SERVICE PROFILE

Pipe Freezing

Overview

As a services line, nitrogen pipe freezing for isolations has been on the market with regularity since the 1970's, however, the first patents on the services have been documented as early as 1940's. The main purposes of the 'freeze plug' have been to create isolations in the following applications.

1. **Single isolations for low risk applications such as valve repair and maintenance.**
2. **Secondary isolations where a line need to be broken and only a single isolation exists.**
3. **Isolations to a section of pipeline (both on and below ground and subsea).**

Pipe Freezing Principle

The basic theory behind a 'freeze plug' is the cooling of the outer wall of the pipe to such an extent that the medium contained within (usually water) forms a plug inside the pipe, adhering to the wall and creating a solid isolation. Tests have been carried out with plugs holding in excess of 8,000 psi. To accomplish the freeze, a 'jacket' (a cryogenic heat exchanger) is placed around the pipe and liquid, usually liquid Nitrogen, is circulated within. The earlier jackets were essentially a contained void space where liquid nitrogen came into direct contact with the pipe, however, modern jackets work more on the principle of a heat exchange with the liquid Nitrogen circulating through veins in the jacket. The jacket length is usually twice the diameter of pipe and approximately one inch thick.

The precise steam flow rates and combined chemical injection rates that are required are determined during the detailed engineering and procedure generation process. Vapour phase

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cleaning can target the removal of LELs, H_2S, iron sulphide, ammonia, and mercaptans.

Metal Strength at Low Temperature

At low temperature the elastic module of materials increases. In general, the tensile strength and yield strength increases as the temperature decreases. Therefore, there is no additional risk to the pipe being pulled or bent slowly at low temperature. Due to increased brittleness at low temperature, any impact on the pipe should be avoided.

Since most stainless steel pipes are designed for cryogenic conditions exposure to low temperature during the freeze plug will not create any risk to their metallurgy.

Gel Freeze Plugs

In numerous cases isolations are required where there is no internal medium to freeze, the usual applications are:

1. Modifications or additions to flare headers, where the intention is to keep the plant and therefore flare system fully operational.
2. Any gas line where a temporary isolation is required to enable repair of an existing valve.
3. New tie-ins on gas or steam lines.
4. Temporary blocks for hydro-testing.

Gel Freeze Plug Methodology

Cross-linked gel water systems are ideal to use as a medium to allow for creation of a stable double block and bleed freeze plug. Comprised of a high-viscosity water based gel, it will displace oil or fill a void space in a gas line due to the cohesive nature of the cross-linked gel. The gel constituents themselves are a biodegradable product adapted from the food industry and do not require any special handling for injection or disposal. Due to the extremely high viscosity of the gel it does not behave as a conventional liquid by spreading across the bottom of the pipe but forms a mound. Following the first injection the gelled fluid will remain as a raised mound, likely filling up to 45-65% of the cross sectional area of the pipe below the injection point. The remaining void space will be filled with gel during subsequent injections.

The location of the freeze plugs is chosen to ensure that the freeze jacket sites are free of welds or any kind of pipe damage or stress. The site chosen must also have a fitting or valve between the intended jacket locations to allow for gel injection, pressure testing the plugs and continuous pressure monitoring during the operation. Once the pipe has been inspected and cleaned, the freeze jackets are installed on either side of the injection point and connected to the Nitrogen supply by a cryogenic hose.

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