The Impact of Horizontal Drilling for Natural Gas on Produced Water Management Strategies

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Background

- Historically most wells drilled for water, minerals or energy extraction have been vertical wells.
In recent decades, the use of directional horizontal drilling for energy extraction has increased significantly.
Development of directional horizontal drilling technology for offshore energy extraction has improved production economics by increasing the payzone length in wells and allowing multiple wells to be drilled from the same platform.
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- Directional horizontal drilling for onshore natural gas production has similar economic benefits as offshore production.
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• Horizontal drilling technology applied to natural gas production is changing the scope and economics of produced water management.
Changes to produced water management are required due to the increased volumes of produced water per directional horizontal well

- Typical average daily water production for a flowing vertically drilled natural gas well ranges from 0 to 40 bbl in many Wyoming basins.

- Expected average daily water production for a flowing directionally drilled natural gas well can be from 400 bbl to greater than 600 bbl in those basins.
Changes to produced water management are required due to the increased volumes of produced water per directional horizontal well

- A reasonably sized produced water management facility serving a basin of vertically drilled natural gas wells was 1,000 to 2,000 bbl/day due to transportation economics.
- A produced water management facility serving a basin of directionally drilled natural gas wells would need to be 10,000 bbl/day or greater.
The increased size of produced water management facilities can impact atmospheric regulation of the facilities.
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- A 1,000 bbl/day produced water management facility typically does not emit over 500 lbs/yr of volatile organic compounds (VOCs). Further, with a significant seasonal reduction in methanol use by the producers the combined emissions of hazardous air pollutants (HAPs) and VOCs would be less than 500 lbs/yr.
- Emissions of less than 500 lbs/yr qualifies the facility for a permit waiver regarding air emissions.
The increased size of produced water management facilities can impact atmospheric regulation of the facilities.

- A 10,000 bbl/day produced water management facility would likely emit over 500 lbs/yr of HAPs and VOCs.
- Emissions of more than 500 lbs/yr will require the facility to acquire a permit for atmospheric air emissions and the application of process technologies to reduce atmospheric emissions.
The increased size of produced water management facilities will require changes in produced water transportation methods.
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- Transporting produced water from a well by truck is no longer practical:
  - Five truckloads per day would be required for a well producing 600 bbl/day of water.
  - A 10,000 bbl/day produced water management facility would need to unload over 83 trucks per day.

- Piping water to a produced water management facility will be more economic and practical at the increased scale.
The increased size of produced water management facilities will impact the feasibility of proven produced water treatment and disposal methods.

- Common produced water management techniques not feasible at the increased scale:
  - Evaporation.
  - Freeze–Thaw/Evaporation (FTE®).
  - Injection wells in many locations.
  - Discharge in many drainage basins.
Evaporation not feasible?
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- A 10,000 bbl/day produced water disposal facility using enhanced evaporation for disposal of produced water would require approximately 150 to 200 acres of lined evaporation ponds.
Freeze –Thaw/Evaporation (FTE®) not feasible?
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- A 10,000 bbl/day produced water treatment and disposal facility using (FTE®) for treatment and disposal of produced water would require 100 acres of lined evaporation ponds.
Injection wells not feasible?

- A 10,000 bbl/day produced water disposal well is possible in several Wyoming natural gas producing basins and in those basins disposal wells are an option. However, in many other basins, suitable geologic and hydrologic conditions do not exist for injection of water at that rate.
Surface Discharge not feasible?

- A 10,000 bbl/day produced water discharge is possible in most Wyoming natural gas producing basins. However, in many of those basins, the water rate is determined by total salt loading. This will require water discharged to be of very low salt content.
What is feasible?

- The feasibility of a 10,000 bbl/day treatment/disposal process will depend upon the quality of the produced water and the drainage basin where the facility is located.
- Potential feasible treatment processes are reverse osmosis (RO), electro-dialysis, and ion exchange.
- Others may exist.
Considered RO as the Primary Treatment Technology due to the Large Volume Water Treatment Requirements

- RO is proven feasible as a primary treatment technology for treating large volumes of water. High volume RO plants have operated economically and successfully for decades, primarily in municipal water supply applications.
- RO technology applied to produced water treatment has met with very limited success due to constituents in the produced water that adversely impact the RO process and RO membranes.
Substantial Pre-treatment of Produced Water is required to make RO Treatment Technically Feasible and Economic.

- Treatment of produced water using RO will require the following constituents be removed in pre-treatment:
  - Oil and grease
  - Suspended solids
  - Carbonates and bicarbonates
  - Reduced iron
  - Others
Treatment/Disposal of RO concentrate is required to make RO Treatment Technically Feasible and Economic.

- At the present time most RO concentrate is disposed of by discharge, injection wells or enhanced evaporation.
  - Discharge of RO concentrate is primarily into the ocean and from municipal water supply systems.
  - Injection wells are commonly used to dispose of RO concentrate from inland municipal water supply systems.
  - Enhanced evaporation ponds are used to dispose of RO concentrate primarily in industrial and small municipal systems.
Conclusion

- Continued development of many of Wyoming’s natural gas reserves will depend upon development of treatment technologies capable of treating large volumes of produced water efficiently and economically.
Conclusion

- Methods to reduce emissions of VOCs and HAPs are needed.
- Substantial pre-treatment of produced water will be required for most potential high-throughput water treatment processes.
- Methods for disposal or beneficial use of the concentrate produced in many of these processes are needed.
Questions?

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