Consortium for Emerging Gas Resources in the Greater Green River Basin

"Advances in Drilling Technologies for the North American Rockies"

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IPAMS

CLOSED-LOOP SYSTEM AS A COST EFFECTIVE ALTERNATIVE TO RESERVE PITS

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Introduction

Prima Energy Corp. and Nabors Drilling USA, Inc. have teamed up to drill over 50 wells utilizing a highly automated closed loop system in lieu of traditional earthen reserve pits. Environmental and economic damage caused by drill site construction and reclamation has been greatly reduced with no increase in total well cost. Drilled solids are stripped from the mud while drilling, and are put to beneficial use. Remaining fluid is transported to the next drill site and used on the subsequent well, thus virtually eliminating drilling waste, reducing water consumption, and improving surface owner relations

Background

Operators have drilled over 7000 wells in the Wattenberg Field of Colorado over the past 15 years. Due to the large increase in population and environmental sensitivity in the front range area, it has become desirable to minimize the surface disturbance and truck traffic associated with our drilling operations. Heavy drilling activity during and immediately following the 1990 - 1992 tax credit qualification period caused public concern and numerous Colorado Oil & Gas Conservation Commission rule changes. Prima has drilled over 400 wells in the Wattenberg Field and continues to pursue methods to reduce impact associated with drilling and production operations, and improve the public perception of our industry

New Technology

Nabors Drilling USA, Inc., Environmental Equipment Corp., and Prima Energy Corp. embarked on a program to develop a closed loop drilling system in 1993. The system uses a high speed linear motion shale shaker to remove the bulk of the cuttings, which are moved by a loader to a storage pile. Remaining mud is then pumped from the drilling rig's 400 bbl steel tank to a highly automated chemical addition trailer which adjusts PH, automatically mixes, hydrates, meters, and injects a polymer flocculent into the mud stream The coagulated mud is then pumped into a standard centrifuge, which removes all remaining solids. The remaining water, which is remarkably clear, is then returned to the circulating mud system to be re-used as drilling water.

Field Results

Prima has drilled roughly 50 wells with the automated system, and have seen the following benefits from the use of this system:

1. Eliminates excavation expense and risk of damaging underground pipelines and utilities.
2. Reduces surface disturbances and surface damage payments.
3. Eliminates the most unsightly part of our industry-PITS
4. Reduces time and manpower requirements to build and reclaim pits and locations.
5. Reduces truck traffic associated with drilling operations by up to 75%.
6. Eliminates soil segregation and wind erosion problems.
7. Reduces pad size and cuts in sensitive and hilly areas.

8 Greatly reduces waste tracking and need for land farming operations.

Field Results (cont.)

9. Eliminates the need to fence reserve pits in certain areas.
10. Allows drilling in areas with a high ground water table.
11. Eliminates risk of waterfowl mortality in pits.
12. Provides finely ground clay for berm construction around tank batteries.
13. Reduces water consumption by up to 80%.

Waste Elimination

Frequently, drilling is conducted on level farm fields, where no site preparation or reclamation is required other than ripping to relieve compaction. The only remaining waste at the conclusion of drilling operations is a pile of finely ground cuttings, mostly comprised of clay, stacked on the location. These cuttings have proven to be very useful for berm construction around production facilities, as the clay provides a very effective barrier should a spill occur. Many local feedlots and other agriculture interests have found this product to be an inexpensive material to line waste ponds, corrals, and feedlots to prevent animal waste from fouling the shallow ground water found in the alluvial soils in eastern Colorado.

Economics

The following table was prepared to show the cost comparison of conventional rotary drilling using reserve pits versus the current closed loop drilling system utilizing mud motors and diamond bits

	Conventional drill Standard Pit	Mud motor 7 7/8" bit Closed loop system
Water	6400 bbls-$4720	1200bbls-$1350
Location	300'x300'-$3000	200'x300'-$900
Mud	$2000	$1700
Damages	$3500	$2500
Berm	$1000	$0
Mud Haul	$2800	$900
Dewatering Unit	$0	$8250
Total Cost	$17,020	$15,600

Summary

The closed loop drilling system developed has proven to be a reliable, cost effective tool for reducing conflicts with surface owners and reducing impact to the environment. Field results have shown no net increase in total well cost to utilize the system. Applying this system on wells drilled on valuable vegetable crop land can result in significant savings by reductions in normally high surface damage payments, eliminating the cost of laser leveling, and all but eliminating future economic liability for crop failures. This system, when integrated with a drilling rig such as the package Nabors Drilling USA, Inc. offers, provides a trouble free solution to the problems many operators encounter when trying to develop gas and oil reserves in populated areas

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Closed Loop Mud System in the DJ Basin of Colorado

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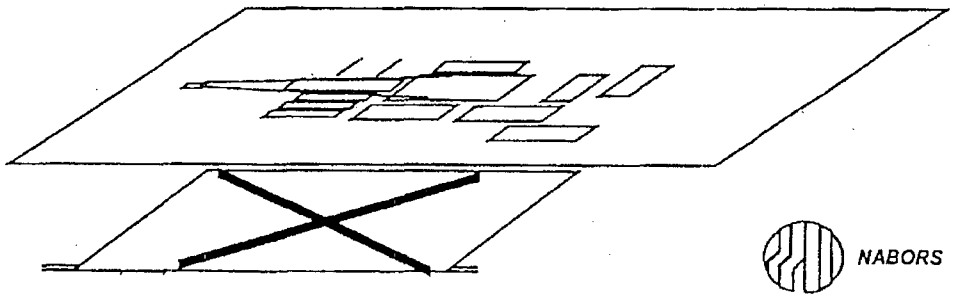
Requires No Reserve Pit

- Total Location area down to 250 ft X 150 ft
- Reduced Construction, Damages, and Reclamation



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Rig Uses Less Water Per Well

- 1200 bbl's on 7500 ft Codell Well
- Unit Produces 185 Gallons of Clear water per Minute
- Capable of Maintaining Mud Weight of 8.7 LB per Gallon while Drilling 7-7/8 Hole at 225 Feet per Hour with 425 Gallon per Minute Pump Rate.

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Mud Disposal Virtually Eliminated

- Less than 400 bbl's at End of Well
- Water Reuse on Site is Possible
- Reasonable Amounts of Cement or Cement Contaminated Mud can be Processed
- Drainage Ditches are Pumped into Mud Tanks and Processed

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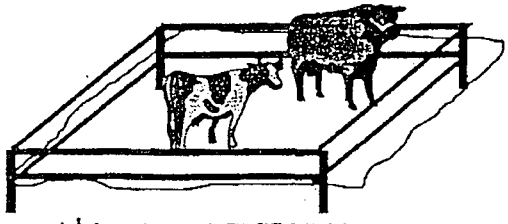
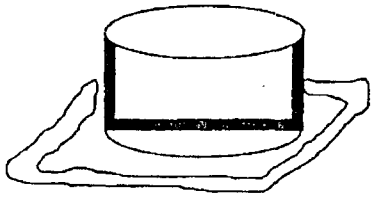
Cuttings used as By-products

- Feedlot Corral Bedding
- Berm Material for Production Tanks and Facilities
- Landfill Fill Material





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Costs of Using System on Average Codell Well

- Unit with Labor and Extra Fuel - $4,500
- Polymer and Acid - $1,100
- Linear Motion Shaker - $ 600
- Centrifuge - $1,250
- Trucking, End Loader and Misc. - $ 800
- TOTAL COSTS - $8,250

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Tangible Savings on Average Codell Well

- Surface Damages - $1,000
- Construction and Reclamation - $2,100
- Water Hauling - $3,370
- Drilling Mud - $ 300
- Mud Disposal - $1,900

TOTAL SAVINGS- $8,670

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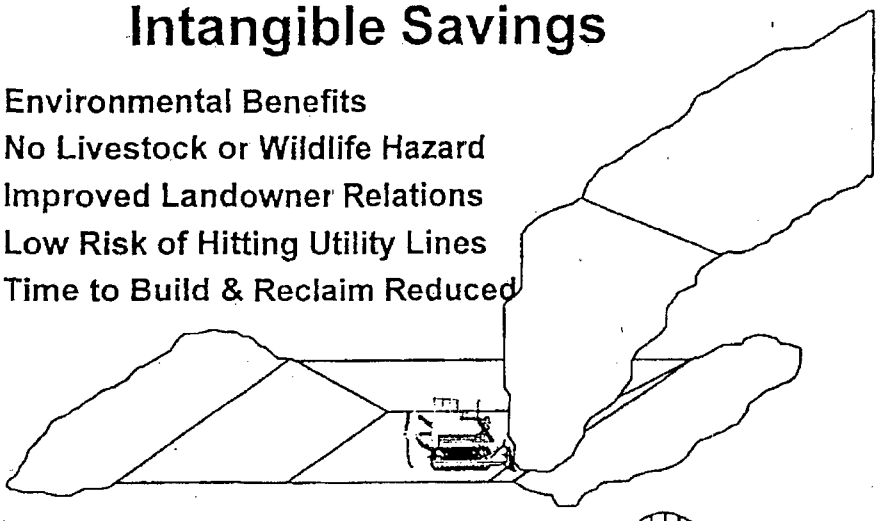
Intangible Savings

- Environmental Benefits
- No Livestock or Wildlife Hazard
- Improved Landowner Relations
- Low Risk of Hitting Utility Lines
- Time to Build & Reclaim Reduced



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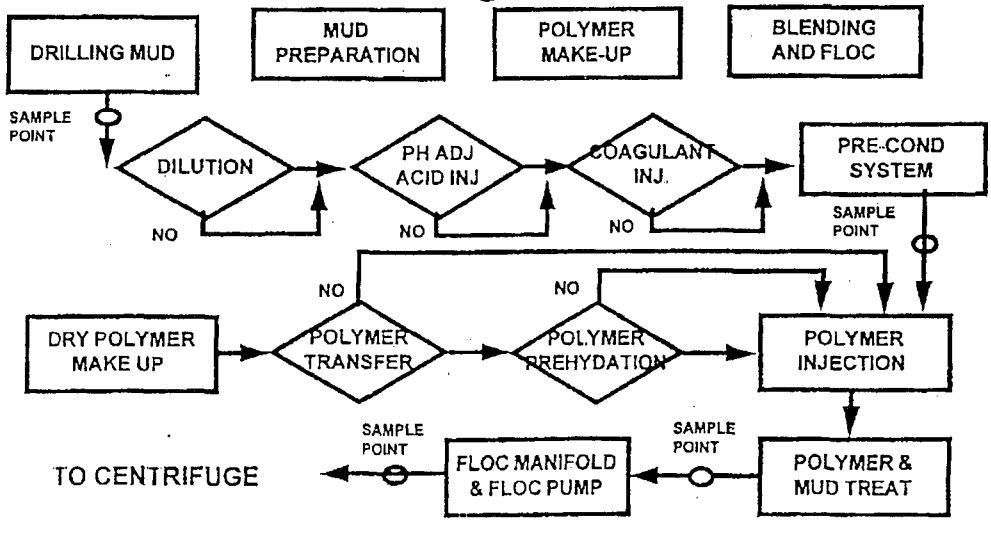
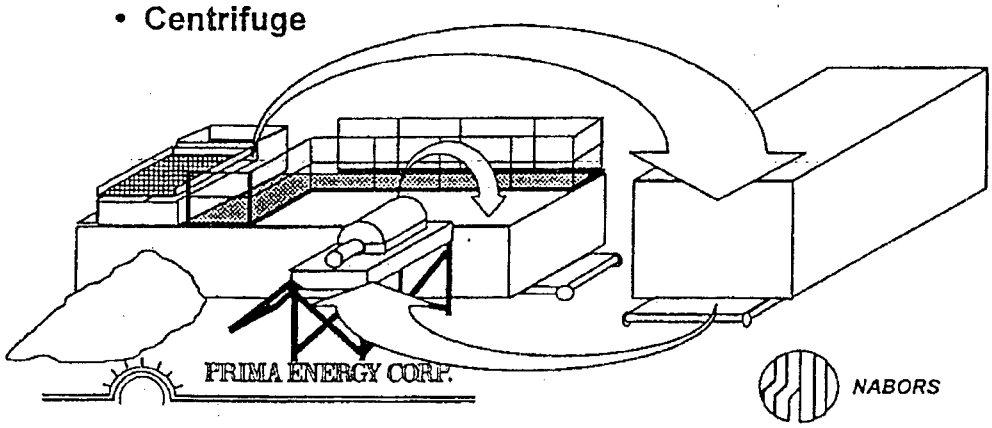
Dewatering Process Diagram



System Setup

- Linear Motion Shaker
- Dewatering Unit
- Centrifuge



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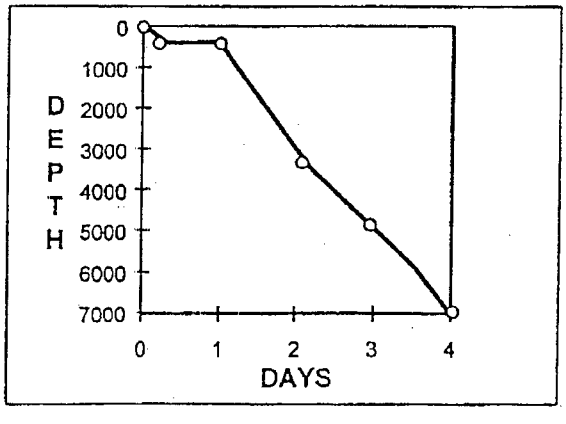
Depth Verses Time
(Well with Dewatering Unit)



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