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Facilities Selection Impacts Reservoir Performance

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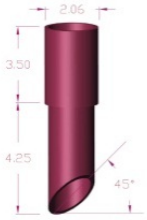

Managing the Reservoir from the Burner Tip

- Every decision can either look back toward the reservoir or look forward toward the end use
  - Looking back asks the question “how will this decision affect reservoir performance, ultimate recovery, and profitability”?
  - Looking forward asks the question “how will this decision affect installed facilities?”
- The first decision that installs equipment incompatible with full reservoir pressure has shifted the focus forward

Why do we change focus?

- The primary cause of shifting the industry focus is decreased risk tolerance:
  - Safety risks
  - Environmental risks
  - Performance/profitability risks (distant third)
- The primary tools of risk-elimination are:
  - Supply Chain Management
  - Process Safety Management (PSM)
  - Processes and Procedures

Supply Chain Management

- In the 1970's auto makers and large retailers began using computers to work towards the goal of "just in time" inventory control
- By the 1980's PhD and MBA candidates were writing thesis on this trend and Oil & Gas jumped onto the band wagon
- Focus and intent of Supply Chain Management is:
  - Manage units of production to provide components as required with minimal warehousing
  - Manage the tools of production to minimize the amount that they constrain the production process
- Units of production are the things that go into the final product
- Tools of production are the things that stay in the factory when the final product leaves (like robots, assembly lines, factory lighting, compressed air systems, etc)

Supply Chain Management

- In Oil & Gas our units of production are hydrocarbon molecules and there is no really good method to manage the supply of those molecules
- Our tools of production are valves, valve repair kits, pipe, tanks, pumps, compressors, gensets, etc.
- To properly implement Supply Chain Management in Oil & Gas, we would need to take extraordinary efforts to ensure that:
  - Repair/replacement equipment was immediately available
  - Field workers are adequate in number and extensively trained in repairing and diagnosing failures in all of the tools of production
  - Cost control takes a secondary position to production optimization
  - Work management has "flexibility" as a primary goal
- Proper implementation is kind of boring and hard to build an empire upon so our industry has decided to apply techniques appropriate to units of production to tools of production

Process Safety Management (PSM)

- PSM is a set of processes and procedures designed to:
  - Ensure that system design contains appropriate risk mitigation
  - Ensure that system modifications meet the standards of the original design as applied to current operating parameters
  - Ensure that procedures used will minimize the risk to the environment, the public, workers, and equipment
- The basic tenet of PSM is to balance risk mitigation with risk density

Risk Density

- Risk density is a measure of the likelihood and consequences for an excursion to:
  - Harm employees
  - Damage other equipment
  - Harm the environment
  - Harm the public

- A plant
  - Is manned 100% of the time by a number of people
  - Has numerous components
  - Has fluids that can do real harm to the environment
  - Is often located in population centers
  - Very high risk density

Risk Density

- A wellsite
  - Is manned 1-2% of the time, usually by a single person
  - Has very little equipment
  - Has little opportunity to harm the environment
  - Is generally remote from population centers
  - Very low risk density

- Successful risk-mitigation strategies will always consider risk density in the establishment of processes and procedures

PSM

- When you ignore risk density, then it is reasonable to apply processes appropriate for a refinery to wellsites:
  - Require Management of Change (MOC) and Hazardous Operations (HazOp) reviews to change orifice plates in a meter run
  - Require full lock-out/tag-out protocols to spray a wellsite for weeds
  - Develop extensive drawing packages for wellsites (and require the drawings to be updated before work can be started)

PSM

- When you consider risk density:
  - MOC and HazOp are not required for routine activities (e.g., swapping compressors within a fleet, changing plunger type, changing orifice plates)
  - Lock-out/tag-out is only required when multiple unrelated activities are done concurrently or the well is left unmanned in an unstable condition
  - Operating procedures are flexible to the point where they can be ignored if a particular well requires other procedures

Processes and Procedures

- Process—a description of something that must be done
- Procedure—a description of how to do something
- Both are intended to:
  - Minimize the risk of an error
  - Ensure that everyone does the same task the same way on every location every time
- Actual outcome is to:
  - Force workers to lie about having followed procedures that are inappropriate for a given location
  - Stifle innovation
  - Provide an easy excuse for failure (instead of providing a reasonable path to success)

Where to PSM, Supply Chain Management, and Processes/Procedures fit into normal operations?

Completion techniques

- Experience shows that CBM wells completed with Cavition Stress Technique significantly out perform any other completion (often by a factor of 20-40 times)
  - Cavitations only work in a limited number of wells
  - Cavitations are messy and have an unpredictable duration which makes scheduling difficult
  - Looking towards the reservoir, any well that could possibly have a successful cavitiation must be cavitated
  - Looking towards the budget and the schedule it is easier to case and frac the wells even if the result could be less than 1/40th the production rate

Completion Techniques

- Experience shows that coal is self healing and frac proppant quantity/type is largely irrelevant
  - Looking towards the reservoir would have frac's with large carrier volume and only enough sand to enhance abrasive action
  - Looking towards supply chain management you farm out the decision to the frac contractor and you get a huge sand load and exotic carrier material

Flowing bottomhole pressure

- Steady pressure improves the affected reservoir area and results in higher flow rates and more ultimate recovery
  - Looking towards the reservoir you would make an effort to determine the most effective pressure relationship between reservoir pressure and flowing bottomhole pressure and try to stay as close as possible to that value over time—if there is a wellhead choke it is a "backpressure" choke that holds FTP constant
  - Looking towards the lease equipment and gathering system you put a "pressure regulating" choke that ignores upstream pressure and keeps downstream pressure constant

Lease equipment

- Typically, each pressure class will result in costs about 10-20% higher than the next lower pressure class
  - Looking towards the reservoir would have you pick an MAWP based on reservoir pressure and will typically be something like ANSI 600 (1440 psig or 10 MPag) and not require wellhead chokes to protect the artifacts
  - Looking towards a low pressure gathering system would select ANSI 150 (280 psig or 1.9 MPa) or less and would require wellhead chokes and wellsite ESD's to protect the artifacts

Gathering systems

- Gathering systems can either be a tool of reservoir management or a sales tool
  - Looking towards the reservoir
    - The system MAWP is consistent with reservoir pressures
    - The system anticipates difficult reservoir fluids (large quantities of condensed water, significant potential for corrosive fluids)
  - Looking towards the sales line
    - Pressure rating is largely irrelevant (you can build compressor stations to maintain whatever MAWP you select)
    - Cost is king, and assumptions about installation costs are often naïve
    - Assumptions about the long-term reliability of remote, automated equipment can be very naïve

Processes

- We use administrative processes and procedures to relieve individuals of the risk of making the wrong decision
  - Looking towards the reservoir
    - Individuals have the authority to make changes that are required to optimize reservoir performance
    - A meter change, changing pump speed, or running a pig requires budget money, not MOC
    - Local control of maintenance resources and local ability to change priorities
  - Looking towards process-driven activities
    - Every decision refers to a process document
    - Every change requires MOC
    - Maintenance resources are centrally controlled and the work order system has goals like “all work will be scheduled 30 days in advance”, “no spare parts will be issued without a work order”, and “no squirrel stores”

Conclusions

- The reason for the very existence of our industry is to exploit Oil & Gas ***reservoirs*** for profit
- Any activity that loses that fact will make less profit than it could have
- Any statement that contains the phrase "reservoir _____ is irrelevant" (e.g., "reservoir pressure is irrelevant") leads to a sub-optimal decision
- Any procedure or process that doesn't consider the needs of the reservoir is sub-optimum
- Any facility that puts an artificial constraint on the reservoir is inappropriate

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Thank you for your attention.
Additional information can be found at
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