RF SIGNAL TRANSMISSION FOR THE WATER TREATMENT INDUSTRY

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Within the water treatment industry, radio frequency transceivers are the ideal solution for the wireless transmission of digital and analog I/O signals associated with chemical dosing across a wide range of water treatment applications.

WHITEPAPER

TABLE OF CONTENTS

INTRODUCTION

Radio Frequency Transceivers Play an Instrumental Role in Water Treatment

Manufacturing pulp and paper requires tremendous volumes of water — approximately 15,000 gallons for every ton of paper manufactured. All the water used in a paper mill must be treated before it can be discharged back into the environment.

Chemical treatment applications such as defoamers are widely used, because the chemicals they disperse eliminate surface foam and minimize entrained air (which prevents additional foam from forming). The volume of chemicals dispersed in these applications varies widely — so data and analytics are needed to measure foam levels and to ensure that the correct volumes of chemicals are dosed. These types of systems work more effectively when data can be transmitted wirelessly.

This document provides an overview of the benefits associated with effectively utilizing radio frequency transceivers for the wireless transfer of digital and analog Input and Output (I/O) signals within a large, geographically dispersed defoamer application at a U.S. paper mill.

Integrating the correct I/O radio frequency signal transmission communication components within process & control applications significantly reduces installation and maintenance costs by eliminating long cable and conduit runs.

Radio frequency transceivers are extremely beneficial when integrated with other analog and digital secure Industrial Control Systems (ICS), including:

- Supervisory Control and Data Acquisition (SCADA) systems;
- Distributed Control Systems (DCS);
- Programmable Logic Controllers (PLC).

It is abundantly clear that Secure Data Transfer (SDT) is a major concern within all Industries. Secure Data Transfer is now generating the same level of interest as energy efficiency and operational benefits. The machine-to-machine (M2M) data acquisition component of this system counteracts typical threats and vulnerabilities to this system, meets the secure data acquisition requirement and provides the necessary security countermeasures to mitigate the associated risks to sensitive, business-critical data.

This document illustrates the entire secure ICS solution, designed and developed specifically for this large scale defoamer application. It also covers system topologies, and identifies required system components — including the M2M and Industrial Internet of Things (IIoT) devices integrated into this application.

Problem Description

In this particular application, effluent water from various parts of the mill is collected in the central clarifier. Water used throughout the plant gets contaminated, and so it must be cleaned before it is discharged.

The central clarifier water is pumped miles away to a series of retention ponds, where it is treated prior to final discharge. In theory, the water entering pond 1 forces existing water out into pond 2. Pond 2 water then cascades into pond 3 and then into pond 4, for further settling. Pond 4 is considered to be the cleanest water — and this can be discharged into the river.

The retention ponds have aeration heads that are strategically positioned to manage oxygen levels. While oxygen is a critical component to keeping the ponds clean, the agitation of the water caused by aeration creates foam — particularly in high conductivity water.

Entrained air and surface foam can cause a variety of quality, production and environmental problems for industrial operations. In this particular application, when foam forms on the surface of the ponds, it is dried out by the sun and then becomes airborne.

Airborne foam can cause respiratory health hazards for employees and it can often lead to hazardous foam deposits building up on nearby structures and equipment, depending on the origin of the foam.

If process foaming conditions are not dealt with in a timely manner, significant costs can be incurred for labor, time and materials to clean up the mess.

SOLUTION

Automation Solution Implementing RF Signal Transmission

To avoid foam formation in process water (and to eliminate airborne foam and its associated detrimental effects), it is necessary to feed an anti-foam chemical to knock down the foam when it is first detected.

A defoamer or an anti-foaming agent is a chemical additive that reduces and hinders the formation of foam in industrial process liquids.

Prior to the development and implementation of the automated defoamer dosing system described in this document, a defoamer chemical was being dosed at a fixed rate into various locations within the clarifier.

This fixed feed treatment method proved to be very costly. In some cases, it was also ineffective:

- When conditions are optimal with zero foam present in the system, unnecessary dosing will result in chemical overfeed conditions.
- During excess foam conditions, the system was unaware of the foam build up, and did not disperse enough chemical to address the problem.

This new automated defoamer dosing system described in this document is designed to dose defoamer or anti-foam chemical into the retention ponds based on foam being detected at the central clarifier three (3) miles away from pond 1.

The foam is detected using both analog and digital foam detectors, which are positioned at the central clarifier and collection basin.

The stage 1, 2 and 3 automation layout diagrams included in this document will help provide a clearer understanding of how this system is laid out and how this unique control philosophy has been applied.

System Description

The primary components contained in this Smart Digital Automation solution is the EquipSolutions CRIUS® multi I/O controller working in conjunction with RF analog and digital signal transceivers.

The EquipSolutions CRIUS chemical dosing system integrates a state-of-the-art web-based controller including an embedded web server with the extremely flexible Radioline signal transceivers which have a high degree of reliability, thanks to the AES encryption and frequency hopping spread spectrum (FHSS) method they use.

This Smart Digital innovative integrated system approach will guarantee the optimization of the defoamer programs at this paper mill facility.

This automated system will ensure centralized 24/7 awareness of the clarifier water treatment program and foam presence. The automated system will also ensure optimal chemical feed for foam control resulting in a significant cost reduction for defoamer chemicals.

CHEMICAL DOSING STRATEGY Stage 1

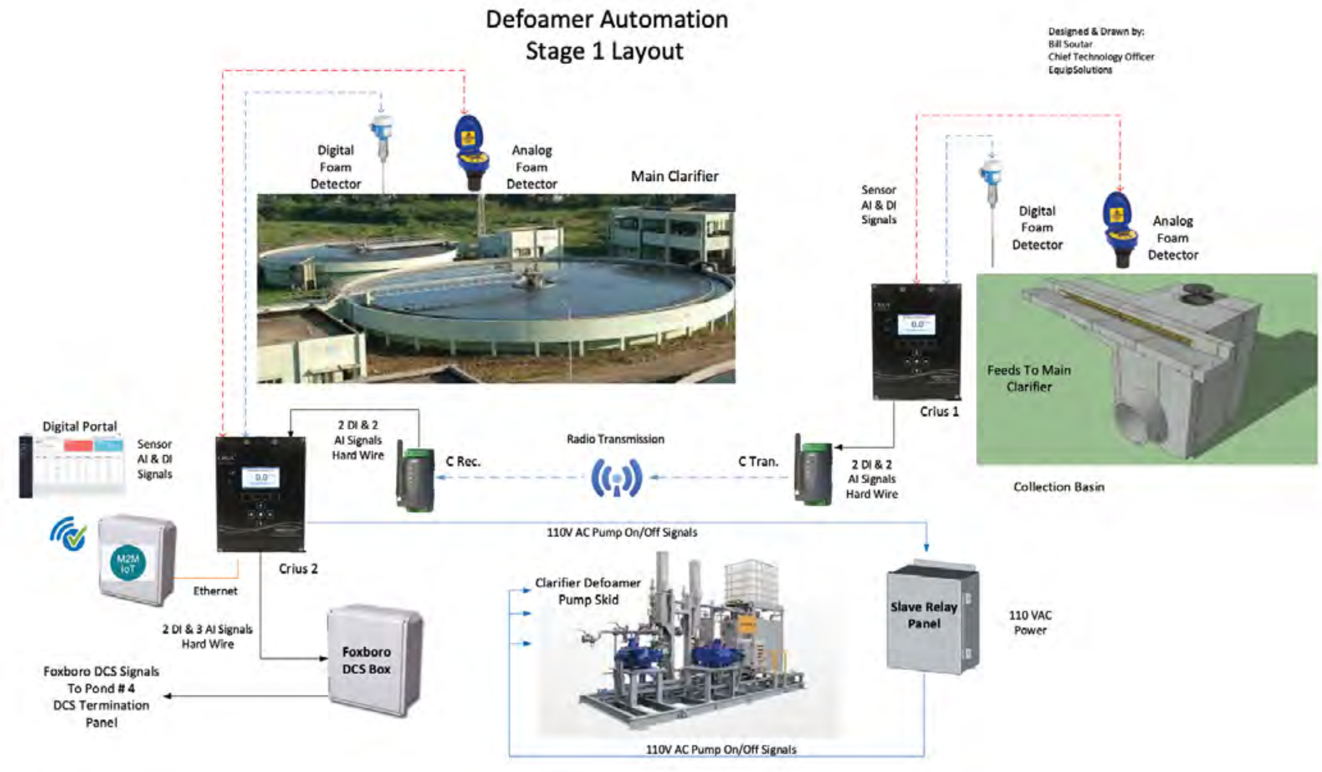
The chemical feed strategy at this Pulp & Paper plant is as follows:

Stage1:

The collection basin is located at the inlet prior to the wastewater clarifier. This is the area where the primary foam sensors will be located to initiate the three (3) defoamer dosing pumps treating the waste water clarifier.

Primary analog and digital foam sensors are positioned in the collection basin ahead of the clarifier to detect foam presence.

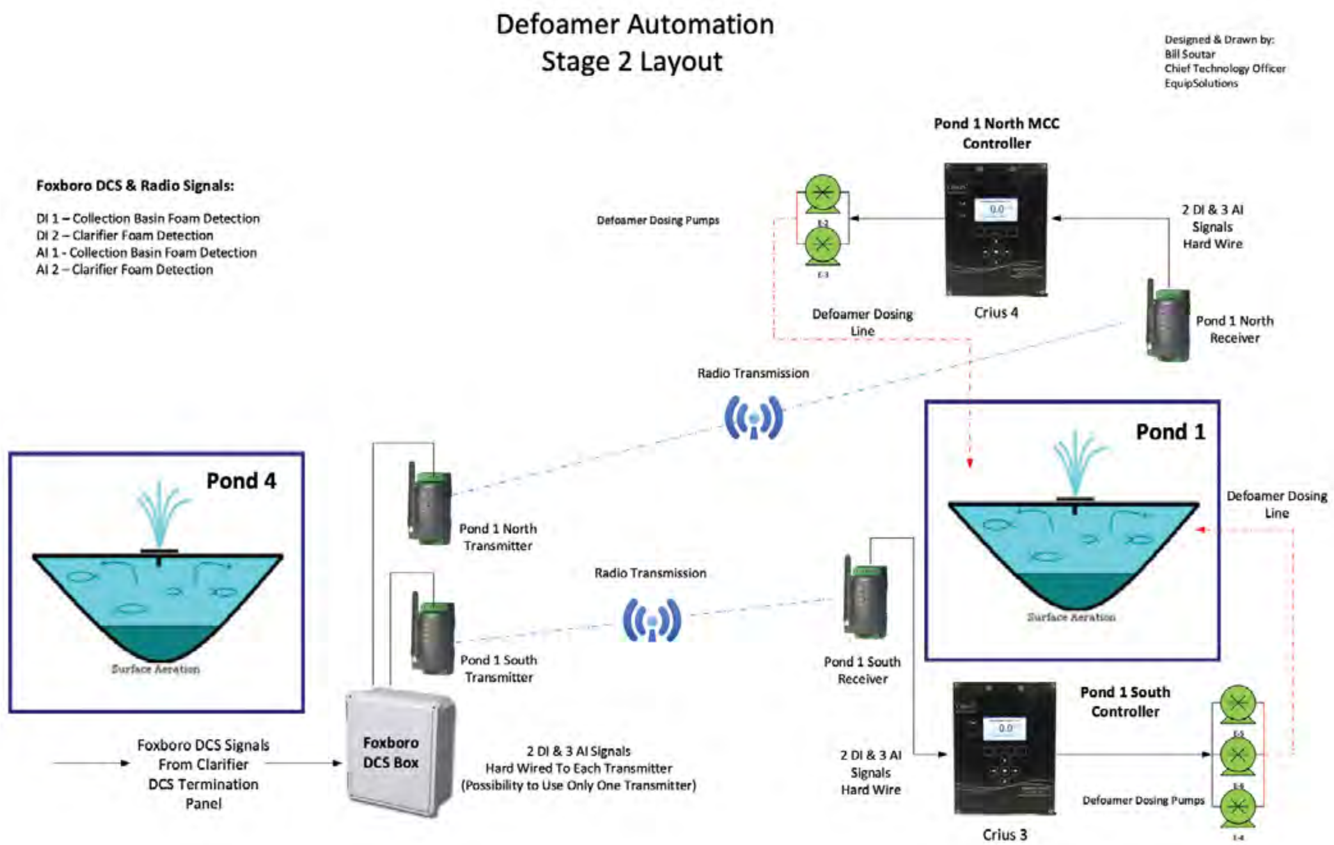
The digital and analog signals will be transmitted from the collection basin's CRIUS 1 controller to the CRIUS 2 controller located at the central clarifier using radio transceivers. The CRIUS 2 controller will be programmed to turn three (3) defoamer pumps on and off based on foam presence in the primary collection basin. These pumps are located at the central clarifier and the discharge injection points are configurable.



CHEMICAL DOSING STRATEGY
Stage 2

Secondary foam detectors will be positioned at the central clarifier to initiate defoamer dosing at pond #1. In total, two (2) analog signals and two (2) digital signals will be wired from the Crius 2 controller to the plant Foxboro DCS I/O panel. These signals will be transmitted over the Foxboro DCS network to retention pond #4 and collected at a termination box provided by EquipSolutions. Utilizing the Foxboro DCS for signal transmission will significantly reduce the installation costs. The two (2) analog signals and two (2) digital signals will be transmitted via radio transceivers from pond #4 to the Crius controllers located at pond #1.

The primary trigger to initiate defoamer dosing at pond #1 is the secondary foam sensors located at the effluent of the waste water clarifier. The defoamer dosing pumps at pond #1 will turn on as soon as foam has been detected at the central clarifier and turn off when the foam has been removed or knocked down to an acceptable level. Delay on and delay off timers have been integrated into the control logic to further optimize chemical usage.



CHEMICAL DOSING STRATEGY
Stage 3

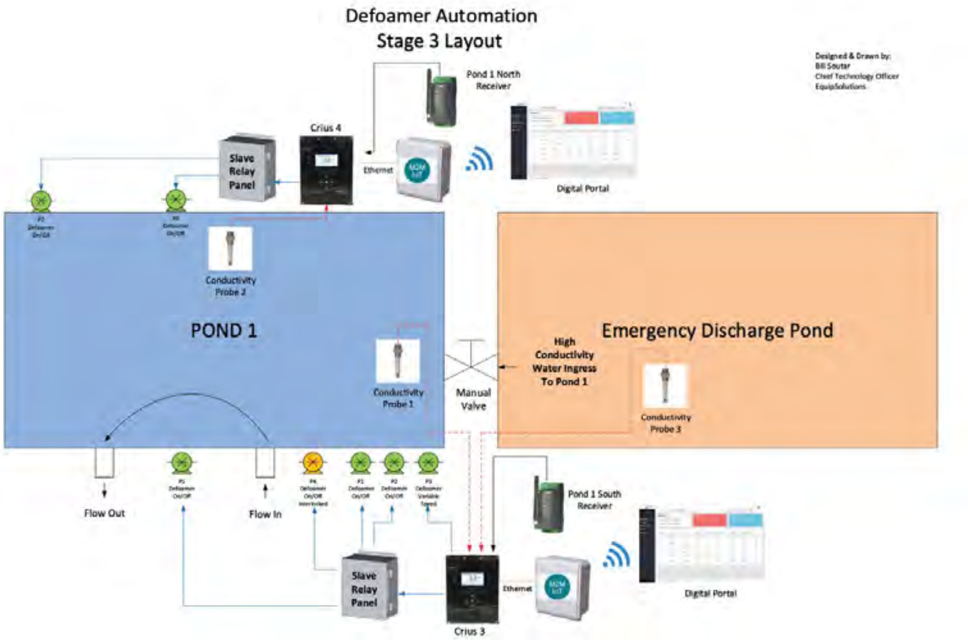
The two (2) analog signals and two (2) digital signals will be transmitted from the pond #4 location to the pond #1 south and pond #1 north Motor Control Center (MCC) locations using radio transceivers. Foam presence detected at the central clarifier will be used to activate all of the on/off defoamer dosing pumps located at pond #1.

Additionally, a conductivity sensor will be positioned in pond #1 at the Emergency Discharge Pond inlet. This conductivity measurement will feed back to the CRIUS 3 controller located at the pond #1 south feed station. A variable speed pump dosing defoamer will be ramped up and down proportional to high conductivity water ingress from the Emergency Discharge Pond.

A second conductivity sensor will be positioned in the Emergency Discharge Pond to monitor and trend conductivity. A trim control or maintenance defoamer dosing pump will be interlocked with the main defoamer dosing pumps. The trim or maintenance defoamer dosing pump will only turn on when the main defoamer dosing pumps are off. The trim or maintenance defoamer is dosed to maintain a "zero foam presence" condition in pond #1.

A third conductivity sensor will be positioned in pond #1 close to the north MCC building. This sensor will be used initially to trend conductivity in this part of pond #1. It may also be used as a variable to control defoamer dosing in any low circulation areas of the pond that may exist. The three (3) conductivity sensors described in this application also provide a mechanism to achieve overall system conductivity profiling. Conductivity information is collected and stored by the automation system and can then be applied to AI and predictive analytics.

Predictive analytics is a broad term describing a variety of statistical and analytical techniques used to develop models that predict future events. Data collection is one of the components of predictive analytics that entails analysis of data to identify trends, patterns or relationships among data. Moving to predictive analytics and predictive modeling adds business value and prepares any organization for machine learning and AI to help prevent system failures in the future.



Radio Transceiver System Considerations

Things to consider when integrating radio transceivers with an application:

Environment:

- Will the radio modems be installed inside or outside?
- Will data be sent line-of-sight or will there be obstruction?
- What is the distance that needs to be covered by the radio modems?
- Are there wireless antennas on the same band nearby?

Latency:

The majority of industrial applications are fully functional when wireless radio modems are installed instead of hard wired — but there are several factors to consider when replacing hard wire with RF transmission.

Wireless signal transmission introduces latency or delay when sending and receiving data. However, most applications/systems can accommodate some latency. In most cases, fine tuning the response times can resolve any latency problems that may occur. Too much latency on the other hand can impact operations — so latency is something that must be considered.

Distance & Modem Selection:

Long range, short range, 868 and 900 MHz, and 2.4 GHz. 1mW to 1W outputs. 900 MHz works mostly in North and South America, 868 MHz in Europe because of different allocation of the radio spectrum. 2.4 MHz works almost everywhere.

Long range modems are usually adjustable between 115,200 bps and 9,600 bps, to maximize performance in longer distance situations.

Antennas:

Antennas are typically straightforward and easy to work with, but they can cause a lot of problems if you don't understand the basics. If the wrong antenna is selected for an application, it may result in poor or even zero signal transmission between point A and point B.

There are two basic kinds of antenna typically used for radio modems: An omni-directional antenna and directional antenna.

- The omni-directional antenna broadcasts 360° but in some cases has a shorter range.
- The directional or high gain antenna works in one direction, for both transmitting and receiving.

Aiming a directional antenna is easy if you can see the other antenna. But if it's too far to see, using a map or GPS and compass to point a more precise direction may be necessary to even start the process.

A radio frequency site survey can be done ahead of time to establish signal strength patterns in more challenging settings. Changing modem placement can make a big difference in signal strength around high-power metal equipment. Baud rate or data rate is another thing that needs to be considered when applying RF data transmission equipment. Many industrial applications do not consume much bandwidth so in most cases this is not a problem but still needs to be a consideration.

However, baud rate can be even more important as it affects the distance your wireless signal travels. Typically, as baud rate decreases, the receive sensitivity increases. Receive sensitivity directly impacts how far a wireless signal can be received in the same way as transmit power impacts distance.

Executive Summary

Digital transformation is a key strategic objective in any industry today. The benefits associated with modernizing work practices, leveraging new technologies and optimizing operations are significant.

The fact remains that for many operations this can seem overwhelming. Control systems are locked down, information is hard to access or process, transmitting signals through hard wire is expensive and system changes and equipment installations can be costly and time-consuming.

In summary, wireless analog and digital signal transmission is the perfect fit for this new web-based automated defoamer dosing system approach, offering superior local and remote monitoring & control, analytical sensing, wireless communications and data acquisition capabilities.

This radio frequency signal transmission model also adds value to the customer by introducing the following benefits:

- Minimal installations cost
- Faster installation time
- Reduced maintenance costs
- Increased profitability
- And the elimination of chemical overfeed and underfeed scenarios.

The new automated defoamer dosing system resolved the foam formation issue — as well as the airborne foam issue at this paper mill — by ensuring precise chemical dosing control utilizing radio frequency transceivers.

For more information on customized solutions for your business, contact EquipSolutions today @ **888-200-1800,** or email inquiries to: **CustomerCare@equip-solutions.com**.

About EquipSolutions

We are an engineering company providing custom equipment primarily for the water treatment industry. As well as providing the application specific equipment solution for our customers, we also provide all of the associated PLC automation and controls programming, analog & digital radio signal transmission, Machine-to-Machine (M2M) remote communications, systems integration services. We provide secure data transfer services to ensure that our customers' business-critical data is not compromised. We offer complete, innovative water treatment system solutions to our clients. Visit us online at **www.equip-solutions.com**.

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