TETRA TECH RPS ENERGY | TRAINING

N741: Principles and Practices of Mud Motor

Instructor(s): Robello Samuel

Format and Duration

Classroom - 2 Days
Virtual - 4 Sessions

Summary

This course offers a unique and focused training experience on positive displacement motors, commonly known as mud motors. These simple yet elegant machines have become integral to the bottom hole assembly (BHA), particularly when drilling shale wells. Despite significant advancements in technology, challenges related to mud motors persist.

This course can be offered either as a one-day or a two-day training session. The one-day training covers essential concepts, performance metrics, advancements in technology, future designs, and practical guidance on when and how to effectively use mud motors in challenging situations.The two-day workshop expands on these topics with additional talks from industry technology leaders and is specifically tailored for engineers, mud motor experts, and manufacturers.

Business Impact: This course empowers participants to optimize the use of mud motors for improved drilling efficiency, reduced tool failure, and better wellbore placement—especially in challenging shale and directional drilling environments. By understanding motor design, performance, and operational dynamics, attendees will enhance BHA reliability, lower non-productive time, and drive cost-effective drilling outcomes.

As part of the training, participants will receive a copy of the "Positive Displacement Motor: Theory and Applications" color textbook (400 pages) authored by Dr. Robello Samuel.

Learning Outcomes

Participants will learn to:

1. Describe the history and general information about hydraulic downhole motors, including turbodrills, positive displacement motors (PDM), and turbine screw motors, along with their applications.
2. Explain the properties and advantages of cycloidal gearing and its role in the development of hydraulic motors.
3. Analyze the design optimization of motors, including working bodies, spindle sections, rotor and output shaft connections, valves, and curvature mechanisms.
4. Evaluate motor performance characteristics, including surface performance curves, downhole performance curves, and the impact of density, viscosity, and gas content on performance.
5. Classify and specify different types of mud motors, including their designations and meanings, as well as specifications for the power section.
6. Assess string torque and drag considerations when using motors, including force and stress analysis, stretch and buckling, and reactive torque compensation.
7. Discuss operational considerations for motors, such as precession, nutation, hydraulic hammers, motor stalling, and torque reactions.
8. Calculate pressure loss and optimize bit hydraulics and nozzle configurations to enhance performance in drilling operations.
9. Model the dynamics of motor systems, including types of oscillations, dynamic characteristics, and

N741: Principles and Practices of Mud Motor

Instructor(s): Robello Samuel

Format and Duration

Classroom - 2 Days
Virtual - 4 Sessions

critical speed calculations relevant to hydraulic downhole motors.

10. Identify applications of PDM in drilling technology, including advantages, operational indicators, and specific uses in various drilling and repair technologies.

Training Method

This is a classroom or virtual classroom course comprising a mixture of lectures, discussions, case studies, and practical exercises. The course duration can be tailored to meet training needs and competence levels, offered as either a one-day or a two-day session.

Who Should Attend

This course is designed for drilling engineers, well operations personnel, rig supervisors, drilling supervisors, and mud motor designers and manufacturers who seek to gain a deeper understanding of mud motor design and its applications in drilling.

Course Content

1. INTRODUCTION
   - History reference.
   - General information about hydraulic downhole motors (turbodrills, PDM, turbine screw motor) and areas of their application.
   - Cycloidal gearing: properties, advantages and role in the development of hydraulic motors.
   - World market for PDM.
   - Hands-on exercise
2. MOTOR DESIGN OPTIMIZATION
   - Working bodies (rotor-stator pair)
   - Spindle section
   - The connection of the rotor and the output shaft
   - Valves
   - Curvature mechanisms
   - Threaded connections
   - Hands-on exercise
3. MOTOR PERFORMANCE CHARACTERISTICS
   - General classification and unification of basic technical indicators and characteristics of hydromotors
   - Surface performance curves
   - Correction for density, viscosity and gas content
   - Actual Downhole performance curves
   - Mathematical description of the characteristics of PDM and recalculation methods when changing regime parameters
   - Differential pressure drop and monitoring of the drilling process

N741: Principles and Practices of Mud Motor

Instructor(s): Robello Samuel

Format and Duration

Classroom - 2 Days
Virtual - 4 Sessions

- The properties of the elastic stator lining as one of the main factors determining the contact interaction and the conditions of engagement in the rotor-stator pair
- How to use the performance curves
- Examples
- Hands-on exercise

4. MOTOR SPECIFICATION AND CLASSIFICATION
   - Specification of Motor
   - Motor Designation and their meanings
   - Specification of Power section
   - Power section designation and their meanings
   - Classification of mud motor, Diameter..etc
   - Hands-on exercise
5. STRING TORQUE AND DRAG CONSIDERATION WITH MOTOR
   - Force analysis
   - stress analysis
   - Stretch and Buckling
   - Drillpipe twist
   - Reactive torque compensation
   - Hands-on exercise
6. MOTOR OPERATIONAL CONSIDERATION
   - Precession and nutation
   - Motor and string rotational speed consideration
   - Hydraulic hammers
   - Motor Stalling
   - Torque reaction
   - Interaction with pipe rotation
   - Hands-on exercise
7. HYDRUALICS
   - Pressure loss calculations
   - Bit Hydraulics and nozzle optimization
   - HMSE
   - Cuttings Transport
   - Rotor nozzle
   - Split flow
   - stalling
   - Hands-on exercise
8. BHA DESIGN
   - Motor BHA
   - CoiledTubing BHA
   - Casing BHA
   - Various Force Analysis
   - Torque reaction

- Torque compensation
- Standpipe pressure response
- Hands-on exercise

9. DYNAMICS OF MOTOR SYSTEM
   - Schematic functional diagram and types of oscillations in the system (axial, torsional, in a liquid column)
   - Dynamic characteristics of the PDM as an element of the "mud pump-drill string-PDM-bit-bottom hole" system
   - Inertia parameters. Reduced moment of inertia
   - Features modeling of a dynamic system when drilling wells using hydraulic downhole motors
   - General mathematical model of the system, disturbing factors, similarity criteria
   - Manage the mode of operation of the PDM in the process of drilling a well
   - Dysfunction
   - Stick-Slip, Whirl
   - Critical Speed Calculations
   - Hands-on exercise
10. OPERATING PARAMETERS ROADMAPS
   - Drilling
   - Backreaming
   - Tripping
   - Drag Chart
   - Vibration Chart
   - Domain Chart
   - Hands-on exercise
11. APPLICATION OF PDM IN DRILLING TECHNOLOGY
   - Applications and operational advantages of PDM
   - Drilling technology PDM. Differences from rotor technology
   - Record indicators (by diameter of bit, by depth, by bottom hole temperature, by ROP, by penetration, by deviation from vertical, by durability)
   - Features of the use of PDM in various technologies of drilling and repair of wells (for example, the experience of leading companies):
   - drilling vertical wellbore
   - typical directional drilling
   - directional drilling with different radius
   - horizontal drilling
   - high-performance drilling
   - wellbore expansion
   - borehole drilling
   - downhole pipe milling
   - drilling of wells and small diameter channels
   - core drilling
   - depression drilling

- high pressure and temperature drilling
- Motor assisted RSS
- casing drilling
- vertical drilling with angle stabilization system
- coiled tubing drilling
- drilling with magnitolocation
- Agitators
- Hands-on exercise

12. OPERATION AND TECHNICAL MAINTENANCE OF PDM
    - General issues of operating a PDM
    - Technological schemes for assembly and disassembly of the PDM
    - Check of a technical condition and preparation of the motor for work
    - The main causes of failures during operation
    - Typical wear and damage
    - Motor repairMud Motor Hydraulic and Mechanical Optimization (Free Software Demo).
    - Hands-on exercise