LOCTITE® Pulse Smart Leak Detection

SMALL BUT NOT TO BE FORGOTTEN.

How innovative sensor technology enables smart maintenance even for less prominent components in the process industry.

INTRODUCTION.

The right **maintenance approach** is a crucial factor for operating an industrial plant in a **safe, cost-effective, and sustainable** manner. The optimization of maintenance has been, and continues to be, a subject of constant research. Growing expertise regarding the operation of assets, digital tools for planning, and many other factors has led to efficient maintenance of increasingly complex systems, processes, and assets. Finding the optimal maintenance approach is also about finding the balance between the risk of failure and the efforts required to reduce that risk. Anyone who is on the journey to improve their maintenance will inevitably come across terms such as reactive maintenance, preventive maintenance, or data-enabled predictive maintenance. Due to the initial investments for sensors and data analysis systems, innovative, data-driven approaches are still not adaptable to all kinds of assets. This is especially true for the various smaller instruments, components, and assets found in processing plants.

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1 HYDROCARBON LEAKAGES.

Industries like oil and gas, chemicals, or similar that are processing fluid media **are facing one common maintenance challenge: preventing, identifying, and reacting to leaks** at various types of assets. **Flange connections are a particularly weak point for leaks** to the outside. There are several possible causes for flange leakages. For example, unequal or insufficient bolt loads can affect the required compression load level of the gasket. Such conditions can lead to leakages, as well as the influence of varying temperatures and aging influences on the heavily loaded bolts. Also, improper flange alignment, unequal gasket compression, or local overload causes subsequent leakage [1, 2]. In most cases, operators know the most problematic assets or pieces of equipment that regularly cause leakages at their plant. Even so, sufficiently **monitoring all of them is a complex task.**

Leakages are a maintenance-relevant issue because they can lead to serious consequences that affect the safety of employees, the environment, and the plant itself. This is especially true for flammable liquids and gases that can form explosive mixtures with air. Leaks can be classified in different severity grades. If the right measures are not taken in time, the severity of a leak increases over time.

Every hour that a leak goes unnoticed, environmental issues like water contamination and the respective consequences become more likely. Energy losses and the efforts required for repairing a leak increase over time, up to a point where a shutdown of the whole process may become necessary.

Timely identification of the leak is therefore elementarily crucial to keep severity low and therefore reduce consequences and costs to a minimum.

Examples.[4]

- Leakage at refinery in Kuwait on June 26, 2000: US$ 766 m loss
- Leakage in Wickland on April 9, 2001: US$ 159 m loss
- Oil spill in Mayflower on March 29, 2013: US$ 5 m loss
- Leakage at PES in Philadelphia on June 21, 2019: US$ 750 m loss. Refinery shut down shortly after incident, filed for bankruptcy
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Leakages.[6]

- A refinery can emit ~600 tons of VOCs (Volatile Organic Compounds) per year from leaking equipment
- Leakages lead to environmental damages, health problems, and major safety risks
- In processing plants, valves and connectors like flanges are accountable for more than 90% of emissions
- The main reasons for flange leaks are gasket/ sealing failures due to wear or improper maintenance or improperly torqued bolts on flanges
- Introducing successful leak detection and repair (LDAR) programs that reduce leakage risk is a challenge for operators as it gets harder to find skilled workers all around the world

Some examples of known flange maintenance practices.

Correct Bolt Tensioning.

- Assembly of the screws with a defined torque
- Testing and documentation of the correct execution
- Continuously training people

Regular Inspections.

- Reliable inspection routines
- Trained people
- Standardized documentation

Flange Sealing.

- Different technologies depending on service conditions
- Encapsulation with machined steel clamps and high-pressure polymer injection
- Low-pressure epoxy injection into flange gap
- Tape-based solutions, e.g., made of petrolatum to wrap the flange
- Encapsulation with a brushable flexible polymer coating

2 CHALLENGES AND HIDDEN COSTS OF MAINTENANCE OF FLANGES, PIPES, AND OTHER ASSETS.

Leakages happen, even with the best maintenance. Especially in highly complex industrial environments with thousands of assets.

A refinery operates thousands of flanges, and hundreds of kilometers of piping, besides many other leak-critical assets. A great portion of those assets can be defined as critical enough to justify a higher maintenance focus. The criticality can be determined by the medium that is being processed, operating pressure, or other external factors like mechanical influences.

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Inspection Cost Factors.

Depending on the criticality of the asset, operators need to define an optimal inspection schedule. For higher-risk assets inspection cycles are usually in the range of once a week or more. The efforts for inspecting one asset like a flange or a pipe section can vary, mainly depending on the accessibility of the specific asset. In some cases, special tools need to be used or insulation removed. The environment in which the assets are being operated also plays an important role. In some cases, processes already need to be stopped, even for inspections. The time that is being spent for each asset in combination with the inspector's skill set defines the inspection reliability. The inspection reliability greatly influences the probability of a leak being detected. **The frequency and reliability of the inspection determine the minimum time during which a leak can go unnoticed, and thus the severity and associated costs.**

In addition to the inspection itself, the condition of assets needs to be

well documented. Documentation can be done manually or with the help of digital maintenance tools on tablets, smartphones, or other devices. Digital tools may help to optimize the documentation.

Repair, Clean-ups, and Downtime.

Leakages come with directly accountable costs like loss of product, pressure energy, or heat energy. Minor leakages or issues that would result in leakage can usually be repaired during operations or planned shutdowns. A leakage that has developed into a severe problem may cause widespread contamination and even additional damages to nearby assets. This results in major clean-up efforts and repair jobs with higher complexity. This alone is a huge cost driver.

If a severe leak, or the repair of it, causes an impact on the operational production process (e.g., product quality) or unplanned downtime, **the damages can quickly go into hundreds of thousands of dollars.**

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Unplanned downtime. Facts and figures.

- At 32 hours per plant per month, the number of hours lost to downtimes is highest in the oil and gas sector. This is not surprising, as work in this extremely safety-critical sector is stopped at the first sign of a potential problem.
- Every hour of downtime in the oil and gas sector costs US$ 220,000. Annualized, this adds up to US$ 84 m for each plant. For refineries alone, losses to Fortune Global 500 companies are estimated at US$ 47 bn with 213,000 downtime hours per year.
- Research by the Aberdeen Group shows that unplanned downtime costs between US$ 10,000 and US$ 250,000 per hour, or US$ 50 bn per year. Defective equipment is the cause in 42% of cases.
- Given these figures and the safety-critical nature of production, it's easy to understand why predictive maintenance is already a strategic goal for 82% of employees – the highest proportion of any sector.
- According to a 2016 study by Kimberlite, operators who adopted a predictive, data-driven maintenance approach were able to reduce unplanned downtime by 36%.

Costs of Safety and Other Risks.

Even though highly unlikely, **major environmental damages or damages to property can quickly go into the millions** and result in fatalities like the examples above have shown. The **environmental impact of leakages** is more and more in the spotlight. They drastically **damage the reputation of an operator**. Regulatory requirements are becoming increasingly challenging to comply with. In some cases, insurance companies step away from insuring leakage risks or request that measures are put in place to reduce leakage risks [1, 3]. In any case, **insurance costs increase with higher regulatory requirements and higher liability**.

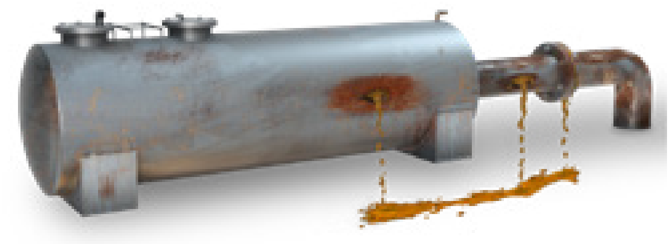
Insurance costs increase with higher regulatory requirements.

Even though it might be routine, highly frequent inspections, especially in hazardous areas of the plant, can be dangerous to personnel. Non-routine emergency repairs increase risks significantly.

What if leaks could be detected in time?

If leaks could be detected with high confidence and reliability just at the moment they occur, this would drastically decrease the probability of severe leaks and therefore consequential costs.

Improving cycles or the reliability of manual inspections is a potential lever to address these challenges. However, this is often not achievable. Human beings are prone to errors. Finding highly qualified personnel is a challenge all over the world. And in the end, high-frequency manual inspection comes with a price tag.



Failure

Solution

3 APPLYING INNOVATIVE DIGITAL APPROACHES FOR MAINTENANCE OF FLANGES, PIPES, TANKS, ETC.

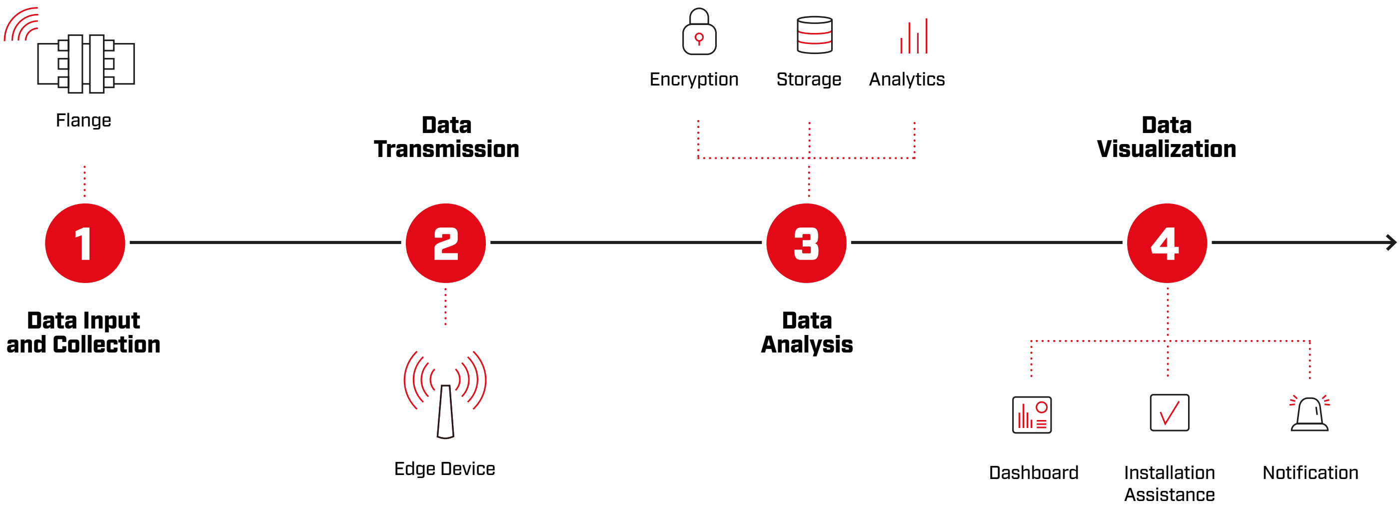
Introducing new maintenance approaches for a group of assets needs to come with a net positive contribution. The costs for introducing and running the new measure must be below the benefits it provides. There might be costs for new hardware and services, additional manpower required, upskilling efforts, controlling measures, and integration-related efforts. Also, potential production losses due to shutdowns for retrofits need to be accounted for.

Data-enabled predictive maintenance is being used in more and more industrial fields. Processes that are characterized by a high level of automation and therefore the availability of relevant data, were the first to adopt predictive maintenance. Still, millions of assets remain offline. Predictive maintenance is currently on the rise as prices of data storage and processing power significantly decrease. Network capabilities have increased significantly with at least one option (cellular, local Wi-Fi, wired connection, satellite) being available nearly everywhere in the world at any given time, even in the most remote locations. The battery life of non-cabled solutions is also becoming better and better. This leads to **the new independence of local infrastructure and makes predictive maintenance more accessible to operators** [5].

Data-enabled predictive maintenance is being used in more and more industrial fields.

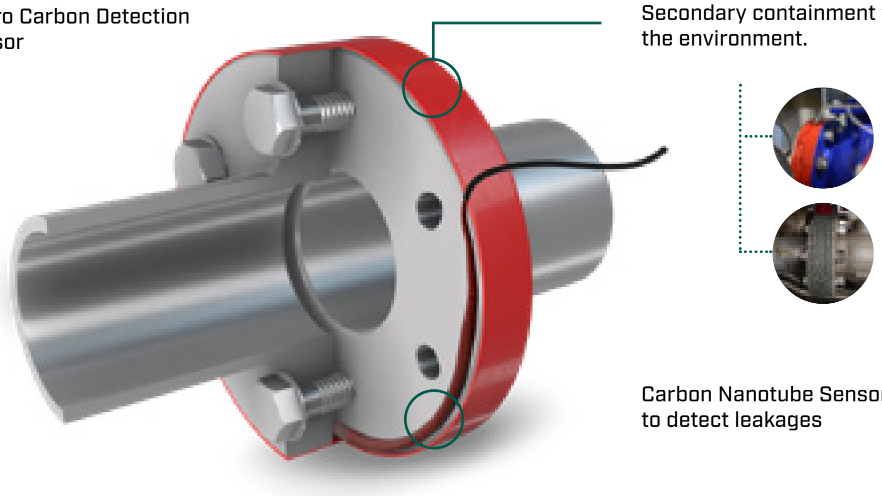
New smart sensor systems can now be retrofitted without the need to stop the plant or integration into legacy central control systems. Monitoring thousands of assets simultaneously and reliably has not been economically feasible in the past for many asset types due to complex technical challenges and the costs associated with sensor technologies and their integration, but it is now becoming accessible to customers.

Henkel’s LOCTITE Pulse solution portfolio picks-up on precisely this and helps you make your plant connected.

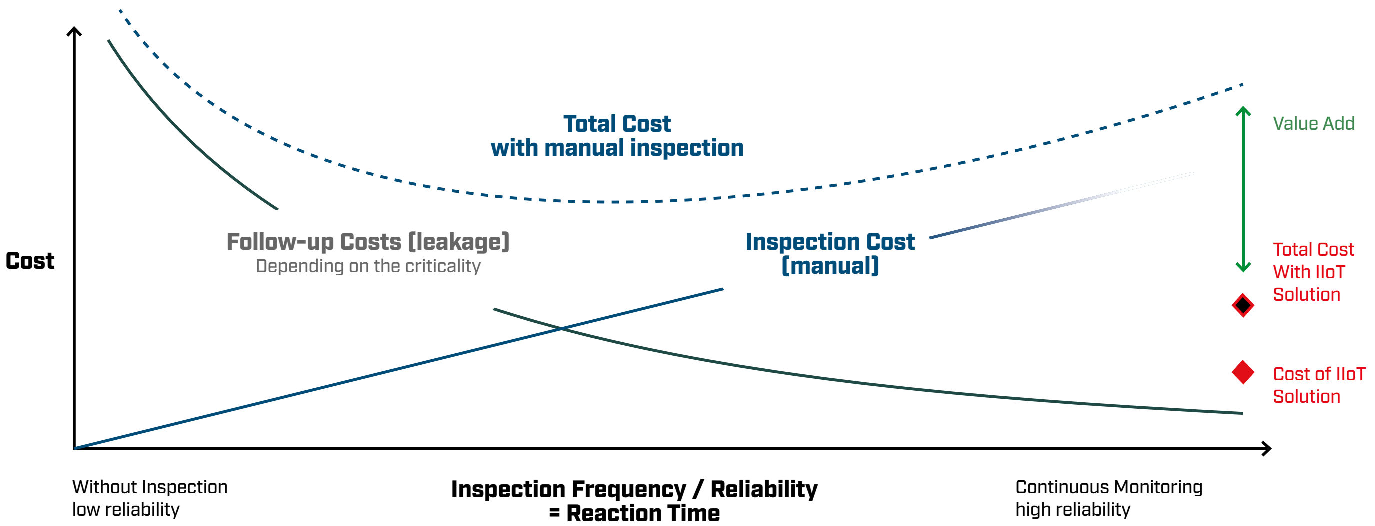


One solution of the LOCTITE Pulse portfolio is **Smart Leak Detection**. The solution consists of innovative carbon nanotube-based sensors that get wrapped around flanges or pipes in combination with secondary containment. Secondary containment helps to prevent the leakage from entering the environment for a certain period of time. The sensor supports detection of the leakage continuously and would notify the operator through the LOCTITE Pulse app or email notifications.

Data flow in LOCTITE Pulse from sensors to a battery-powered edge device to the cloud. Notifications can be received via any smart device and browser.



Finding the right maintenance frequency that minimizes the overall costs related to leakages **is a complex optimization problem**. Due to personnel restrictions, operating at the optimal inspection frequency is sometimes even not possible.



With LOCTITE Pulse Smart Leak Detection, leakages can be identified continuously allowing for repair consequently, before they develop into more severe problems. This can help operators to reduce risks and prevent consequences and costly downtimes due to an undetected leak. Additionally, continuous monitoring can reduce the need for manual inspection of critical flanges.

All these effects combined can add up to **huge potential cost savings per year.**

The associated costs and risks of a leakage increase over time as the leak becomes more severe. Leaks that are detected at the right time can be fixed with rather smaller efforts.

Disclaimer: The suitability of the Loctite Pulse Solution for the individual use case as well any potential benefits/cost savings depends on customer industrial specifics including but not limited to applicable regulatory requirements, individual industrial environment, type and location of industrial assets etc. Any liability resulting from any statements in this Whitepaper and any other written or verbal advice for the Loctite Pulse Solution is expressly excluded, unless otherwise agreed in an individual contract, in the event of injury to life, limb or health, in the event of intent or gross negligence on our part, or in the event of liability under mandatory product liability law.

CONCLUSION.

Especially for critical flanges, as they often occur several hundred times even in small to medium-sized refineries, continuous monitoring is recommended to create an additional level of safety, but also to save costs. In the overall view, operators must not only compare the costs of the solutions directly, but look at the whole picture and, for example, also include opportunity costs, downtimes, etc., in the calculation. Besides this, an increase in transparency and a reduction of environmental risks are key value drivers. In the future, it is to be expected that real-time monitoring solutions will continue to drive the shift from reactive to proactive maintenance, especially based on falling costs for sensor solutions, so that in the future solutions will not only be available or profitable for the most critical flanges and pipes.

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