The FR controllers utilize Model 54 Rosemount probes with Rosemount transmitters for superior control and ease of operation. Model 54 analytical instruments feature self diagnostics. For example, a Model 54 pH analyzer can sense cracked or fouled probes as well as calibration failures. Upon detection of one of these faults, the analyzer sets off an alarm which in turn is detected by the controller which further in turn can disable acid feed and alert both Drew Industrial and Rosemount Services to the problem.

The implementation of the ONGUARD® FR series controller provides total automation of you plant's cooling needs. This system is flexible and expandable to meet your current and future

requirements. Many companies include total automation in their vision, the ONGUARD® FR series controller will help you reach your goals. The ONGUARD® FR series controller is available through a lease program that includes: all maintenance, replacement parts, 24-hour service, and regular preventative maintenance visits.

¹ CORRATOR® is a registered trademark of Rohrback Cossasco Systems, Inc.

² MODBUS is a registered trademark of AEG Schneider Automation, Inc.

³ PROVOX is a registered trademark of Fischer Controls International, Inc.

⁴ SYSTEM 3 is a registered trademark of Rosemount, Inc.

⁵ DMACS is a registered trademark of On-line Software Labs, Inc.

⁶ WONDERWARE is a registered trademark and WONDERWARE IN TOUCH is a trademark of Wonderware Corporation

⁷ FACTORY LINK IV is a registered trademark of United States Data Corporation

⁸ WINDOWS is a registered trademark of Microsoft Corporation.

XYZ CHEMICAL COMPANY

RECIRCULATION RATE 50,000 gpm
 TEMPERATURE DROP 20 deg F
 EVAPORATION:
 = 1% x RR x Delta T/10degF 1000 gpm

BLOWDOWN(BD)= EVAPORATION/(CYCLES - 1)

MAKEUP(MU) = EVAPORATION + BLOWDOWN

PRODUCT A	100 ppm dose	\$1.00	per pound
PRODUCT B	75 ppm dose	\$1.33	per pound
MAKE-UP COST		\$0.35	per 1000 gal
BLOWDOWN TREATMENT		\$0.10	per 1000 gal

CYCLES	MU COST \$ /YR.	A COST \$ /YR.	B COST \$ /YR.	BD COST \$ /YR.	TOTAL \$ /YR.
2.00	\$367,920	\$438,613	\$437,517	\$52,560	\$1,296,610
2.25	\$331,128	\$350,891	\$350,013	\$42,048	\$1,074,080
2.50	\$306,600	\$292,409	\$291,678	\$35,040	\$925,727
2.75	\$289,080	\$250,636	\$250,010	\$30,034	\$819,760
3.00	\$275,940	\$219,307	\$218,758	\$26,280	\$740,285
3.25	\$265,720	\$194,939	\$194,452	\$23,360	\$678,471
3.50	\$257,544	\$175,445	\$175,007	\$21,024	\$629,020
3.75	\$250,855	\$159,496	\$159,097	\$19,113	\$588,560
4.00	\$245,280	\$146,204	\$145,839	\$17,520	\$554,843
4.25	\$240,563	\$134,958	\$134,621	\$16,172	\$526,314
4.50	\$236,520	\$125,318	\$125,005	\$15,017	\$501,860
4.75	\$233,016	\$116,964	\$116,671	\$14,016	\$480,667
5.00	\$229,950	\$109,653	\$109,379	\$13,140	\$462,122
5.25	\$227,245	\$103,203	\$102,945	\$12,367	\$445,760
5.50	\$224,840	\$97,470	\$97,226	\$11,680	\$431,216
5.75	\$222,688	\$92,340	\$92,109	\$11,065	\$418,202
6.00	\$220,752	\$87,723	\$87,503	\$10,512	\$406,490
6.25	\$219,000	\$83,545	\$83,337	\$10,011	\$395,893
6.50	\$217,407	\$79,748	\$79,548	\$9,556	\$386,260
6.75	\$215,953	\$76,281	\$76,090	\$9,141	\$377,464
7.00	\$214,620	\$73,102	\$72,919	\$8,760	\$369,402
7.25	\$213,394	\$70,178	\$70,003	\$8,410	\$361,984
7.50	\$212,262	\$67,479	\$67,310	\$8,086	\$355,137
7.75	\$211,213	\$64,980	\$64,817	\$7,787	\$348,797
8.00	\$210,240	\$62,659	\$62,502	\$7,509	\$342,910

The implementation of an automated system will reduce labor cost associated with operation of the cooling system.

Before Automation	4	hours/day	@	\$50.00	\$/hr
After Automation	1	hours/day	@	\$50.00	\$/hr
Annual labor savings				\$54,750	\$/yr.