Reducing Costs and Maintaining Uptime and Production with a Centralized Chemical Management Solution

A Bentley White Paper

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Published:
October, 2020
Creating Savings in Challenging Times

Now more than ever, oil and gas operators are looking for cost-effective solutions with a fast return on investment. One such solution is chemical and corrosion management. Owner-operators around the globe use a rich variety of chemicals across upstream, downstream, and midstream operations. These chemicals are used for various processes, including drilling, cementing, completion, stimulation, and production. Chemicals play a crucial role, especially where emulsion breakers, antiscalants, corrosion inhibitors, and biocides can make the difference by maintaining uptime, production, and integrity while also reducing risk and increasing safety.

Specialty oil field chemicals are used throughout the oil and gas industry to improve well performance for more cost-efficient and environmentally friendly exploration and production. Chemical management can play a crucial role in monitoring these chemicals to maintain uptime and, therefore, keep production flowing. Failure to do so would involve downtime and heavy financial implications. While the implementation of chemical injectors can ensure that wells are being injected, it is even more important to measure how much is being injected, understanding the performance of the chemical so is it being used correctly, what the associated costs are, and what the implications of under or overdosing with chemicals are.

This paper will look at the many benefits of a centralized chemical management system and the role that it plays in supporting decisions. It will also look at how far-reaching the monitoring of chemicals can be in other areas of oil production, as well as how they can all be incorporated into a centralized solution.

Figure 1. Data collection is no longer good enough. Now, it’s what you do with it to generate insights.
Saving More Than Chemical Costs

While chemical management is a generic term that implies the simple act of managing chemicals, there is more to it. This area of operation can cover many other disciplines, such as fluid chemistry, integrity, flow assurance, erosion, production, and environmental and laboratory management. One of the main processes and uses of chemicals for oil fields is chemical injections during production. Chemical injection is a general term for injection processes that use special chemical solutions to improve oil recovery, remove formation damage, clean blocked perforations or formation layers, reduce or inhibit corrosion, upgrade crude oil, or address crude oil flow-assurance issues. Demulsifiers and corrosion and scale inhibitors are the dominant product categories among oil field chemicals; however, as crude oil is generally produced with significant amounts of saline water, demulsifiers need to be used in processing to separate water prior to refining. Without this separation, there would be significant corrosion problems.

Insufficient dosage rates of chemical injections can severely jeopardize production and, ultimately, lead to expensive downtime. A worst-case scenario is the complete destruction of an asset. Therefore, over the years, there has been a tendency to over-inject chemicals because the thinking was that it was better to have too much rather than too little. In some instances, customers were over-injecting chemicals by over 20% of the required amount for one chemical in a well over a year. Depending on the type of well, overinjection could cost up to EUR 350,000 per year. Across an entire field, which could be hundreds of wells, the costs can rise considerably.

Many operators have chemical injection systems in place, but they need to know how they are injecting the correct dosage into the well. Over-injection only creates inaccuracies in how much is being used, especially with older flow measurement technologies or with manual operations. Not only is it a waste of money because chemical usage is not optimized, but also injector systems were not designed for excessive amounts of chemicals. Therefore, the chemicals themselves can damage the system. It is imperative to have a chemical management solution that not only monitors chemical usage, but is also able to provide information on how much over-injection is costing, how it affects production and corrosion levels, and how to drive down costs and optimize usage.

A reliable chemical management solution is an enabler of maximizing production. Modern production methods and environmental constraints demand chemical solutions. As oil fields age, there is an increased need for chemicals to ensure steady production, highlighting how important a chemical management solution is to measure production and performance.
Data Challenges and How to Deal with Them

One of the main challenges when creating a successful chemical management system is data. Chemical injection dosages, tank levels, and chemical inventory should be monitored, and they produce data from which you can draw insights. However, you cannot draw insights from something that is unmeasured, such as over-injections. If you are monitoring data, it needs to be reliable, without gaps, and accessible in a timely manner. Even in the digital age, critical oil and gas data is still held in spreadsheets and tables or siloed away in inaccessible applications. Therefore, collating and reporting takes time and many resource hours; and when the reports are finally ready, they are out of date, negating any opportunity for proactive responses because the window of opportunity has passed or the problem scenario has already occurred. Effective chemical management requires connecting all relevant data and information sources together for reliable and accurate decision-making.

The need for a dedicated chemical management system, operating within a connected data environment, should be high on the “strategic to-do list” for oil producers.

While SCADA and historian systems are popular for storing data, oil-producing operators need the right analytics and visibility to gain timely insights and to act upon them to get the most out of the data. Many operations have separate applications that require you to manually collect data for different engineering disciplines, such as chemicals, corrosion, integrity, erosion, production, environmental, and lab analysis. The difficulty comes in bringing all data sources together in one system to provide a complete picture of chemical and corrosion management and performance.

To address this problem, Bentley’s AssetWise platform is underpinned by a connected data environment and is an illustration of how interoperability is the cornerstone of information accessibility. AssetWise allows the seamless integration of isolated systems and processes that bring the information you need into its analytical platform for consolidation, analysis, insights, and decision support. The data is turned into actionable information and viewed within dashboards that are easily tailored to specific needs.
Requirements of a Chemical Management System

The primary use of a chemical management system is to enable owner-operators to manage their oil field operations more effectively. Therefore, the system needs to be comprised of several core components that enable positive change. Some of these components are:

Notifications for taking action
A dedicated chemical management system reports on measurements like flow rates, levels, chemical usage, and discharge pressures. It will also be committed to providing alerts regarding any upcoming events that affect production, such as notices of potential equipment failure and drops in pressure or flow rates. These events could be early indicators of the overuse of chemicals in the injectors. The system will automatically inform maintenance teams or chemical engineers so that they can plan and schedule corrective action before the problem gets worse, as opposed to requiring unplanned site visits after a failure occurs.

Visualization
Displaying information that is easy to read and visualize, and allows you to move away from spreadsheets, can only be a good thing. When multiple dashboards are used that incorporate a variety of visual styles, it is even easier to see important information. All of it can be viewed separately, or as part of a digital twin, using a combination of near real-time data, images, 3D models, and GIS to provide a holistic representation of the operation.

Continuous monitoring
With the large and complex set of assets, systems, components, and parts that make up any given operation, there are numerous things that can go wrong that affect process flow rates and pressures, as well as operating temperatures. Some of them include general wear and tear, equipment fatigue, and human error. It only takes a small change in one of these variables to upset the condition and performance of a finely tuned system, and the consequences of a small error can be large and costly if left unchecked. It is also important to know the day-to-day metrics of production against targets, chemical usage, and discharge so that you can effectively measure performance. However, it is also crucial to have a system that recognizes these changes (or the results of these changes), addresses them, and alerts personnel problems before they happen.

Scalability
A chemical management solution should have a template and replication feature to create a standard for commonly used systems and structures so that new additions or equipment can be swiftly uploaded to the registry. Any changes across multiple sites or assets can easily be replicated across all required points by adjusting the template for a specific instance.

Security
Many assets are owned by multiple vendors. Therefore, a flexible, yet secure, chemical management system is necessary for tracking who is using what while maintaining the security and privacy of each vendor. Each vendor needs their own secure access to the system, especially when it involves financial data. They also need the ability to schedule
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truck services for manual sampling and injections so that vendors are aware of what chemicals are needed, and when and where they need to be applied. This information is crucial, especially when dealing with assets across a large geographic area. Each vendor can securely monitor their own activities and integrity maintenance of confidential information, while the overall operator has access and control of all information.

**Master chemical list**

A critical, but often forgotten, requirement of a chemical management system is to create and maintain a master chemical list that has all the attributes of each chemical, including safety information as supplied from each vendor. The list is normally integrated with procurement and allows interaction with each vendor over new and changed chemicals. As an example, when some chemicals become more concentrated, they could have a detrimental effect on the performance of the equipment with which they interact. The viscosity and frequency of chemicals also play a large role in flow rates, pressure, temperatures, and general wear and tear. Creating and maintaining a chemical list is important within a chemical management solution because not only can people track chemical levels, but they can also track chemical performance, suitability, safety, and risk.

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**Remote and reliable operations**

The use of chemical injection systems is subject to extreme conditions. They are often placed in remote, hostile environments where the elements alone can cause serious equipment failure. Therefore, users need to closely monitor and manage their assets to prevent failures and maintain performance and production. When operating in these harsh conditions, it is inevitable that these injection systems will eventually fail; it is a question of when, rather than if. Having a reliability strategy in place, such as AssetWise Asset Reliability, that can run alongside the operational chemical management solution, such as AssetWise 4D Analytics, is a win-win situation. Together, these solutions can increase uptime, reliability, and availability across the operation to drive a proactive maintenance approach for chemical injection pumps and equipment.

**Connected data environment**

Collecting and analysing data from a variety of sources is critical for any successful chemical solution. Introducing automation through data collection and processing engines is a key benefit because engineers can focus on data results rather than collecting data. Having everything in one central application saves time spent looking for the right information, whether from IoT sensors, web forms, asset information, sampling data, chemical stock, and production data. Now, all this data can be viewed and acted upon in near real-time.
Calculation engine

Raw data is valuable on its own, as it provides the historical and current values of any monitored parameter. However, any additional information that is created from data already there is just as important. A chemical management solution should utilize a comprehensive calculation engine that can turn raw data into business information, allowing the creation of key performance indicators (KPIs) using customized calculations, Boolean logic, and nested loops for corrosion, scale, hydrates, emulsions, and compliance. Users can implement existing data to create any calculation, adding new insightful information.

Bentley’s AssetWise 4D Analytics: For Chemical Management and So Much More

AssetWise 4D Analytics’ chemical and corrosion management capabilities, part of AssetWise Digital Twin Service, has a unique position in the oil and gas industry because it can manage all aspects of data collection, analysis, visualization, and reporting. Since it is flexible and can handle multiple data types from many sources, it can also be used for all engineering disciplines to cover integrity, flow assurance, erosion, chemical, production, and laboratory management for all oil and gas operations. Any information that produces time series data—from spreadsheets and IoT sensors, to existing SCADA systems or data historians, to other structured and unstructured data—can be incorporated into any chemical management or production solution and analyzed to provide insight and increase operational efficiency.

Here are some of the other disciplines that AssetWise 4D Analytics can be applied, and where chemical monitoring also plays an important role:
Flow assurance
Flow assurance, or “guarantee of flow,” is when production is guaranteed through minimizing restrictions and risks on physical hydrocarbon flow. There are typically two types of flow patterns. The first is a self-flowing pattern. The second is a pattern with a variety of artificial lift systems like jet pumps or electric submersible pumps, which are installed in many producing wells. Water and chemical injections are critical in maintaining the required levels of water to achieve the stipulated recovery factor. In addition, the fields’ formation fluids have physical and chemical properties—such as high carbon dioxide, hydrogen sulphide, and crude viscosity—that can cause severe problems to flow if left untreated. The major challenges for flow assurance are inorganic scaling, organic scaling, corrosion, sand production, injectivity decline, and injector conformance, all of which affect field productivity.

Therefore, it is important to monitor flow assurance to improve production from underperforming wells with stimulation techniques. The different phases of a field life have different challenges. For instance, later in life, when production is slowing, there can be an increased risk of water production. In early life, it can be characterized by higher pressures, potentially leading to an increase in hydrate formation. In both instances, a flow assurance strategy should address these issues during any phase of the field’s life.

Well integrity
Well integrity activities concentrate on maintaining and monitoring the overall integrity of assets for producer, injector, and exploration wells, safeguarding the environment and surroundings from any sudden release of well fluids. Users can monitor the performance of safety critical elements of various wells and take proactive measures to repair any possible failures, including sustained annulus pressure in B-annulus, failing of Christmas tree valve, scaling issues with productivity and injectivity, water injection conformance affecting the reservoir’s artificial pressure support, and declining well productivity index.

Corrosion and erosion monitoring
Corrosion is a very expensive problem, and companies must plan for any unexpected expense as a result of a corrosive attack. Corrosion costs the energy industry over USD 1 billion every year, and with a pipeline costing approximately USD 3 million per kilometer to replace, prolonging asset lifespan is both desirable and valuable to an operator. There are several available options to help combat corrosion. Internal corrosion monitoring usually involves coupon testing, residual inhibitor monitoring, corrosion rate probes, and intelligent pigs. These solutions often can be, and are, used together to mitigate corrosion. A common solution adopted by oil and gas owner-operators is corrosion inhibitors, which form a protective barrier on corrosion-prone surfaces and protect infrastructure from corrosive attacks. Inhibitor levels can be determined through laboratory testing on or offshore; however, there can be problems when carrying out analysis. Field conditions can differ from the lab, such as the mix of treatment chemicals, pressure, and temperature. Therefore, operators can inject chemicals into the total fluid stream. Typically, however, the inhibitor partitions into the water phase and protects the pipeline at the water-metal boundary. It is critical to understand the chemical dosage based on the total fluid and how much is required in the water phase for the assessment and KPI tracking inside a chemical management system.
**Scheduling and truck treatments**

While tank-level monitoring is required to track chemical levels within the tanks for injectors, operators must ensure that tanks are filled as frequently as required by scheduling trucks to drive out to each well. Besides keeping an inventory of chemicals, it ensures that the right chemical and the correct amount is delivered, as missed truck treatments can account for the under-injection of chemicals. With a reliable tracking system in place providing a historic and current audit trail, this mismanagement of chemicals will be a thing of the past.

**Inventory and tank monitoring**

Knowing the level of the liquid in your chemical storage tank is critical to maintaining your operations without interruption. Monitoring tank levels helps you when ordering more chemicals, as running out of chemicals could severely hamper production during any process. Also, certain chemicals need to be stored at specific levels to maintain their properties or operational requirements. If the storage is carried out with sensors rather than manually, the data can be used to provide a history of usage, as well as predict usage and to order new chemicals ahead of time.

**Integrity operating envelope (or well operating envelope)**

An effective integrity operating window (IOW) program—which establishes safe operating and acceptable limits of process variation before an asset begins to degrade—can help operators stay ahead of potential repairs and reduce risk. Well performance management is a critical aspect of production system optimization in an oil and gas field. Accurately defining the well operating envelope will not only ensure asset integrity, but it will also ensure realistic production performance expectations (or forecasts) from available well resources. The methodology employs visualization to graphically represent the operating envelope for the wells based on these constraints, and alarms ensure that engineers are notified in a timely manner when any envelope is breached.

**Production**

While it is important to measure chemical usage, it is more important to measure how chemical usage affects production. If wells are under- or over-injected, it is important to show any trends in production and the relationship between production and chemicals, as well as other factors.

**Environmental**

The exploitation of oil and gas reserves has not always been without some ecological side effects, as accidents can happen. Oil spills, pollution, damaged land, fires, and their long-term effects have all been recorded at various times and places, sometimes involving fatalities. In recent times, the social impact of operations, especially in remote communities, has also attracted attention. While the oil and gas industry has worked to provide environmental protection, much more can still be achieved. Chemical monitoring and proper management are important for minimizing the industry’s impact on the environment. Any operation should be driven by compliance. To protect the environment and the atmosphere, it is paramount to properly manage toxic chemicals safely. Monitoring and reporting will be required to comply with stricter statutory and corporate requirements. Failure to do so will lead to large fines and a plummeting reputation. For example, not including the lives lost, BP’s Deepwater Horizon spill has cost the organization over USD 65 billion.
Chemical Management: A Step Toward Digital and Operational Excellence

A reliable chemical management solution is the way forward to optimize chemical usage and their costs. More importantly, it will increase uninterrupted production through improved uptime by ensuring that you are applying the correct chemicals at the optimal rate to deliver best and continuous operating performance. Eliminate the nightmare created by spreadsheets, isolated data, and unreliable, out-of-date information, and replace it with a dedicated solution that brings the critical and relevant data together in one application.

With a centralized chemical management system for production and process, laboratory, corrosion, scale, wax, budget, and monthly report data, as well as chemical treatment scheduling for trucks, you can ensure a timely and cost-effective use of oil field chemical treatments to ensure the best performance of all oil field assets at all times. The optimization of the assets and processes will dramatically reduce chemical costs, allowing you to be more productive in managing oil production through optimized chemical treatments. Not only are the savings in chemical spend significant, but your overall improvement in maintaining flow, keeping equipment running reliably, and keeping your workforce and environment safe will lead to a reduction in unplanned downtime and allow production to continuously run through increased availability.

![Figure 4. A centralized chemical management solution enables up-to-date, timely, and relevant information to help maintain efficient and cost-effective oil production.](image)