Chemical Injection in Oil and Gas

Endress+Hauser
People for Process Automation

Register

1 How to use level measurement and Inventory Management Systems for improving productivity

In all fields of the oil and gas industry, chemicals are injected into process lines and fluids. Take oilfield services (OFS), chemicals are used to film the side of the wellbore for improved stability. In pipelines they avoid build-up and keep the infrastructure healthy.
But how may the operator optimize the chemical injection process and minimize Health, Safety and Environment (HSE) risks? The White Paper answers exactly this. It is about integrating the best fitting level measurement instrumentation and a suitable Inventory Management System. With this many risks are avoided and savings are possible like chemical recovery and just-in-time management.

2 The role of chemical injections

In the oil and gas industry we inject chemicals in order

- to protect the infrastructure
- to optimize processes
- to assure flow
- and to improve productivity

Chemicals are used in pipelines, tanks, machines and wellbores. It is crucial to avoid risks coming along with the injections. Too little chemicals may lead to downtimes or process fluid cloggings, too much chemicals may damage the infrastructure and lead to empty supply tanks or complicate the regeneration process. It is also about the correct density of the product and the correct blending of multiple chemicals.

3 Infrastructure protection: injecting chemicals to inhibit corrosion

Corrosion is a natural process, in which a metal gradually is destructed by a chemical or electrochemical process while contacted with its environment. Typical sources of corrosion are pH, CO_2, H_2S, chlorides, oxygen and bacteria. Oil or gas are called “sour” when the concentration of hydrosulfides, H_2S, is higher than usually. Oxygen is extremely problematic on injection wells, EOR. Already very low concentrations cause high corrosion rates. In this case oxygen scavangers are used.

Bacteria can grow inside pipes and tanks under anaerobic conditions, which generates high concentrations of H_2S. Pitting is a result of this and can get severe. Bacteria build-up mostly happens in low velocity applications. Other contributing factores for corrosion are temperature, abrasion, pressure, velocity and the presence of solids.

We know the following common types of corrosion:

1. Local corrosion: pitting, crevice corrosion, filiform corrosion
2. Galvanic corrosion
3. General attack corrosion
4. Flow-assisted corrosion, FAC
5. Intergranular corrosion
6. De-alloying
7. Environmental cracking: stress, fatigue, H2-induced, liquid metal embrittlement
8. Fretting corrosion
9. High temperature corrosion

For controlling corrosion the following measures are important to regard:

- ☐ Be specific in selecting the right material. Metallurgic specialists define which metals are best to use.
- ☐ Also coating and painting are relevant topics to choose well.
- ☐ Adjusting production to increase or decrease the velocity in a pipe.
- ☐ In case particles are present in the fluid, a decrease may be better for the lifetime of instruments and pipes
- ☐ Controlling the pH, reducing the chloride quantity, eliminating oxygen and bacteria and reducing the rate of metal oxidation with chemical injections.
- ☐ Effective and best composition of the chemicals to regulate the pressure in the pipeline or vessel where the fluid needs to go in.

4 Chemical injections to assure and condition flow by preventing build-ups

In order to prevent deposition typically inhibitors are injected. Depositions or build-ups in the oil and gas processes usually are asphaltenes, paraffins, scaling and hydrates. Of those asphaltenes are the heaviest molecules in crude oil. When they adhere, a pipeline can quickly plug. Paraffins precipitate out of a waxy crude oil. Scaling may be caused by the mixing of incompatible waters or by changes in flow like temperature, pressure or shear. Common oilfield scales are strontium sulfate, barium sulfate, calcium sulfate and calcium carbonate. To avoid those build-up inhibitors are injected. For preventing freezing glycol is added.

If we want to condition the flow we have to

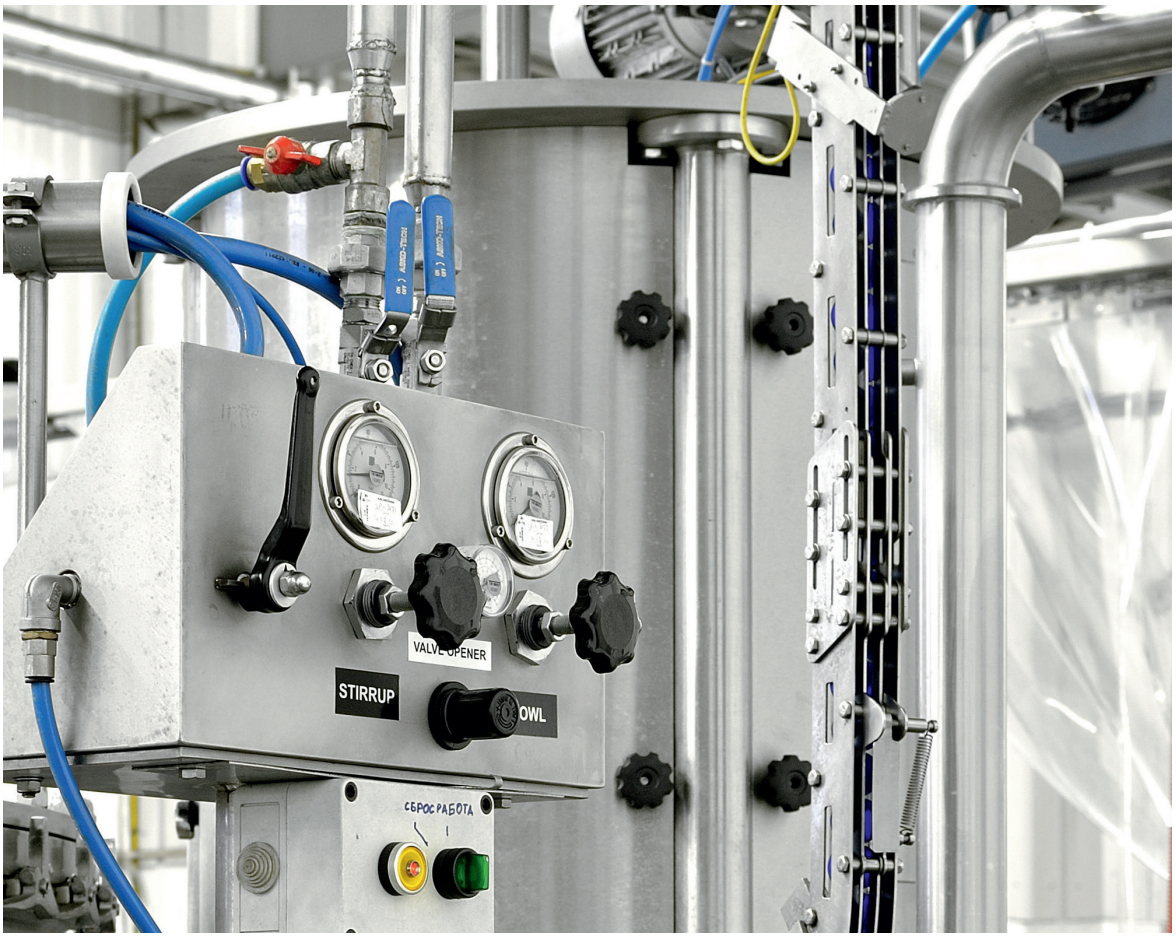
- prevent emulsions: they cause enormous production delays in separators
- avoid frictions like with asphaltenes
- reduce viscosity as oil is typically a Newtonian fluid

5 How to deal with risks

There are various risks associated with chemical injections. Sometimes the injected chemicals do not have the desired effect, sometimes the process of deposition or corrosion just continues under injection. In case too much pressure is used for the injection, the production may be damaged. Or when the tank level is not measured correctly and a platform runs short of media, production may need to stop. Those scenarios cost the operator, the service company, the oil company and everyone else in the downstream a lot of money. Refineries may charge penalties when supplies decrease or stop.

Imagine an operator being very busy running operations, while several colleagues push him to change his activities: The maintenance manager wants to take one system out of line for a periodic maintenance check. The quality manager is knocking on the door demanding the implementation of new safety-rules. The well manager is pushing him to use less dense chemicals to prevent damage to the well. The operations manager wants dense or more viscous materials to minimize the risk of buildup. The HSE forces him to mix enough bio-degradable chemicals in the fluid.

All colleagues with different demands, all pushing for ultimately the same thing: to improve operations, make them safer and keep the infrastructure fit. Nevertheless, running six chemical injection systems for eight production wells and two EOR wells is quite a challenging organization – especially when the inventory needs to be monitored, the fluid quality has to be checked, the system performance must match the well properties and so on and on.... **In this case it is good to automate the process and with a future perspective allow to run operations remote.**



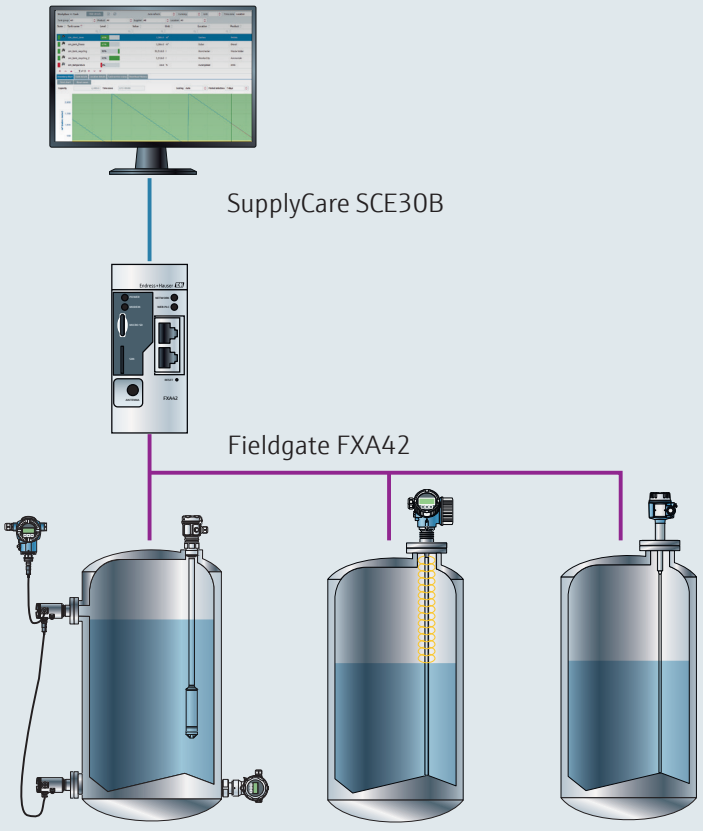
6 Inventory Management Systems for simplified, automated processes

For managing inventories correctly Inventory Management Systems are of big help for the operator. They support to improve regeneration processes and assist in optimizing fluid orderings. As a result those activities lead to additional cost benefits and answer the demands of the different colleagues: the HSE manager, the quality manager, the operations manager, the well manager and the maintenance manager.

How does it work? Let us use an example to explain how all chemical injections may be organized for a single platform or a group of platforms.

On a platform usually there are several injection skids for EOR, the oil and gas production and for the pipeline infrastructure.

Choosing the right level measurement needs to consider a solution for Inventory Management



Each skid has its critical measuring aspects to deal with. A typical chemical injection system or skid consists of the following parts:

- Tank for storing and blending the chemicals (may also be on the fly)
- Level measurement device
- Metering pump
- Pulsation dampener to protect the downstream infrastructure (not required for all types of pumps)
- Check valves
- Gauges
- Backpressure regulator
- Temperature transmitter and temperature compensation
- 2/4/...24 injection lines, which can be individually isolated by valves

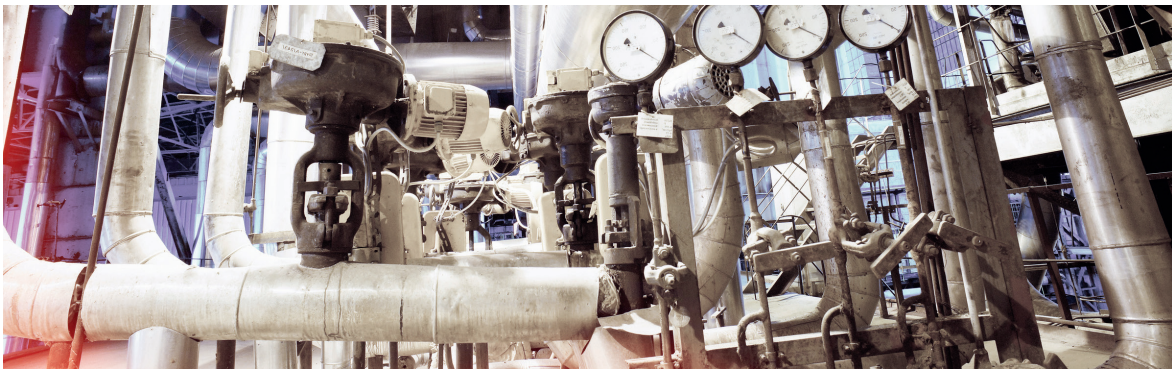
One injection line usually has a flow meter, where mass flowmeters are preferred, a pressure transmitter (transducer) and a pressure regulator to control the pressure of the injection: pressure reducing regulator (PRR) or a back pressure regulator (BPR) and a pressure control valve (PCV) may be used as well.

The right combination of good mass flow measurement, pressure measurement, temperature control and Inventory Management Systems **avoids downtime** as you do not run out of supply and **reduces costs by just-in-time supplies:**
By comparing the tank level measurement of the skid with the main inventory measurement one can derive trends and optimize the JIT-principle of inventory management. Future requirements can be matched with current inventories and supplies are ordered in good time to avoid running out of chemicals to inject.

Detect system and connection leakages: By processing injection rates and level measurements in one system you detect differences in measurements. When comparing in mass, the sum of injections should be equal to the level measured in the tanks. If this is not the case, system connections need to be checked if injections are done wrongly or if leaks occurred (HSE disaster avoidance).

Check of density and blending correctness: Individual tank level measurements and injection rate measurements allow a correct blending performance. A backup or safety system ensures the correct blending based on the density or tank level compared to plan.

Avoid damage to the infrastructure over and under injections: While pressurization and flow injection the infrastructure is endangered to get damages. Reliable pressure and flow measurement devices optimize injection performances and save resources.



If each tank is equipped with a level device, it still does not mean that the process may be optimized. No matter which type of gauge is used to measure the level, the measured values must communicate to the software where to monitor and manage the inventories. It is about how to get the data from the measurement point to the control room where it should be displayed as information for the operators. In most cases, the gauges provide information via common interfaces like analogue outputs or via digital protocols like HART, Modbus, Profibus or others. Those communication methods have to be converted in order to fit to the IT infrastructure. Gateways provide field data for the control room usually via Ethernet. Based on this data, different inventory software tools have to perform basic or highly complex calculations to convert for example level to volume or mass.

As soon as the term “software” comes to our mind, we think about programs running on PCs. It is true that classic software is installed on a server with high calculation capabilities and performances. User access the information via a dedicated interface. However, software interfaces nowadays run directly in web browsers, reducing installation costs and commissioning time, making maintenance of additional clients obsolete. Data of embedded software is provided via webserver technologies and is visualized on any device, which is web-browser capable, like smartphones, tablets, PCs or TVs.

It is crucial to ensure flexible and easy access to the data for each person in the company which needs the information to make a decision. Intranets or even the internet via a VPN access provide the possibility to use the measured or calculated information efficiently at each plant. As the data now is available in electronic form, it is obvious that the reconciliation between Inventory Management Systems and ERP systems is not rocket science anymore.

Going one step further: you may improve your supply chain management even more by giving your suppliers access to the chemical inventories and enabling them to resupply raw materials proactively. Trigger points can be defined for alarms, for shipments or safety stock lines. Knowing your current consumption and the available inventories, the supplier plans shipments just in time. As a result, you have a continued production while keeping inventories to a minimum. By outsourcing those tasks to the supplier, you focus on your core business and concentrate more effectively on your customer’s needs using the available resources.

Benefits of SupplyCare Inventory Control

- Simple implementation
- Tailored to the application
- Open communication
- Proven in use
- Allows easy connection to main enterprise inventory control system

7 How to select the right mass flowmeter

For ten years it was quite common to take a mechanical flowmeter. With higher safety and security levels we expect from instrumentation for the oil and gas industry nowadays, a Coriolis flowmeter is the most logical and safest choice. The Coriolis flowmeter is a highly accurate direct mass and density measuring instrument.

When it comes to material choice, 316/316L is widely accepted in the oil and gas market. In onshore applications it is the market standard. For higher corrosion resistance or higher pressures, Hastelloy or a Ni-based Alloy C22 is used. Typical injection pressures are up to 6000psi (~425bar), this is also valid for injecting filming materials in drilling applications. Flow rates are typically low (as low as up to 1mm or 1/24th inch) – not only because of the pressure. It is about a continuous process: long-term or in batches. Most flow meters have ½ inch flanges, but threaded connections are also utilized. Typical flange size is Cl. 1500 or 2500.

One flowmeter to meet those requirements very well is the Proline Promass A. It has a very good zero-point stability at these very low flow rates and an excellent rangeability with very low pressure loss (the exact details depend on the actual flow conditions). It is available as both a 4-wire and a 2-wire device with direct 4 to 20mA (no adapter barriers). The connection and information inter-exchangeability to the Inventory Management Solution is seamless. The Proline Promass A has a single tube design, so there is less chance of clogging, a small footprint and a low weight. Onshore it requires only very little support and offshore it reduces the system weight. Additional offerings are NACE MR0175/MR0103 compliance, PMI testing and weld seam testing according to ISO 10675-1, ASME B31.1, ASME VIII and NORSOK M-601.

What is important is that Promass A disposes over a wide range of international hazardous approvals and various installation concepts, like intrinsically safety (Ex is/IS). The so-called Heartbeat Technology adds a wide spectrum of monitoring options and allows inline and online verification, it also reduces the effort for SIL proof testing. Specific gateways via the instrument enable the operator to quickly find all support information for first line of troubles shooting and lean operations. The operator has access to smart information of the device via cloud – as spare part and component lists, user manuals, a trouble-shooting guide and much more.

Promass A

8 What is important in selecting pressure and temperature transmitters

Liquid compositions, temperature and pressure ranges, the flow, the location of an installation and the need for certificates are usually the basis for selection criteria. Chemical injection skids are often used on offshore platforms, where weight is very important. Since the chances of over-pressurization are minimal, a compact pressure transducer with a 4-20mA analogue signal is more than enough for single line use. The signal goes to the system DCS and the operator thereby monitors the individual line pressures. When selecting the transmitter, vendor support and services, ease of installation and commissioning and the delivery performance are most relevant.

For a temperature transmitter, supplier services should also be more relevant as it is a single process signal, where no additional diagnostics are required. Qualitative parameters start to become important when the application is very complex and continuous adjustments are needed. Also in cases of filming chemical injections while drilling, the temperature and pressure diagnostics of the infection system are not leading over the drilling procedure and are therefore of minor importance. When selecting a supplier, availability in the field as well as support and fast delivery times are critical to keep your operations running.

Criteria for selecting temperature devices:

- Highest plant availability and safety with reliable sensor technology
- Traceable and accredited calibrations
- Fast, robust and highly accurate sensors in order to save costs and optimize processes
- Lowest operating expenditures through seamless integration, easy handling and long lifetime
- Trouble-free system and operations certification through international approvals
- User-friendliness and expert's support through all stages of the life cycle

Criteria for selecting pressure devices:

- High accuracy and stability, also under harsh conditions
- Fast response time
- Ceramic sensor option
- Trouble-free system and operations certification through international approvals

9 Summary

Chemical injections are daily business in oilfield services and in the production of oil and gas. They protect the infrastructure, optimize processes, assure flow and improve productivity. Besides the challenges over and under injection rates like pressure and flow, small scale inventory management increases the profitability of a single system up to a platform and for the complete organization. Inventory Management Systems only make sense when all relevant parties of the organization have easy and fast access to the data. Open networks and the compatibility of a single tank level measurement with the complete chain up to supply vessels or trucks allow control on all levels: from the platform to the headquarter. Exact performance rates of flow and level also help to avoid any risks of HSE disasters. Before the Inventory Management Solution is set up, the right field instrumentation needs to be selected. Selection criteria here are the quality of the devices concerning availability and reliability, to get them in short delivery times, to use open systems for inter-connectivity and to receive local service on a global scale.

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