Project Management Institute.
Kingdom of Saudi Arabia

Hot Tapping and

Line Stoppling Process in Cross Country Pipelines

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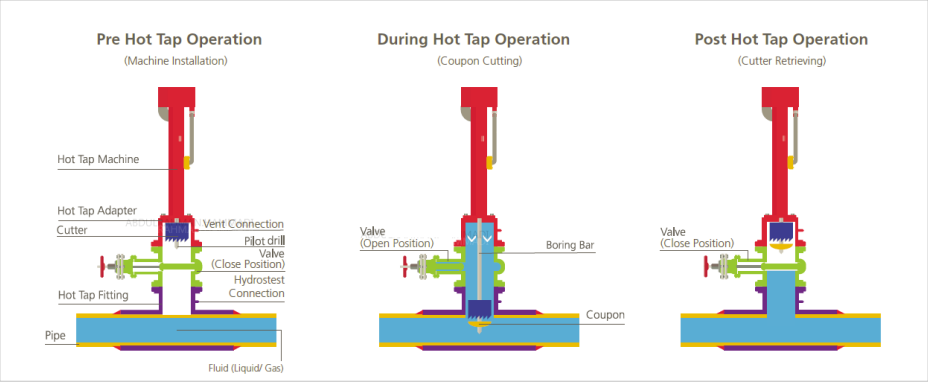
ABSTRACT

Pipeline hot tapping and line stoppling are one of the most worldwide used technique to connect a new branch line to a pressurized pipeline while it is in operation either in oil or gas or services of any type from one part to another without interruptions to the live operations and lose production. It also gives the ability to perform repairs, modifications and branch extensions without disturbing operations giving advantages in the considerable cost and increase in plant performance.

This paper provides a brief overview of the hot tapping process, its applications, different types of hot tapping machines and safety precautions that are necessary. The provided insights are intended to illustrate the importance of hot tapping and line stoppling in pipeline infrastructure management, as well as how the practice is changing.



1. Hot Tap Operation

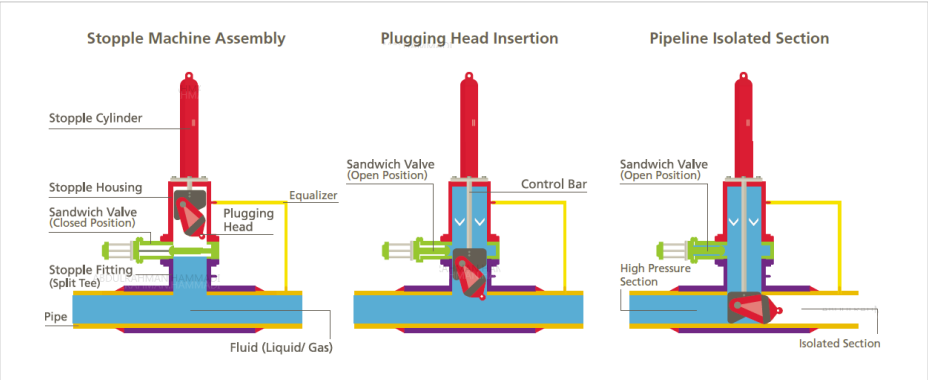


Figure 2. Stoppling Tap Operation

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INTRODUCTION

Maintaining pipelines in the oil and gas industry are exhaustive and crucial for ensuring the uninterrupted flow of crude oil, natural gas, or any other essential products across long distances. These pipelines serve as the backbone of energy distribution, enabling the transportation of billions of barrels of oil and cubic meters of gas. However, like any infrastructure, such pipelines require periodic maintenance, repairs, modifications, or expansions over their operational lifetime. Traditionally, such tasks require a complete pipeline shutdown and subsequent cleaning, leading to substantial operational downtime, loss of revenue, and potential disruptions to supply chains.

To address such challenges, the industry has developed and introduced pipeline hot tapping during the early 1970s which is a technique of attaching bolted or welded branch connection to a pipe while it is in service using specialized equipment for cutting a bore in a pipe while stoppling operation in another hand, is a pipe plugging device, normally inserted through a split tee with a full line size hot tapped while the line is pressurized.

This allows work to be carried out on live pipelines without interrupting the ongoing operations. Single Hot tapping enables new pipeline branch installation most commonly at 90 degrees while keeping the pipeline pressurized and functional whereas stoppling is used to temporarily isolate the pipeline by plugging. Thus, significantly reducing downtime and associated costs. This article explores the HT&S process, its benefits, the technology behind it, safety considerations, and the future potential of this important innovation in the oil and gas industry.

ADVANTAGES OF HOT TAP AND STOPPLING

HT&S Operations are a widely used technique in pipeline construction and maintenance, especially in the construction of brownfield cross-country pipelines besides the plant piping. It allows for connecting to existing pipelines or making modifications without shutting down the system. The advantages of this technique can be summarized accordingly:

CONTINUOUS OPERATION

One of the biggest advantages in the Hot Tap technique it allows for modifications or connections to be made while the pipeline remains operational in service. This prevents costly shutdowns and subsequent activities such as decruding and purging. Also, pre-commissioning and re-startup activities in addition to the reducing in service disturbance, which is crucial for pipelines transporting oil, gas, or other critical products.

MINIMIZED DOWNTIME

Due to the uninterrupted operations continue the project or maintenance as well as the product delivery schedules and timelines remains unaffected. This is important in large-scale cross-country pipelines, where even a short downtime could lead to significant delays and financial losses.

COST EFFICIENCY

Avoiding shutdowns means significant cost savings, due to the avoidance of stopping production and as a result preform exhausting decruding by clearing pipelines from products using several displacement scrapers runs till pipeline is safe to perform the work. In addition, running through pre-commissioning and startup processes which leads to a high-cost impacts to organizations. With HT&S operations all such excessive work can be avoided, reducing both labour and material costs.

SAFETY IMPROVEMENTS

Hot tapping is calculated risk designed to be performed safely, even under pressure. The equipment used and procedures followed ensure that the risks of leakage, fire, or explosion are minimized, making it safer for workers and the environment then utilizing the ordinary shutdown and startup methods.

ENVIRONMENTAL BENEFITS

Since the process allows tapping into live pipelines, there is no need to vent or empty large volumes of hazardous materials, reducing the risk of environmental contamination such as spills or undesired flaring.

FLEXIBILITY

In cross-country pipelines, where routes can reach to significant long distances, having the flexibility to add connections, by-passes, or branch lines during operations can be a huge advantage which Hot Tap provides safely and efficiently. This flexibility provides the option to add several systems to the hot tapped pipelines such as Surge Relief System, new Jumpover connection, Corrosion and Leak detection small probes. Hot tapping can be used to accommodate future extensions of the pipeline networks, allowing operations to add new branches, loops, or connections of most sizes to expand capacity without interrupting the current flow.

EMERGENCY REPAIRS

HT&S enables access to the pipeline for emergency repairs without requiring the full system to be shut down, which is crucial in cases where rapid intervention is needed to maintain flow or prevent accidents. Several cases have been encountered such as retrieving stuck scraper, valves replacement or leaks repair.

LOWER RISK OF OVERPRESSURE

In most cases the pipeline normal operating conditions are maintained specially the pressure, hot tapping reduces the risk of over-pressurization that can potentially occur when a pipeline is restarted after a shutdown avoiding surge cases.

THE HOT TAPPING PROCESS

The hot tapping process involves several carefully controlled steps to ensure a safe and efficient modification of live pipelines this control steps are crucial to at the stages of the process:

PLANNING AND PREPARATION:

The planning phase is critical in ensuring that the HT&S operation is executed safely, efficiently, and with the required quality. It should consider all aspects of the operation, including design, hot tap calculation, HSE requirements and preparations, quality, scheduling and resources. Before any work begins, engineers assess and verify the parameters of the pipeline to ensure that it is safe for hot tapping such as the pipeline's material, pressure, and product to determine the best approach for hot tapping.

A risk assessment is conducted to address potential hazards such as coupon loss inside the pipe, and safety measures are put in place. This review includes the review of the normal operating pipeline pressure, temperature and conditions the require pressure reduction (if required), and the optimal locations to weld the branch connection after preforming proper pipe wall thickness measurement such as Ultrasound Testing (UT) scans.

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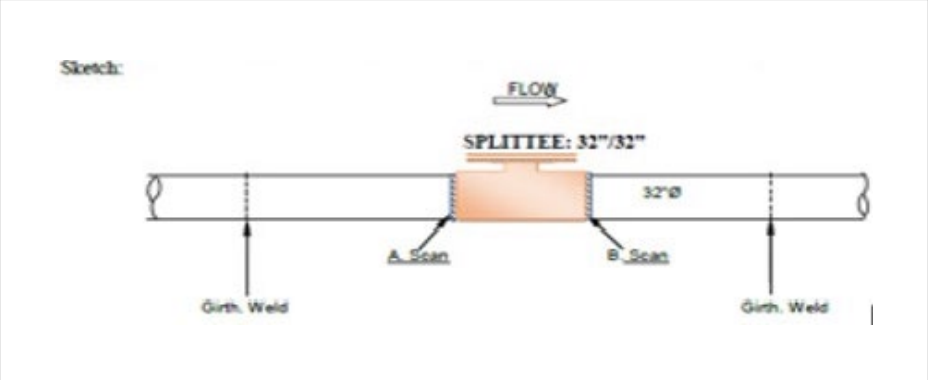

Figure 3. UT Report

ATTACHING THE HOT TAPPING MACHINE

The hot tapping machine, which consists of a drilling assembly in addition to permanent or temporary sandwich valve, is installed onto the pipeline at the required location (cutting shall not be performed on the exiting original pipeline weld girth due to its hard metallurgy).

The machine is typically attached to a pre-installed fitting (often a split tee) that seals the pipe.

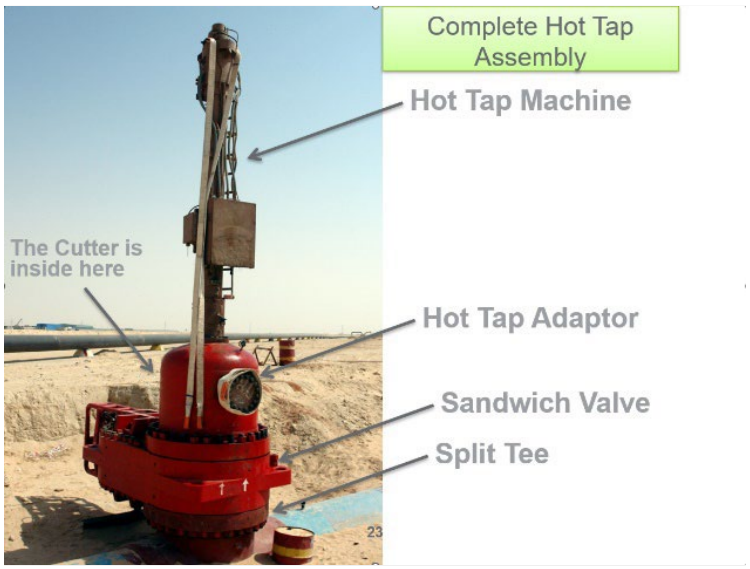

Figure 4. Complete Hot Tap Assembly

DRILLING THE PILOT HOLE

Once the hot tapping machine is secured in place, a hole saw is used to drill a pilot hole into the live pipeline. This is done carefully to centreline, firmly cut and hold the coupon cut from falling inside the pipeline. After the pilot drill completes drilling the pipe, the cutter saw is progressively increased to match the size of the new branch connection.

Throughout this process, the pipeline remains pressurized with continuous flow of the product being transported.

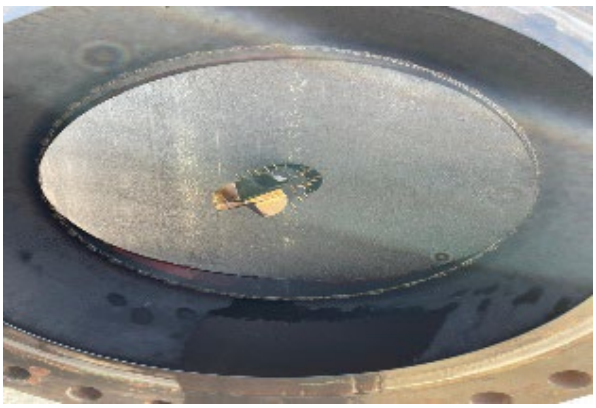

Figure 5 & 6 Cutter Assembly with Retrieved Coupon

INSTALLING THE BRANCH CONNECTION

Once the drilled hole reaches the desired size and coupon is free, the cutter travels additional inches to have clean cut in case of single hot tap to enable smoother coupon retrieval process. However, in case of stoppling operation, clean cut is mandatory to clean the shavings and sharp edges to avoid damaging the sealing element. Interestingly, for some conventional stoppling operations, the first stopple deployment is considered as swap cleaning for the area where the sealing element will take place noting that the size-to-size hot tap operations produce considerable amount of metal shavings.

After the cutter is retrieved to its original position, hot tap valve is secured and the chamber is depressurized to safe location., the hot tapping machine is then removed with new branch connection is installed and connected to the pipeline.

RESTORATION

After the hot tapping process is completed, the pipeline returns to normal operational condition without having any shutdown.

TYPES OF HOT TAPPING MACHINES

There are various types of hot tapping machines available depending on the vendors, each designed for specific pipeline sizes, materials, and project requirements:

SMALL DIAMETER MACHINES

These are designed for use on pipelines with smaller diameters, such as those used in distribution networks for natural gas or fire water also to install the Corrosion and Leak detection systems small probes. They are compact and efficient, ideal for the related infrastructure. They can be operated manually or powered by air compressors. New models and initiates have been seen for some electrical hot tap machines. There are no maximum flow restrictions for the small bore hot tap operations.

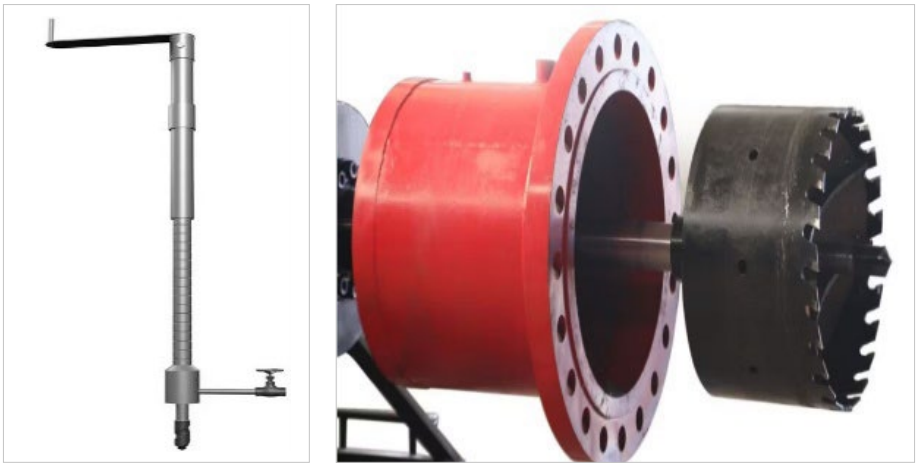

Figure 8 &7 Small versus large Hot Tap Machines

LARGE DIAMETER MACHINES

These sizes of machines are usually used for larger pipelines, such as the pipelines transporting water or oil and gas across long distances in trunk lines or cross-country pipelines. Large diameter hot tapping machines are built to handle the high pressures that can be encountered in such pipelines. In addition, large diameter bores are required a guide-bar to be installed at the hot tap opening to prevent the passing scraper to stuck at the hot tap opening

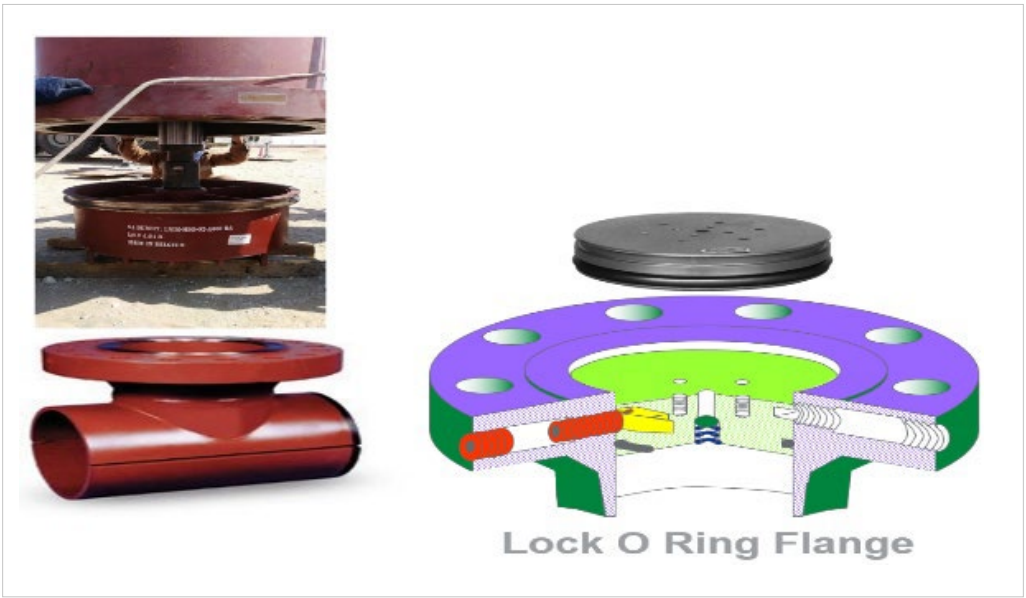

Figure 10 &9 Guide bar and LoR Flange Assembly

SPECIALIZED MACHINES

Certain hot tapping machines are designed for specific materials, such as carbon steel, stainless steel, cement lines, or high-density polyethylene (HDPE). These machines are tailored to ensure that the hot tapping process does not damage the pipeline material, maintaining structural integrity and preventing leaks (Jackson & Lee, 2019).

MANUAL AND AUTOMATED SYSTEMS

Hot tapping can be performed using manual systems for small-scale projects or automated machines for more complex or large-scale operations. Automated systems are increasingly being used in high-risk environments, such as deepwater pipelines, where precision is critical (Miller & Sanchez, 2021).

HOT TAPPING SAFETY CONSIDERATIONS

Hot tapping involves working on live, pressurized pipelines, which presents a variety of safety hazards. Making such process safe was one of the main drivers to acquire the optimum benefits from this method accordingly several mitigation measures were considered to avoid the associated risks:

PRESSURE-RELATED HAZARDS

Hot tapping is performed on pipelines that remain under pressure, and any error in the process could result in the sudden release of pressure, causing potential injury to workers or damage to equipment. Continuous pressure monitoring is essential (Parker et al., 2018). Furthermore, below pressure tests are essential to avoid such hazards:

- **Hot tap fitting** is hydrostatically tested at factory
- **Hot tap valve** is tested hydrostatically at shop for both body and seats
- **After the hot tap fitting is welded** it undergoes hydrostatic test to assure welding integrity
- **After hot tap valve is installed,** it undergoes leak tested to assure the valve has not got damaged during transportation and installation
- **After HT machine is installed**, the whole hot tap assembly is leak tested to assure bolting tightness

EXPLOSION AND FIRE RISKS

ipelines often carry flammable materials like natural gas, oil, or petroleum products. Improper handling during hot tapping can result in explosions or fires. To prevent this, explosion-proof tools and equipment are used, and strict safety protocols are followed (Parker et al., 2018).

CHEMICAL EXPOSURE

Workers involved in hot tapping may be exposed to hazardous chemicals, particularly when tapping into pipelines that transport toxic or corrosive substances. Personal protective equipment (PPE), such as specialized suits, gloves, and breathing apparatus, is necessary to protect workers from exposure (Thompson et al., 2018).

EMERGENCY READINESS

Comprehensive emergency plans and Job Safety Analysis (JSA) must be in place before any hot tapping operation begins. This includes fire suppression systems, immediate shutdown procedures in case of a leak, and evacuation protocols (Parker et al., 2018).

APPLICATIONS OF HOT TAPPING

The versatility of hot tapping has made it a critical tool in the oil and gas industry. Its applications include:

PIPELINE REPAIRS AND MAINTENANCE

Hot tapping is used to replace or repair pipeline valves, instruments, or sections of piping without shutting down the entire system. This is particularly valuable in older pipelines that require regular maintenance.

PIPELINE EXPANSIONS

When a new branch or segment needs to be added to an existing pipeline, hot tapping enables the expansion without disrupting the ongoing operation of the original pipeline. This is crucial in areas where maintaining uninterrupted flow is essential, such as during peak energy demands (Petrov & Andrews, 2017).

MONITORING AND INSTRUMENTATION

Hot tapping can be used to install sensors or monitoring devices that provide real-time data on pipeline conditions, such as pressure, temperature, flow rates or Leak Detection System (LDS), Corrosion Monitoring System (CMS). This is particularly useful for ensuring the integrity of pipelines in harsh environments or remote areas

OFFSHORE APPLICATIONS

Hot tapping is especially valuable in offshore pipeline networks, where shutting down operations is not only costly but also logistically complex. Offshore platforms often use hot tapping to install new equipment or modify pipelines without disrupting production. There has been significant developments to the subsea hot tapping technology and remote operations.

TRENDS AND FUTURE INNOVATIONS

As the pipeline industry evolves, hot tapping and stoppling continue to foresee technological advancements, making it safer, more efficient, and more adaptable to complex environments. Some key trends and innovations include:

ROBOTICS IN HOT TAPPING

Robotics is an emerging trend in hot tapping technology. Robotic systems can perform hot tapping in hazardous or hard-to- reach areas, such as deepwater pipelines or pipelines transporting hazardous materials. These robots can be equipped with sensors and precision tools, reducing the need for human intervention in dangerous environments (Miller & Sanchez, 2021).

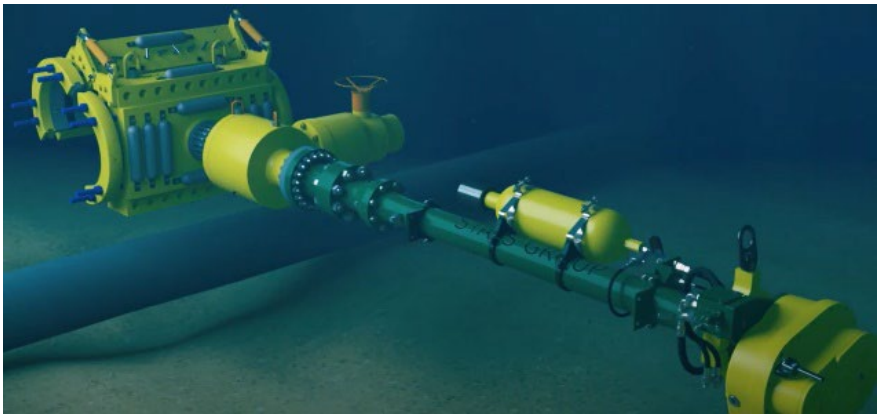

Figure 11 Subsea Hot Tap Machine

AUTOMATED HOT TAPPING SYSTEMS

Automated hot tapping systems are being developed to increase the precision and efficiency of the process. These systems can be remotely operated, reducing the need for manual human interference and minimizing the risk of human error (Miller & Sanchez, 2021).

ADVANCED MATERIALS

The development of high- strength composites and corrosion-resistant alloys for hot tapping tools and cutters are improving the durability and performance of the equipment. These materials are particularly useful in pipelines that operate in severe conditions, such as high-pressure or highly corrosive environments (Thompson et al., 2018). In some cases, conventional cutters are replaced with Dimond or carbide cutters for better cutting.

Figure 13 &12 Conventional Vs. Diamond Cutter

DOUBLE BLOCK AND BLEED PLUGGING HEAD

a form of plugging isolation tool that allows for the safe tie-in of pipelines. DBB head consisting of two mechanisms of sealing elements and a bleed vent used to depressurize and monitor the hot tap fitting chamber and the pipeline isolated section, allowing for the safe installation of the new branch connection.

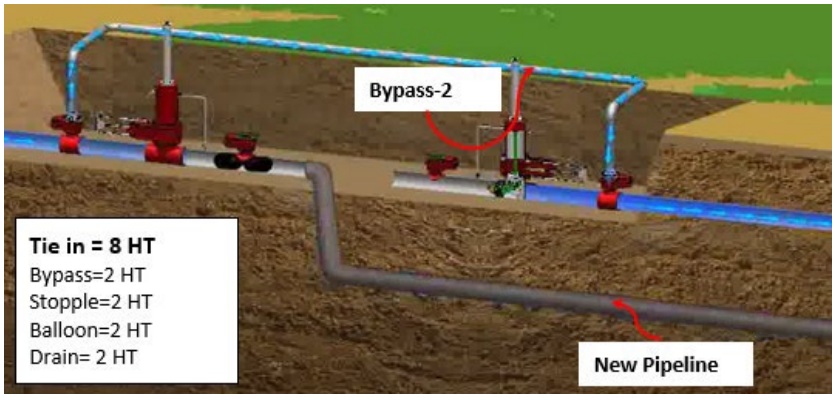

Figure 15 Double Stopple Operation with Full Through Bypass utilizing Conventional plugging heads

Figure 15 Double Stopple Operation with Full Through Bypass utilizing DBB plugging heads

CONCLUSION

Pipeline hot tapping and stoppling for subsequent tying and commissioning are essential techniques used in the oil and gas industry to maintain the pipeline network. These techniques enable for the replacement or repair of pipeline sections without interrupting the flow of the product. However, these techniques require meticulous planning, procurement, and execution to ensure that they are carried out safely and efficiently. Any deviation from the design specifications or safety procedures can result in calamitous consequences, including loss of life and property damage. Therefore, it is crucial to follow the best practices and guidelines outlined in this document to ensure the safe and efficient implementation of pipeline hot tapping, stoppling, tying, and commissioning.

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