THE VIKING EXPLORER
INSIGHTS TO THE OIL & GAS INDUSTRY

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LEASE & ASSET PRESERVATION CONSIDERATIONS DURING SHUT-IN

PART 2 : MANAGING INTEGRITY RISK & REDUCING DAMAGE FROM WELL SHUT-INS AND START-UPS

Integrity Risks from Well Shut-in to Start-Up

The recent global over supply of crude oil and soft demand has resulted in oil companies shutting wells in to prevent destroying value and to protect their balance sheets. The time frame, until production startup becomes economic, is uncertain and therefore, it is imperative that appropriate actions are taken to maintain and manage the integrity of shut-in wells and associated delivery systems. Consideration of many factors within the entire flow system, from reservoir to production delivery systems, is necessary to manage the risk of temporary or permanent damage to the near-wellbore, wells and surface facilities.

These shut-in periods can be viewed as an opportunity to perform certain key actions and collect various pieces of information to ensure well integrity and optimized future performance. This part of the Viking Explorer will focus on the well integrity aspect in terms of primary and secondary barriers and areas of optimization.

Managing Integrity Risks from Well Shut-ins

Shutting in wells for any reasons has various associated risks involved and one of the high-risk factors is the integrity of the well during shut-in or while returning to production.

Some of the points which may impact well integrity are:

- **Shut-in Methodology**: Based on the sequence of operations during shut-in process, forces generated on pipes/connections may impact integrity of the well.
- **Shut-in Duration:** Forces acting on pipe and connections will change over the duration of the shut-in since the temperature of the wellbore will try to reach undisturbed levels.
- **Thermal Effects of Multiple Wells:** The potential interaction of nearby wells may also have an impact on change in undisturbed temperature profile.

One of the other methods which can be implemented by operator is curtailing the production down by choking the well production. This may not have a significant impact on the integrity of the well based on the initial design of the well. However, this may need evaluation for the new operating window for annulus A pressure management for the subsea wells, where the access for various annuli is limited.

Shut-In Considerations

It is important to establish a detailed plan for wells to be shut-in since it may have a significant impact during start-up. Some wells have some unique characteristics that require special consideration during shut-in and start-up operations. Some of the considerations are:

- Downhole or Surface Shut-in
- Well Integrity

Downhole or Surface Shut-in

It is important to consider benefits and hazards of surface versus downhole shut-in. Depending on the availability and feasibility the well can be either shut-in downhole using plug/safety valve or other means near the reservoir or at the surface using Christmas trees and manifolds.

Well Integrity

It is important to understand before shut-in if any of the primary or secondary barriers have been compromised.

- **Well Condition**: Wells with corrosion/erosion issues need to be analyzed prior to shut-in to ensure pressure limits and/or a pressure management plan is established that will address potential well integrity concerns.
- **Pressure Monitoring**: Tubing and annuli pressures should be monitored to determine overall integrity. If an annulus must be filled with fluid to reach a certain pressure reading, the start-up procedure must consider its impacts and address actions to ensure well integrity is not compromised.
- **Information**: It is highly recommended to review and update information related to well prior to shut-in which may facilitate trouble shooting and/or intervention if the need arise. Few items which are important are listed below
    - Casing Program and pipe ratings
    - Cement tops
    - Wellbore fluids including all the annuli (type, density)
    - Wellhead diagram and ratings
    - Any significant issues observed

Above listed considerations are few examples to help operators understand the impact and process which may be followed for shut-in wells. It is equally important to evaluate and understand a holistic approach for the well integrity which will include materials of pipe/equipment, fluids and their exposure to material, water cut, solids settling, etc.

Well Start-Up Process

For wells that have been temporarily shut-in, the most important aspect will ultimately be the ability to bring the well back on production safely and with optimal productivity.

Discussed below are various aspects which need to be considered and confirmed before well start-up, including:

- Barriers
- Loads
- Optimization

Determining Barrier Integrity

Primary and secondary barrier assessment should be addressed prior to start-up.

- Barriers may include production tubing, production casing and packers. Pressure testing these barriers to expected loading conditions is recommended.
- Barriers with integrity issues will need to be addressed prior to start-up. Based on the type of barrier, it may be redressed/replaced, or some operational limits can be put in place to address the same.

Loss of well integrity can be stated as loss of primary and/or secondary barrier in the well. The following describes aspects to consider for the barrier assessment:

- **Historic Evidence:** Review existing well data prior to shut-in or start-up to determine if there is any evidence of breach in primary or secondary barrier.
- **Instantaneous Pressure Changes**: If any of the annuli show a sudden change in the readings, it should be evaluated and compared with the other annuli readings to help locate the potential failure point.
- **Equal Pressures Across the Annuli**: Annuli with same pressures may be an indication of communication across barriers or a possibility of leak at the wellhead itself.
- **Pressure Test**: Conducting a pressure test of primary and secondary barriers is a direct means of verifying barrier integrity.
- **Fluids**: Annulus bleed off during production or shut-in, can provide useful information. The composition of captured fluids can be analyzed to determine if there is communication between annuli. However, consideration should be given if various other fluids have been used earlier to pump in these annuli.

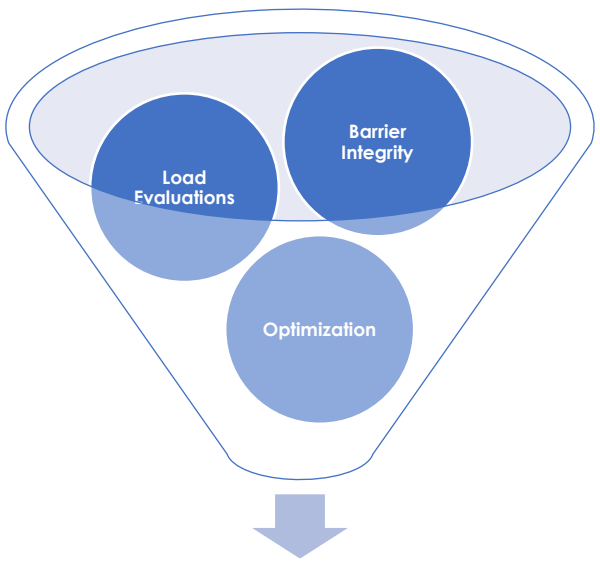
Load Evaluations

After the shut-in period, getting the well back into production will exert combined forces on the pipe, equipment and connections in the well. One must make sure to avoid exceeding the allowable limits for the primary and secondary barrier during the life of well.

- It is possible to gather new information about the well during the shut-in period such as fluids, water cut, possible breaches in outer casing, etc. This is very important information for the well start-up process.
- It is recommended that the worst-case loading conditions must be evaluated once again to ensure the allowable limits are not exceeded of the primary and secondary barriers.
- The operator may be able to determine the operating limits of the well based on information gathered during shut-in.

Before well start-up, it is recommended to re-evaluate the loading conditions and determine if any changes and modifications to the operating limits are justified. Incorporating the information gathered from barrier integrity assessment will be a key step in developing load specific to critical barriers that need to consider following:

- Communication between barriers
- Potential corrosion/erosion of pipe
- Degradation of fluids



It is important to evaluate loads for the life of the well. Basic loading conditions that should be evaluated are discussed below; however, an operator may need additional cases based on fit for service applications.

- **Temperature:**
  - Stimulation loads
  - Maximum anticipated start-up rates
  - Late life production rates (high water cuts may become challenging)
- **Pressure:**
  - Pressure test
  - Tubing Leak
  - Well Kill Operations
  - Acidizing/Well Stimulation
  - Annulus Build-up Pressures

Optimization

The production and reservoir engineers may be able to take advantage of the non-productive time due to shut-in for further optimization of the well or to gain knowledge of the reservoir performance and characteristics.

- For land wells, this may be the opportunity to implement/install more suitable artificial lift methods or new downhole equipment to increase productivity.
- Re-evaluation of the future loading conditions may provide opportunity for a more cost-effective design that improves operating limits, safety and well productivity.
- Extended shut-in periods offer an opportunity to perform pressure transient analysis such as build-up tests to gain knowledge for a reservoir or completion design performance.

One of the areas to check before the well start-up programs is the optimization of the overall well performance. This part of the process will include inputs from most of the groups such as reservoir engineering, drilling and completion engineering, and the production engineer. Well optimization should always look at a holistic approach and inputs from all the involved parties will yield a better optimized design.

Some of the things which can be considered during the optimization process include:

- **Operational Limits**: Based on the review of barrier integrity, load analysis and production parameters, one may be able to extend or limit the operating conditions to increase the efficiency of well.
- **Re-Completion:** Consideration for re-completion should be given as it may provide opportunity for adding zones/perforations or isolate non-productive zones.
- **Artificial Lift Method:** Based on the information if a new artificial lift method is needed it should be evaluated for the increased well performance.
- **Modifications/Changes**: If the current well design needs any modifications/changes for improved productivity by installing any additional system/equipment that should be evaluated and implemented.

Conclusion

Extended shut-in periods and well production restart requires a detailed planning and execution process to ensure the well integrity. These extended shut-in periods can be turned into opportunities for improvements in well performance, and optimization of the production system. Disciplined implementation of the shut-in and restart plans could signify economic gain in the long term and a faster recovery of the productive condition of the wells and the field.

One of the important aspect which goes along with well integrity is the integrity of surface facilities.

The next issue of Viking Explorer will discuss the integrity and optimization of the surface facilities. Stay tuned!!