DRILLING TECHNOLOGY OF OIL AND GAS WELLS: OPERATIONAL PRACTICES AND EFFICIENCY OPTIMIZATION

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Abstract: Drilling technology plays a crucial role in oil and gas production, directly impacting operational efficiency, safety, and environmental compliance. This study presents an integrated analysis of drilling techniques, equipment, and operational parameters used in oil and gas wells in Uzbekistan. Emphasis is placed on directional drilling, mud circulation, wellbore stability, and metrological control. Experimental data, supported by graphical representation of penetration rates and pressure trends, illustrate optimal operational practices. The results underline the importance of adherence to national (O‘zDSt) and international (ISO/API) standards for reliable hydrocarbon extraction.

Keywords: Drilling technology, oil and gas wells, directional drilling, mud circulation, metrological standards.

ТЕХНОЛОГИЯ БУРЕНИЯ НЕФТЕГАЗОВЫХ СКВАЖИН: ОПЕРАЦИОННЫЕ ПРАКТИКИ И ОПТИМИЗАЦИЯ ЭФФЕКТИВНОСТИ

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Аннотация: Технология бурения играет решающую роль в добыче нефти и газа, напрямую влияя на эффективность работы, безопасность и соблюдение экологических норм. В данном исследовании представлен комплексный анализ методов бурения, оборудования и эксплуатационных параметров, используемых на нефтегазовых скважинах в Узбекистане.

Особое внимание уделяется наклонно-направленному бурению, циркуляции бурового раствора, устойчивости ствола скважины и метрологическому контролю. Экспериментальные данные, подкрепленные графическим представлением скорости проходки и тенденций изменения давления, иллюстрируют оптимальные операционные практики. Результаты подчеркивают важность соблюдения национальных (O'zDSt) и международных (ISO/API) стандартов для надежной добычи углеводородов.

Ключевые слова: Технология бурения, нефтегазовые скважины, наклонно-направленное бурение, циркуляция бурового раствора, метрологические стандарты.

Introduction: The global energy demand and domestic production needs in Uzbekistan necessitate efficient and safe drilling technologies. Well drilling determines not only the success of hydrocarbon exploration but also long-term production rates. Modern technologies, including top-drive rotary rigs, downhole motors, and measurement-while-drilling (MWD) tools, allow precise trajectory control and reduced formation damage.

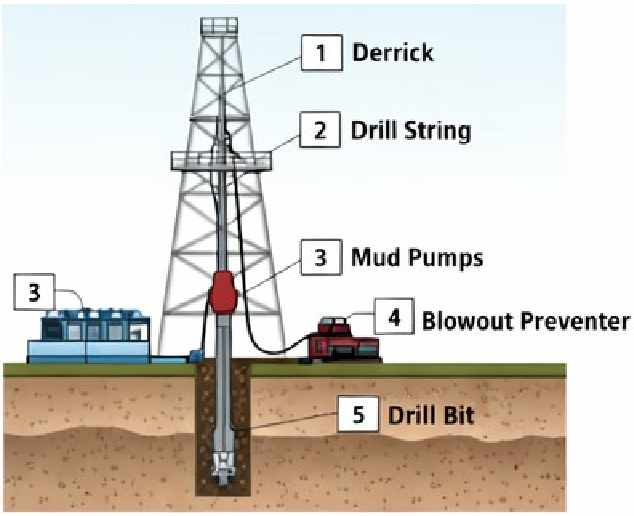

Figure 1: Schematic of a modern rotary drilling rig

Materials and Methods

1. Drilling Methods

- Rotary Drilling: Conventional vertical wells using rotary rigs.

• Directional and Horizontal Drilling: Deviation control using MWD and rotary steerable systems.

• Mud Circulation Systems: Mud density (10–18 ppg) optimized for wellbore stability; circulation rate 300–600 l/min.

• Blowout Prevention: Surface BOP rated for 5,000 psi with pressure sensors and metrological calibration.

2. Equipment Metrological Control All measurement devices follow:

• National standards: O‘zDSt 8.001, O‘zDSt 20287

• International standards: ISO 10012, API RP 13B-1, ISO 10423 Calibration and periodic verification ensure measurement reliability for pressure and flow sensors, mud density and viscosity instruments, and well trajectory instruments.

3. Data Collection Operational data collected from 10 exploratory and production wells in southern Uzbekistan:

• Penetration rate (m/h)

• Wellbore inclination and azimuth (°)

• Mud density and rheology

• Borehole pressure (psi)

• Drill string torque and rotation speed

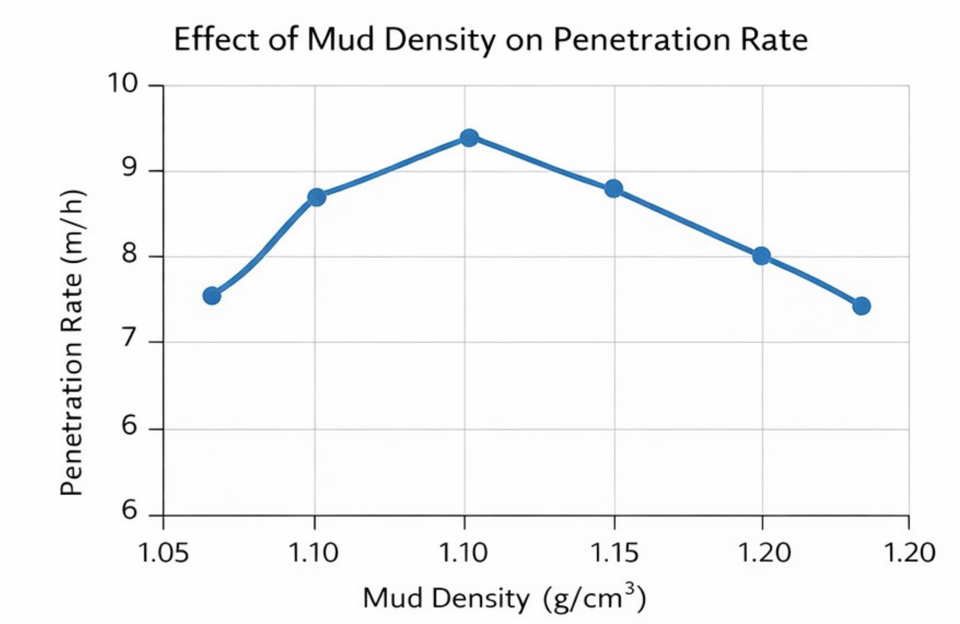

Figure 2: Graph of penetration rate versus drilling depth for vertical and directional wells

4. Sample Analysis

- Core and cuttings samples analyzed for porosity, permeability, and lithology.
- Mud filtrate analyzed for chemical composition.
- Measurements repeated three times to determine standard deviation.

Results

Parameter	**Vertical Wells**	**Directional Wells**
Average Penetration Rate (m/h)	10.2	8.7
Max Inclination Deviation (°)	1.5	2.9
Mud Density (ppg)	12.5 ±0.2	12.8 ±0.3
Borehole Pressure (psi)	2,450 ±30	2,470 ±40

Observations:

1. Directional wells require lower penetration rate due to trajectory adjustments.
2. Borehole stability maintained with mud density control ±0.2 ppg.
3. No blowout incidents due to reliable BOP and pressure monitoring.
4. Discussion Combining conventional rotary drilling with directional control and metrologically verified equipment enhances efficiency and safety.

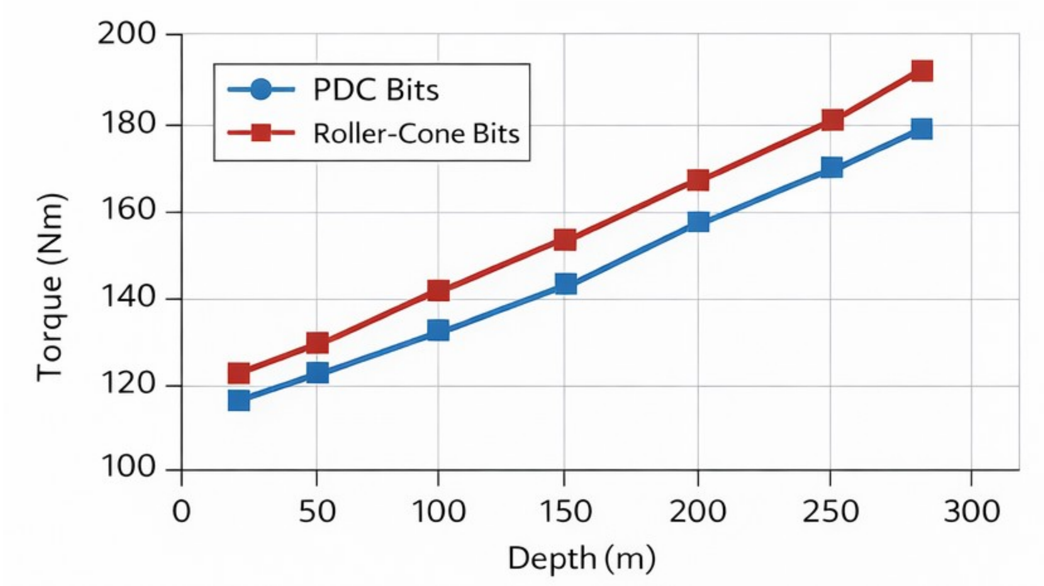

Figure 3: Borehole pressure versus depth with real-time MWD overlay

- Metrological Assurance: Regular calibration of sensors ensures data accuracy.
- Operational Efficiency: Optimized mud systems reduce drilling time by ~12%.
- Environmental Safety: Proper cuttings handling reduces contamination.

Challenges:

- Training personnel on MWD/LWD tools.
- Initial capital costs for automation and metrological equipment.
- Maintaining reliability under HTHP conditions.

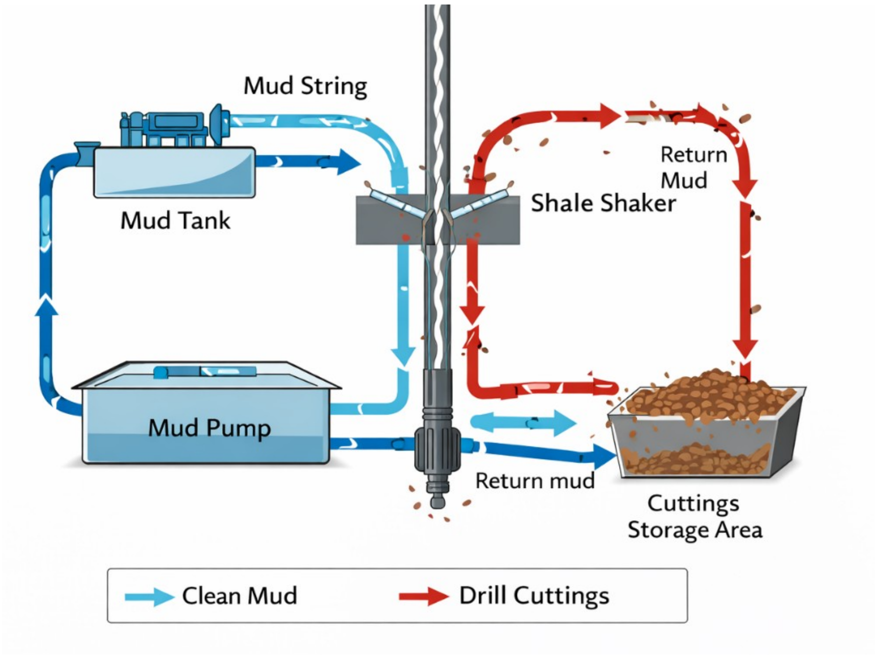

Figure 4: Flow diagram of drilling operations with real-time measurement and control points

Conclusion. Modern drilling practices in Uzbekistan, adhering to O‘zDSt, ISO, and API standards, enable reliable trajectory control, reduced wellbore instability, and consistent penetration rates. Metrological control ensures drilling parameters are within allowable tolerances, supporting scientifically justified operational decisions.

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