CAPROCO
INTERNAL CORROSION MONITORING SPECIALISTS

Injection / Sampling Systems General Information

INTRODUCTION

Injection/sampling systems are an invaluable component to corrosion control systems implemented in a variety of industries.

Sampling aids in the detection and measurement of key reactants or products in a corrosion process, such as corroded metal ions and oxygen. Sampling also allows the measurement of the pH level and the concentration of inhibitors present in the system. Sampling can be used in any environment to measure general corrosion, and the effects of corrosion control measures can normally be quickly detected.

The aim of inhibitor Injection is to form a stable adherent film on the internal surface of a pipeline or vessel, which acts as a barrier to aggressive products in the flow line. The function of the inhibitor can be to slow down the anodic or cathodic reaction, or to generate a film which increases the electrolytic resistance of the circuit. The liquid inhibitor can be added either as a batch or a continuous injection.

Injection/Sampling for the Oil Industry

Oil production systems handle crude oil mixed with water that can contain salts and dissolved gases (e.g. $C0_2$ and H_2S), which are corrosive. The concentration of dissolved gases can be very high and the pH correspondingly low, creating a very corrosive environment. To minimize this situation, sampling to accurately verify the corrosive environment present, and injecting effective inhibitors, can prove to be an efficient preventive maintenance method.

Generally, oils leave a film on the internal wall of the vessel or pipeline transporting them, and thus act as an inhibitor. Eventually water displaces the oil from the surface because of its greater density, thus eliminating any barrier between the water and the pipe wall. This effect can be accelerated by high fluid velocities. The stability of the oil film can be improved by the injection of water-displacing agents. It is better, however, to inject specific corrosion inhibitors because water displacing agents can also act as emulsifiers, which may have detrimental effects if they interfere with subsequent process operations.

Where two or more phases are present, it is important that the injected inhibitor is distributed properly. The rate at which the inhibitor is washed off the internal wall of the vessel or pipeline will depend on its solubility in the major phase. The dispersion of the inhibitor is aided by the quality of atomization at injection.

Injection/Sampling for Water Treatment

Injection / sampling systems are a valuable tool in controlling corrosion in cooling water systems. Most water systems carrying natural water will contain varying amounts of: scale- forming compounds, calcium and magnesium bicarbonates, sulfates, etc. and corrosive ions such as Cl^-. An injection/sampling system offers the advantage of easy, accurate sampling, and efficient distribution of inhibition agents, thus preventing corrosion, fouling, or scaling. In closed water systems, injection of oxygen scavengers can offer protection by deaeration.

APPLICATION

Caproco offers three styles of injection/sampling systems: retrievable (high pressure), retractable (low pressure) and fixed (high or low pressure). The retrievable and retractable systems both allow operators to: undertake injection, retrieve samples, and inspect and maintain equipment while the system is under full operating conditions. The fixed assemblies also allow injection and sampling under pressure; however the operating system must be depressurized before the equipment can be removed.

The standard Caproco injection/sampling system consists of an access fitting with a hollow tube, which allows either injection of chemical, or withdrawal of samples from the system. Where applicable, a nozzle may be fitted to the tube for injection purposes.

Injection/ sampling is done through the tee of the access fitting body, using a nipple and shut-off valve to connect to the injection liquid source or sampling delivery point. An optional check valve is available to ensure that the fluid in the system does not back flow to the injection equipment if for any reason the pressure in the injection system falls below the line pressure.

Sampling

The valve on the access fitting allows a sample to be taken at any time while the system is fully pressurized. By making a connection to the valve, the sampled liquid can be safely directed to an appropriate container, reducing the risk of hazardous contact and potential spills.

Caproco offers a range of sampling tubes that can be mounted either projecting into the line or flush with the pipe wall.

Injection

Caproco injection systems can be designed for discharge rates varying from 0.1 to 50 US gal/hr (0.38 to 190 lit/hr) or higher if necessary, with discharge pressures up to 6,000 psi (41.4 MPa).

For low injection rates (less than 2 gal/hr / 9 lit/hr), drip methods using either an open tube or quill in order to disperse the chemical are available. However, the recommended technique for a batch injection is through an atomizing nozzle.

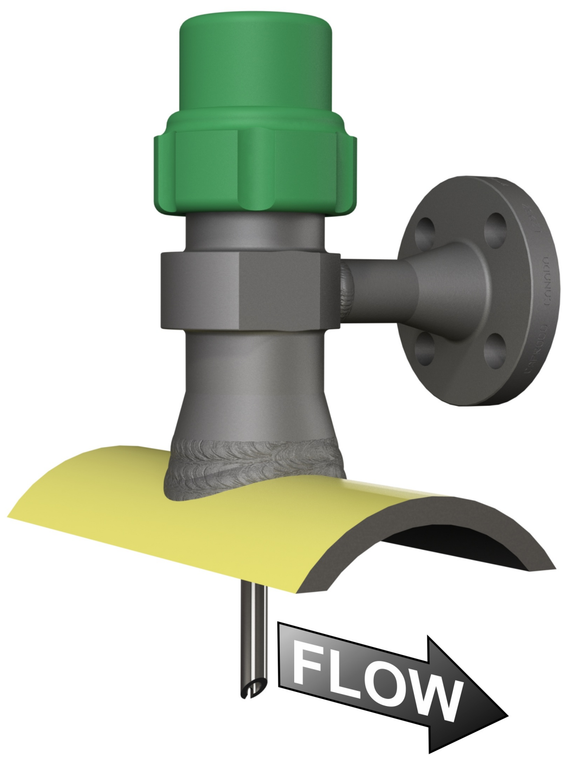
Drip injection tends to leave a high concentration of the injection chemical at the pipe wall surface below the injection point, resulting in substandard application. To avoid this, a spring-loaded atomizing nozzle and/or a batch injection pump is recommended.

The Caproco injection system is suitable for: algaecides, bactericides, chemicals, corrosion inhibitors, defoamers, deionizers, emulsifiers, emulsion breakers, glycol, methanol, ordorizers, oxygen scavengers, product additives, scale inhibitors and wax inhibitors.

Generally the most effective position for injection is at the center of the pipe or vessel, in the direction of the product flow (e.g. using an injection tube x head).

Highest fluid velocity is normally at the center of the line, therefore injection at this point ensures efficient distribution of the introduced fluid. However, in large vessels the location and direction for maximum distribution is largely dependent on the product fluid's entry geometry and velocity. It is also inadvisable to have injection tubes that are exceptionally long because of likely vibration problems.

In multiple phase flow, where the injection liquid is dispersible in one particular phase, a different injection point may be more effective (e.g. in cases where a large percentage of water is present in flowing oil, the optimum target to concentrate the injected spray of a water-dispersing inhibitor is the lower area of the line).



Access Fitting with Flanged-Tee & Injection Quill

If pigging is to be done on the line, the injection point may be flush with the pipe wall to prevent damage or the necessity to remove injection tubes beforehand.

As well as efficient injection, corrosion control is also dependent upon other parameters, such as the original pipe wall surface cleanliness and control of process operations. It must be recognized that there is no universal remedy for each situation and that each system must be treated according to its requirements.

CALCULATING INJECTION RATES

When calculating the dimensions of the injection equipment to be used, fluid dynamics must be taken into account. The type of flow that exists in pipes is described by the Reynold's calculation. The higher the Reynold's number the more turbulent the flow.

$$\mathrm{Re} = \frac{\rho v d}{\mu}$$

Where p = density of the fluid, v = velocity of the fluid, d = diameter of the pipe or tube, and μ = viscosity of the fluid.

The transition from laminar to turbulent flow occurs between Re = 2,000 and Re = 13,000, depending on the smoothness of the entry conditions. In practice most flow is turbulent. This affects skin friction, resistance to flow, and heat generation and transfer. If foaming occurs, surface tension is important, as collapse of bubbles can cause cavitation damage.

Note: The coefficient of viscosity (μ) is very temperature dependant. It diminishes with an increase in temperature in liquids, and increases with a rise in temperature in gases.

IMPLEMENTING AN INJECTION SYSTEM

The following information is need to design an optimum injection system:

System Parameters

- Pipe/vessel diameter (also vessel length if applicable)
- Access fitting type (thread-o-let, sock-o-let, flange size)
- Line pressure
- Fluid viscosity
- Fluid density
- Mass or volumetric flow rate
- Working temperature

Inhibitor Parameters

- Viscosity
- Density
- Temperature
- Anticipated injection pressure
- Mass or volumetric flow rate

The injection point location is determined by the product flow parameters, the injection liquid specifications, the physical measurements of the pipeline or vessel and any limiting factors (e.g. the distance from the end of a vessel to the tube sheet).

It is ideal if the customer can supply as much information regarding the process system and chosen inhibitor as possible when ordering, so that the correct size and length of equipment can be selected.