Blockage remediation methods vary widely depending on the nature and location of the blockage, available facilities, targeted outcome(s) and costs involved. In Blockage Remediation Part 1: Blockage Characterization and Detection, we discussed the importance of correctly understanding the nature of a blockage in order to formulate an effective remediation solution.

This GATEKEEPER will focus on commonly applied remediation methodologies used in the industry, as well as discuss the GATE blockage remediation approach.

Blockage Remediation Methods

The most commonly applied blockage remediation methods, and their application to the most common blockage types, include:

1. Chemical Methods
2. Mechanical Methods
3. Pressure Methods
4. Thermal Methods

Chemical Methods

Asphaltenes & Paraffins: Xylene or other custom solvent packages are commonly used to dissolve asphaltene and paraffin deposits. Direct contact between the deposits and solvent is necessary, which in turn requires a good understanding of deposition location and amount. Additionally, sufficient soaking time and circulation of solvent is needed to obtain the best results.

Hydrates: Inhibitors such as methanol and glycol can be used to melt hydrates. Direct contact between the hydrate blockage and inhibitor is required. However, because of fluid densities and flowline bathymetry, this is often challenging to accomplish. Contact time, location, size and number of the hydrate blockage(s) also impact remediation results.

Scales: Acidizing can be used to dissolve carbonate scale deposits. Direct contact between the deposits and acid is necessary which again requires a good understanding of deposition location. Chemical approaches are typically not recommended for sulfate scales, especially barium sulfate.

Mechanical Methods

Mechanical means are often combined with a chemical-based approach such as running of coiled tubing to help in delivering the appropriate inhibitor or solvent to the blockage location. Coiled tubing may also be used to run custom tools which can help with milling / jetting of solids or the injection of nitrogen to displace liquids. Hydrates can be “drilled” into using coiled tubing in order to deliver chemical and facilitate dissociation; special procedures need to be implemented to mitigate safety concerns when adopting this approach.

Pigging of flowlines may be used when flowlines are not completely blocked to help sweep out solids or for “placing” of custom gel packages. The pigging operation can be performed following the breakdown (i.e. dissolving or melting) of solids with alternative means.

Additional mechanical means include, but are not limited to, mobilization of multi-service vessels (MSVs) with coiled tubing, remotely operated vehicles (ROVs), pumps and other customized subsea equipment, or deployment of flowline hydrate remediation skids. The solids/blockages in the surface facilities, if accessible, can be removed physically. Such blockages may include barium sulfate scales, paraffins, asphaltenes and sands.

Pressure Methods

Hydrates: Hydrate dissociation via depressurization (single or dual sided) is always effective if the required dissociation pressure can be reached. In deepwater systems, achieving the required pressure is not always readily possible and requires intervention equipment.

Pressure Methods

- Depressurization (Single Sided & Dual Sided)
- Pulsing
- Alternating Pressure or Rocking
- Pressure Differential

Thermal Methods

- Flowline Heating
- Hot Fluid Circulation
- External Heating

Chemical Methods

- Xylene
- Custom Solvents
- Methanol
- MEG
- TEG
- Acid (HCl, HF, HoAc)
- Custom Solvents

Mechanical Methods

- Pigging
- Coil Tubing
- Milling & Jetting
- Drilling
- Pigging
- Coil Tubing
- Milling & Jetting

Pressure Methods

- Pigging
- Coil Tubing
- Milling & Jetting

Thermal Methods

- Flowline Heating
- Hot Fluid Circulation
- External Heating

Figure 1: Blockage Solution Options Based on Nature of Blockage
Blockage Remediation Part 2: Remediation Methodologies & Execution

Paraffin: For paraffins, pulsing, rocking and applying large differential pressure across the blockage has proven successful in some cases. Since the system is likely going to see intentionally induced pressure fluctuations, possibly near design limit conditions, safety is of paramount importance.

Thermal Methods

Paraffin: Heating of the paraffin deposits to at least above the Wax Dissolution Temperature (WDT) may remediate the blockage. This is often achieved by heated medium circulation, which is possible only when partial communication across the blockage exists.

Hydrates: Increasing temperature beyond the dissociation temperature will remove hydrate blockages. This is rarely attempted in practice, primarily due to safety concerns related to the large volumes of gas released during dissociation. Also, heating results in the hydrate losing contact with the pipe wall radially. This can result in a hydrate projectile when the solid mass dislodges, posing an associated risk to downstream equipment and personnel.

Paraffin: Heating of the paraffin deposits to at least above the Wax Dissolution Temperature (WDT) may remediate the blockage. This is often achieved by heated medium circulation, which is possible only when partial communication across the blockage exists.

Approach to Blockage Remediation

The GATE Approach to blockage remediation entails the following four stages:

1. Engineering Assessment
2. Remediation Method Selection
3. Planning & Execution
4. Post Remediation Activities

Engineering Assessment

The objectives of the Engineering Assessment of a Blockage are to identify the nature of the blockage and their likely location within a system. This is achieved by reviewing historical field data, system conditions, attempted operations, and fluid sample data.

Thermal hydraulic simulation models may also be used to determine the performance of the system to help determine the possible location of blockages. Models are benchmarked using field data for validation. More details of the engineering assessment portion of blockage remediation can be found in Blockage Remediation Part 1: Blockage Characterization & Detection.

Remediation Method Selection

After a blockage has been identified and the location has been determined, a remediation method needs to be selected.

Using the GATE approach, the first step is to identify all available fit-for-purpose remediation options. The potential remediation options are ranked based on the method’s complexity and overall cost, as shown in Figure 2.

An assessment of cost, risk and probability of success of the proposed solutions is undertaken based on client needs (Figure 3). This methodology shows all possible solutions and can be used to narrow down the remediation options and eliminate those whose likelihood of success does not justify the cost involved or are deemed too risky to personnel or the system.

Once the most viable and tailored remediation option is selected, the execution planning and procedures development begin.

Planning & Execution

During this stage of the blockage remediation, appropriate operating procedures are developed considering the technology selected for the remediation, the systems conditions and its characteristics. Procurement of required personnel, ancillary equipment (i.e. ROVs, MSVs, flowback skids, etc.) and resources are evaluated.

Post Remediation Activities

After the blockage remediation process is completed, the following post remediation measures are recommended:

1. Root Cause Analysis (RCA) to effectively determine the causes leading to the development of the blockage.
2. In light of the RCA, Standard Operating Procedures (SOPs) need to be reviewed and updated to avoid future issues, if possible.
3. Establish Key Performance Indicators (KPIs) of the system, to evaluate improvements after the implementation of the necessary operating changes.
4. Train personnel to recognize signals that indicate a possible issue in the system or the potential that a blockage is developing.

Conclusion

Blockage remediation success depends on a strict and methodic blockage characterization and detection as part of the engineering assessment. Also, the selection of remediation solution and execution plan is paramount in limiting the operations risks and maximizing the cost benefits.

A minimum investment in the Engineering Assessment could save significant time and money in the overall remediation process. The development of a sound remediation plan, that reviews all the options and categorizes them based on the likelihood of success, operational risk involved and cost benefits helps the operator in the decision-making process and in the reduction of operational expenses.

The solution will need to involve corrective actions post remediation that efficiently address the root causes of the problem. The establishment of KPIs and effective training will help avoid similar issues in future.

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