PLUGGING METHODS FOR IN-SERVICE PIPELINE SYSTEMS

Pipelines, over decades, have established themselves as the transportation of choice to offer a safe, reliable way to transport a multitude of products. The reliance we place on pipelines as a transportation system has also accentuated the uptime requirement for these pipeline systems.

However, like anything mechanical, there are times when even the most reliable machine has to be serviced and maintained thus taken out of service for much needed, or even critical maintenance or repairs. The same with pipelines.

When you take a pipeline out of service for any length of time, there are consumers and producers (sellers) who bear the financial impact and the inconvenience of it all.

Plugging a section of the pipeline, to isolate a particular section, is a way to shorten the downtime of the overall pipeline and also shortening the recommissioning time significantly.

The most basic method is probably by merely turning the pipeline off, vent or drain the contents and then effect the required modification or repair, and after this is complete, re-commission and continue to use. The problem with this approach is that the downtime is long and expensive. This approach negates the whole argument of a pipeline being a reliable form of transportation.

The second form I would look at is freeze plugging. The basic premise that this technology functions on the premise that the content within a pipeline is frozen to form a plug or two plugs at a position upstream and downstream from a location that we plan to execute work on, be it a modification or repair. There are even gel plugs available for use on pipe freezing applications on a gas pipeline.

Freezing is a non-intrusive method to create a frozen plug inside the pipeline, stopping the flow of a particular product is in the line, with some, fundamental criteria; the contents must have the ability to freeze, the line must be full of that product, and there must be zero flow through the pipeline.

Start by placing a jacket or rather a cryogenic heat exchanger around the pipe location where the freeze plug is required. Liquid nitrogen is commonly used and is circulated within this jacket to cool the pipe and its contents down, sufficiently, to freeze the contents in the pipeline.

This technology has made advances throughout the years, and it is not uncommon to see these freeze plugs used in hydrotesting activities that may see freeze plugs withstand pressures beyond 3,000 psi.

It is also interesting to note that almost any type of pipe material can be subjected to this method of isolation, assuming adherence to specific parameters and precautions taken.

The third method is an inflatable bag inserted into the pipeline. We focus on the method to insert an inflatable system into a pipeline under pressure. Many moons ago, Iris equipment allowed the installation of a bag together with a device, that, when deployed inside the pipeline through a tapped hole, would open up like a daisy and the bag would locate against this device, which would support the bag and prevent it from moving. Well, that was the theory. Iris is no longer in use today, but there are some effective systems available for this application. Start by tapping a hole into the pipeline; the size of the folded gas bag determines the size of the tapped hole. The prevailing conditions inside the pipeline determines the bag length by considering the contact surface area required of an inflated bag, to overcome the force exerted by the column of water it is trying to hold back; in other words, the friction the bag exerts must overcome the force of the water column trying to push it down the line. The bags are limited in terms of pressure application but offer a very economical option for isolating pipelines; probably better suited to water and wastewater. The bags are made from a durable material outer, like ballistic nylon, with an inflatable inner bladder.

A housing contains the bags (either one single bag or two bags in some cases), the bags are placed in position with a simple mechanically operated cylinder through the hot tapped hole. A nosewheel forms part

of some gas bags for ease of installation. This nose wheel makes contact with the bottom of the pipe wall, causing it to deflect almost 90-degrees, to sit neatly inside the pipe, ready to be inflated and isolate the pipeline.

This system comes into its own on larger pipe diameters with pressures below 100 psi as a standard off the shelf option, but a more bespoke version would probably handle slightly higher pressures.

The next method for isolation is also one of those simple yet effective ways that are impressive in its simplicity; valve insertion.

There are a few options to choose from; one type requires hot tapping the pipeline section through a bolted fitting and the other, milling a slot through the pipe wall for the gate to fit through and enter the pipe.

Maximum application pressure is in the order of 250 psi, and as far as I am aware of, hydrocarbon application of these valves is currently not on offer. A multitude of pipe materials is suited for use, such as uPVC, HPDP, DI, AC & CS and sizes of 12" and below it takes one technician just under an hour to complete the installation, which is also one of the positive features of this technology.

The next option under the spotlight is line stopping. The technology was pioneered around 1956 and was referred to as a line stop or "Stopple" ® as the pioneer, TD Williamson termed it.

Even though "Stopple" ® or line stop refers to a method of isolating a pipeline section, it is indeed more of a system, encompassing a host of activities to arrive at the point where a pipeline can be isolated.

The activities are the following:

- Supply and install a special line stop fitting onto a pipeline section by welding this fitting during a period when the pipeline is in operation. This activity in itself is not only a critical activity but requires accurate and precise consideration to be given to pipeline operating conditions (flow, pressure, temperature, wall thickness and a slew of other factors) to ensure successful and reliable weldment.
    - The main difference between a standard hot tap fitting and a line stop fitting lie in the following:
        - Type of flange on these fittings.
        - Segments are recessed in the flange ID of a line stop flange, and the matching completion plug fits snugly inside the flange ID, seals with an o-ring and has a matching slot for these segments to engage and keep the plug intact under pressure. This design allows the user to recover the expensive low-profile valve used in plugging operations.
        - Line stop fittings would be size on size fittings, except for a folding plugging head, which is a derivative of the line stop plugging option.
- NDT and pressure testing follow welding of the fitting to the pipeline. Following that, install a low-profile valve (sandwich type valve), and a hot tapping machine onto the flange of the fitting.
- A hole tapped into the pipeline, equal to the pipe ID, completes this part.
- By manipulation of the low-profile valve, the equipment is installed and removed during the process to allow for access to the pipeline under pressure.
- Remove the tapping machine, and the plugging actuator fitted with a plugging adaptor and pivot plugging head is installed.
- The pivot plugging head consists of control bar head with attaching bolts to fix the plugging head to the hydraulic actuator, yoke and yoke pin that forms the pivot between the yoke and control bar head and lastly the nose piece where the sealing element is attached.
    - The sealing element is a disc type cup made from a rubber compound that gets bolted onto the nosepiece. The sealing element installed onto the nosepiece is what provides a seal when the pivot head is lowered into and set in the pipeline. The sealing elements are correctly sized for each pipeline diameter, wall thickness, and service application. The quality of the seal is dependent on pipe roundness, internal pipe condition, and internal cleanliness, but a workable seal is achievable in most cases.
    - In certain instances a secondary barrier is created by inserting an inflatable gas bag downstream of the plugging position, and any leak passing by the sealing element vents

through a fitting installed in between the gas bag and plugging head. Now it is safe to proceed to cut and perform remedial work.

- There are permutations to the type of isolation carried out:
    - Single position line stop:
        - One fitting and one plugging assembly (consisting of an actuator, plugging adaptor, pivot head, and sandwich type valve). This option is used in zero flow conditions.
    - A double position line stop without bypass:
        - Two fittings and two plugging assemblies (consisting of an actuator, plugging adaptor, pivot head, and sandwich type valve). This option is used in minimal to zero flow conditions.
    - Double position line stop with bypass:
        - Two fittings and two plugging assemblies (consisting of an actuator, plugging adaptor, pivot head, and sandwich type valve). This option is used in conditions where there is minimal to zero flow but does not disrupt the flow through the pipeline while work is being carried out.
    - There are other options, but that is the subject for a more technical discussion on pipeline isolation.
- So, at this point, the pipe section has been isolated, and repair or remedial work, completed.
- The first order of business is to create a pressure differential of zero across the sealing elements to allow us to remove the line stop actuators.
- Once removed, the completion plug is attached to the hot tap machine boring bar.
- The tapping machine with the plug is then installed onto the sandwich type valve, and the plug is carefully lowered into position with the completion flange so that the recess and segments in the flange line up. This critical action is only possible the taking of careful measurements of all aspects of the assembly (fittings, machine, sandwich-type valves and a host of other)
- Once the plug is set, the equipment is removed, and a blind flange installed on the line stop fitting, and the isolation is complete.

Admittedly, this is a very onerous process, but considering the pipeline pressures and temperatures that this technology is exposed to, it is understandable that the safety of this method also lies in the proven processes that have to be followed.

It is also important to note that there have been some exciting advances made in the line stop offering. Double block and bleed systems, high-temperature applications or even very high-pressure applications, previously viewed in the same light as the unicorn, a mythical fable indeed.

Lastly, and the most advanced option under discussion, is the use of an untethered, remote operated isolation pig. Such systems have been successfully used on offshore pipelines for decades, and more recently they are being used successfully on onshore pipelines as well.

Typical attributes and functions of an isolation pig are:

- It can be launched and received using standard pipeline launchers and receivers that can handle smart pigs.
- It is pigged to the location with either product or other medium in the pipeline; it does not self-propel.
- It is tracked using standard pig tracking methods, but typically also has onboard built-in pig tracking transmitters.
- Some models can create bubble tight seals in gas or liquids
- Some models can negotiate 3D or even 1.5D bends.
- They are commanded to set and form a seal by receiving coded signals from a transmitter located above ground, outside of the pipe.
- Their operating condition can be monitored remotely via their onboard communications systems
- Some models can perform multiple sets and unsets on a single pig run allow for multiple isolations
- Once the seal or isolation is no longer needed, they are pigged out of the pipeline and are received in a pig receiver (or launcher acting as a receiver)

To help explain the benefits of an un-tethered isolation pig let us look at the steps for a basic application - isolating a pipeline to repair or change out a launcher valve:

- Insert the isolation pig into the launcher
- Launch the isolation pig into the pipeline and move the pig with nitrogen to position it just downstream of the subject valve. A precise setting location of the isolation pig is not needed so long as it is downstream of the valve.
- Stop the flow in this section of the pipeline.
- Remotely set the isolation pig
- Note that if piping permits the pipeline downstream can start operating again downstream of the isolation pig
- Excess nitrogen pressure is relieved, either at the launcher or the valve
- Work is performed on the valve
- When the work on the valve is completed, equalize the pressure across the isolation pig and unset it
- Push the isolation pig back into the "launcher" (which is now being used as a receiver) and remove it from the launcher

As you can see using an isolation pig does not require the use of external fittings nor does it require the use of tapping or welding on an in-service pipeline. The added benefit is that there are no fittings, extra valves or blind flanges left on the pipeline once the project has been completed.

For as long as we have operating pipelines conveying everything from water to oil, gas, and fuel, a need remains to isolate pipelines safely.

END