Are you facing corrosion problems in your plant and equipment? Are you second guessing on what to do with it? Don’t fret! This article was written for you.

NACE International estimated the total annual cost of corrosion at USD 276 billion per year for all industries. But when personnel can visually identify corrosion and know where to look for it, the risk can be minimized. Better yet, when engineers can anticipate corrosion and make the best choices, system integrity, longevity of assets, performance, and safety improve.

Corrosion occurs when a metal atom is oxidized by a fluid, leading to a loss of material in the metal surface. This loss reduces the wall thickness of a component and makes it more prone to mechanical failure. Each type poses a threat that must be evaluated when selecting the optimal material for your application.
General (Uniform) Corrosion

The most well-known type of corrosion is also the easiest to spot and predict. It is unusual — but not unheard of — for general corrosion to lead to disastrous failures. For this reason, general corrosion is often regarded as an eyesore rather than a serious problem. General corrosion occurs relatively uniformly across a metal surface. The gradual decrease of the wall thickness of a component must be considered when calculating pressure ratings.

How It Forms

In a marine or other corrosive environment, the surface of carbon or low-alloy steel begins to break down, allowing for the formation of an iron oxide scale which grows thicker in time until it spalls off and new scale forms.

Can Be Measured By

- How fast the material recedes on an annual basis. For example, unprotected carbon steel may recede in a marine environment by 1 mm every year.

- The weight loss that is experienced by an alloy when in contact with corrosive fluids, typically measured in milligrams per square centimetre of exposed material per day.

Potential Solutions

- 316/316L Stainless Steel
- 6-Moly Alloys
- Alloy 2507
- Alloy 825
- Alloy 625
- Alloy C-276
- Alloy 400
When the protective layer of oxide (or passive oxide layer) on the surface of the metal breaks down, the metal becomes susceptible to loss of electrons. This causes iron in the metal to dissolve into a solution in the more anodic bottom of the pit, diffuse toward the top, and oxidize to iron oxide, or rust. The iron chloride solution concentration in a pit can increase and become more acidic as the pit gets deeper. These changes result in accelerated growth of the pit, perforation of tubing walls, and leaks.

Pitting corrosion is best prevented by proper alloy selection. Different metals and alloys can be compared using their Pitting Resistance Equivalence Number (PREN), which is calculated from the chemical composition of the material. PREN increases with higher levels of chromium, molybdenum, and nitrogen. Higher PREN values indicate greater pitting corrosion resistance.

**Potential Solutions**

- 6-Moly Alloys
- Alloy 2507
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**How It Forms**

Other types of corrosion will be on the next issue.
The main functions of flush plans are to cool down the seal area, ensure clean fluid in the area and prevent outboard leakage in order to maintain proper lubrication, pressure, temperature, and solids management. To prolong the seal’s useful life, an ideal work environment for the seal is needed to avoid wear and tear and eventual failures. Certain applications, fluids and seal configurations call for specific types of flush plan. We have summarized the different plans for you.

You need to incorporate the correct flush plan to help protect the equipment you have invested on and minimize future issues like unplanned downtime and expensive repairs. It is also a plus point to your boss knowing that you are taking care of your mechanical seal and saving money. And in tough applications, taking care of mechanical seal in an absolute essential for safety reasons.

### API 682: Flush Plans

<table>
<thead>
<tr>
<th>Plan</th>
<th>Description</th>
<th>Design</th>
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<tbody>
<tr>
<td>Plan 11</td>
<td>• Process fluid from pump discharge is routed to the seal chamber</td>
<td></td>
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<tr>
<td></td>
<td>• Cools and lubricates seal faces</td>
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<tr>
<td></td>
<td>• Requires clean, non-solidifying fluid</td>
<td></td>
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<tr>
<td></td>
<td>• Most common plan</td>
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<tr>
<td>Plan 12</td>
<td>• Similar to Plan 11 but with a filter added into the system.</td>
<td></td>
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<tr>
<td>Plan</td>
<td>Description</td>
<td>Design</td>
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<tr>
<td>Plan 13</td>
<td>• Flow exits seal chamber and is routed to suction&lt;br&gt;• Common on vertical pumps where seal chamber is near full discharge pressure</td>
<td><img src="image1" alt="Plan 13 Design" /></td>
</tr>
<tr>
<td>Plan 14</td>
<td>• Combination of plan 11 and plan 13&lt;br&gt;• Pump discharge diverted to seal chamber&lt;br&gt;• Seal chamber routed to pump suction&lt;br&gt;• Used on vertical pumps where vapor pressure is of concern</td>
<td><img src="image2" alt="Plan 14 Design" /></td>
</tr>
<tr>
<td>Plan 21</td>
<td>• Cooled version of Plan 11</td>
<td><img src="image3" alt="Plan 21 Design" /></td>
</tr>
<tr>
<td>Plan 22</td>
<td>• Plan 21 with a Y-Strainer added into the system</td>
<td><img src="image4" alt="Plan 22 Design" /></td>
</tr>
<tr>
<td>Plan 23</td>
<td>• Closed loop system using a pumping ring to circulate product through seal chamber and heat exchanger&lt;br&gt;• Preferred plan for hot applications&lt;br&gt;• More efficient than Plan 21</td>
<td><img src="image5" alt="Plan 23 Design" /></td>
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<tr>
<td>Plan</td>
<td>Description</td>
<td>Design</td>
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<tr>
<td>Plan 31</td>
<td>• Plan 11 with a separator added into the system</td>
<td></td>
</tr>
<tr>
<td>Plan 32</td>
<td>• External flush stream&lt;br&gt;• Must be compatible with the process fluid&lt;br&gt;• Only “approved” API plan for HF acid&lt;br&gt;• High Flow rates 3-5 GPM</td>
<td></td>
</tr>
<tr>
<td>Plan 41</td>
<td>• Plan 31 with a heat exchanger added into the system</td>
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Source: Swagelok Mechanical Seal Support Systems Training Material.

** Other types of Mechanical Seal Support Plans will be on the next issue
Dos & Don’ts for Sampling System Accuracy

Reliable process sample accuracy can be a challenge for even the most experienced fluid system engineers and analyzer technicians. Often, identifying the cause of inaccuracies can feel like something of a guessing game, and the more time an issue takes to diagnose, the longer your operation may be losing money on product that is not up to spec.

Want more accurate samples?

Here is a quick list of do’s and don’ts for better sample accuracy in your plant:

**Do check for simple system errors.**

Sometimes the reasons for process sampling inaccuracy are easy to identify. Regularly audit your sample system to eliminate simple mistakes—things like reversed check valves blocking your sample flow, or a fast loop flowing backwards.

**Do maintain sample flow.**

Successful sampling depends on ensuring the process sample fluid remains at the right flow, pressure and temperature to bring the fluid into an appropriate condition for analysis. Controlling those three conditions might be enough to eliminate many of the problems plaguing process analyzers around the world. Generally, a faster flow is recommended to ensure good sample mixing, cleaner sample lines, and quicker response time.
Do identify sources of time delay.

Time delay refers to the total amount of time it takes for a sample to travel from the tap in the main process line to the analyzer. Too long a delay can negatively influence sample accuracy. Symptoms of an issue can include measurements that do not appear to be tracking with your process, muted responses, laboratory disagreement, and poor control scheme performance.

There are a few areas that can influence time delay, including the length of the sample probe, the line length and diameter of sample transport lines, too high or too low pressure in those same lines, and beyond. Unsure where to start? Do take advantage of third-party resources to help you uncover potential time delay sources.

Do reduce gas volume upstream.

Gasses may run through the main system at high pressures, and they can ruin a well-designed sampling system. Not only can they cause time delay, as noted above, rapid decompression in the event of a component failure can also pose a safety risk. Therefore, it is a best practice to reduce the pressure of gasses as soon as possible in order to minimize sample system volume on the upstream side of a regulator.

Don’t choose incompatible materials. Fluids leave molecules behind after they touch a surface, and if your process sample loses too many molecules due to adsorption, your sample can spoil. Engineers should take care to select the proper materials for filter elements, regulator diaphragms, tube walls, or gas cylinders that minimize adsorption to improve sample accuracy.

Additionally, materials that are mismatched to your sample fluid may cause failures like sample leakage or even a blockage within the sampling device. Be sure to use compatible elastomer seals to ensure an accurate sample analysis.

Don’t sample from stagnant lines.

Sampling from an active and flowing process line is essential to obtain an accurate sample. Remember: The timeliness of your sample is also dependent on the time it takes the sample to flow from the process to the extraction point. The location of the sample point can be a critical aspect of a successful sampling system.

Don’t design dead legs into the sample transport line.

“Dead legs,” or lines containing an unpurged volume, can negatively impact process sample accuracy. These lines allow molecules to be held up from earlier samples that can diffuse into your current sample, causing a slow analyzer response and the continuous contamination of your system.

Don’t allow excessive flow through vaporizing regulators.

Vaporizers must be kept at a specific temperature for optimal operation, with a heating element typically used to help counteract the Joule-Thomson (JT) effect. While overheating can cause some sampling inaccuracies, a more common issue occurs when the vaporizer ices up due to excessive flow. A good general rule of thumb is to never allow more than 2 standard liters per minute of gas to flow through a vaporizer.

Source: Swagelok Blog – Reference Point