Water in the Cloud: Remote Understanding of Water Chemistry

[Poster Abstract]

Roger D. Chamberlain
Mike Chambers
Darren Greenwalt
Brett Steinbrueck
Todd Steinbrueck


Dept. of Computer Science and Engineering
Washington University in St. Louis

BECS Technology, Inc.
St. Louis, Missouri
Poster Abstract: Water in the Cloud: Remote Understanding of Water Chemistry

Roger Chamberlain
Washington Univ. in St. Louis and BECS Technology, Inc.
St. Louis, Missouri
roger@wustl.edu

Mike Chambers
BECS Technology, Inc.
St. Louis, Missouri
mike.c@becs.com

Darren Greenwalt
BECS Technology, Inc.
St. Louis, Missouri
darren@becs.com

Brett Steinbrueck
BECS Technology, Inc.
St. Louis, Missouri
brett@becs.com

Todd Steinbrueck
BECS Technology, Inc.
St. Louis, Missouri
todd@becs.com

ABSTRACT
Water treatment is one of those essential elements of modern life that is taken for granted by the general population. In this poster, we describe the ability to remotely understand and improve water chemistry using controllers attached to the cloud.

CCS CONCEPTS
• Information systems → Sensor networks; Process control systems; • Networks → Cloud computing;

KEYWORDS
IoT, water chemistry

1 INTRODUCTION
The Internet of Things (IoT) provides tremendous opportunities for enhanced quality of life; however, it comes with substantial uncertainty as to whether those benefits might be outweighed by the risks incurred. The security of IoT devices has been shown to be particularly vulnerable, Costin et al. [2] have identified significant numbers (hundreds of thousands) of IoT devices with exposed vulnerabilities.

BECS Technology, Inc., is a firm that provides water chemistry monitoring and control equipment to the aquatics market. EZConnect™ is the security infrastructure it has developed that provides remote access capability to its devices. This remote access capability satisfies the need for security yet balances that need with the equivalent need for ease of installation and maintenance [1].

Figure 1 shows the essential components of the EZConnect system. Water chemistry controllers are typically installed on a local area network behind a firewall. Applications (either desktop programs or mobile apps) wish to communicate with the controller. Since the firewall (correctly) blocks incoming communications requests, data transfer is facilitated by the controller making an outbound connection to the EZConnect server, which accepts requests for communication to a controller, validates the authority to do so, and forwards vetted messages to/from the controller.

Here, we describe EZAnalytics™, the use of the EZConnect infrastructure to enable cloud-based data logging and analytics on water chemistry data from a collection of controllers.

2 DATA TO THE CLOUD
There is a significant amount of data that is currently retained by the controllers about water chemistry. This includes historical information on sensor readings (e.g., pH, oxidation-reduction potential (ORP), free chlorine concentration, temperature, conductivity, turbidity, etc.), alarms (e.g., readings out of range, etc.), and user
actions (e.g., set-point changes, etc.). In addition, information on chemical stocks are frequently monitored and logged as well.

It is currently possible to retrieve all of the above information from a controller to a desktop application or mobile app by connecting to the EZConnect server, providing appropriate authentication, and asking the controller for its internal data logs. Our current endeavor is to collect this information off of a collection of controllers (e.g., all owned by an individual organization), retain the collected data in the cloud, and realize benefit from the aggregation that is not realized from each individual controller’s data in isolation.

Owner/operators of this equipment are responsible for more than one controller, and they would benefit significantly from a relevant summary view of the state of the water chemistry under their purview. An example of a summary view (appropriate for each controlled body of water) is illustrated in Figure 2.

![Figure 2: Screen capture of summary view data presentation. Additional details are available via a link associated with each individual item.](image)

In the figure, relevant information is organized for quick reference, highlighting the ”big picture” of the water chemistry, and allowing for a more detailed drill down via a link associated with each item. Groups of items are organized into categories (e.g., events, inputs, outputs), and current values are supplemented with trends (indicated by directional arrows) and ranges of values for the previous time period.

The above is facilitated by a number of concurrent processes running in the EZConnect server (which is deployed in the cloud). First, a data logging process periodically communicates with each connected controller and retrieves the data logs for that immediate past period. Second, those data are inserted into a persistent database. Third, a report generator mines the database to generate the information needed for the summary view, and finally, the summary view is served to the user via a secure web server.

3 DATA ANALYTICS

While the summary data presentation is valuable to users, particularly for understanding the current state of the water chemistry that is immediately their responsibility, the true value of the data in the cloud is what it can potentially tell us about water treatment generally. By combining data from a number of controllers, we can learn more than it is possible to discern from any one example.

We are aggregating controller data in two ways. First, data that are from controllers all owned by an individual organization can be readily combined and mined for the benefit of that organization. They own both the equipment and the data. Second, for those organizations that give permission, anonymized data sets can be made available for mining (e.g., see [3, 4]), providing for a potentially much larger data set.

There are a number of things we hope to learn from these data.

- The effectiveness of control decisions. How well do different approaches work at maintaining water chemistry control? What factors are important?
- How to recommend better control approaches. How well will control approaches that are effective in one body of water transfer to another?
- How to minimize chemical usage. The data logs not only contain sensor readings of water chemistry, but also log chemical feed rates and supplies. Can we make water chemistry control more cost effective, by decreasing the consumables needed?
- How to predict problems. Alarm conditions (e.g., due to water chemistry being out of balance) require fast and expensive human response. Both public safety and maintenance effort required will be improved if we can predict problems prior to them reaching the level of an alarm.

Modern machine learning techniques are well suited to addressing the questions we pose above. While the data analysis has not yet happened, as the system is just now being deployed in the field, we are very optimistic that new insights will come from the data aggregation described above.

4 CONCLUSIONS

EZAnalytics provides an operational ability to collect water chemistry data from a collection of control equipment. This data collection is secure, and supports multiple levels of data analysis. The initial deployment provides summary data to equipment owners/operators about the water chemistry under their direct control. The promise, however, is potentially substantially more beneficial. We will be able to use data from multiple installations to learn broad truths about water chemistry control that can be shared across the industry.

REFERENCES

