COURSE OVERVIEW DE0254
Acid Stimulation Techniques
(E-Learning Module)

Course Title
Acid Stimulation Techniques
(E-Learning Module)

Course Reference
DE0254

Course Format & Compatibility
SCORM 1.2. Compatible with IE11, MS-Edge, Google Chrome, Windows, Linux, Unix, Android, IOS, iPadOS, macOS, iPhone, iPad & HarmonyOS (Huawei)

Course Duration
30 online contact hours
(3.0 CEUs/30 PDHs)

Course Description

This E-Learning is designed to provide participants with up-to-date overview of acid stimulation techniques It covers the inflow and outflow performance, completion system, tubing, design, installation and perforating; the integration between reservoir and the production system; the main problem in the production system; the integration between reservoir and the production system; the main problem in the production system; the formation damage, matrix acidizing and hydraulic fracturing; and the well production problem.

During this interactive course, participants will learn the reservoir stimulation including different stimulation techniques, stress and rock properties, acid and hydraulic fracturing, matrix acid stimulation, scale treatment, etc; the selection of artificial lift that includes gas lift, electrical submersible pumps, sucker rod pumps and plunger lift; and the criteria for selection of artificial lift system and artificial lift screening methods as well as economic analysis of artificial lift system.

Course Objectives

After completing the course, the employee will:-

- Apply and gain systematic techniques on acid stimulation
- Understand the causes of formation damage, diagnosis of formation damage, acid treatment design and acid operations and evaluation
- Discuss inflow and outflow performance, completion system, tubing, design, installation and perforating
- Explain integration between reservoir and the production system as well as identify the main problem in the production system
- Determine formation damage, matrix acidizing and hydraulic fracturing
- Identify well production problem
- Determine reservoir stimulation including different stimulation techniques, stress and rock properties, acid and hydraulic fracturing, matrix acid stimulation, scale treatment, etc
- Select artificial lift that includes gas lift, electrical submersible pumps, sucker rod pumps and plunger lift
- Determine criteria for selection of artificial lift system and artificial lift screening methods as well as economic analysis of artificial lift system

Who Should Attend

This course is primarily designed for well engineers, production and drilling supervisors, reservoir engineers, geologists, production and completion engineers needing a practical understanding and an appreciation of well completion design and operation, well stimulation and intervention.

Training Methodology

This Trainee-centered course includes the following training methodologies:-

- Talking presentation Slides (ppt with audio)
- Simulation & Animation
- Exercises
- Videos
- Case Studies
- Gamification (learning through games)
- Quizzes, Pre-test & Post-test

Every section/module of the course ends up with a Quiz which must be passed by the trainee in order to move to the next section/module. A Post-test at the end of the course must be passed in order to get the online accredited certificate.

Course Certificate(s)
Internationally recognized certificates will be issued to all participants of the course.

Certificate Accreditations
Certificates are accredited by the following international accreditation organizations: -

- USA International Association for Continuing Education and Training (IACET)

  Haward Technology is an Authorized Training Provider by the International Association for Continuing Education and Training (IACET), 2201 Cooperative Way, Suite 600, Herndon, VA 20171, USA. In obtaining this authority, Haward Technology has demonstrated that it complies with the **ANSI/IACET 1-2013 Standard** which is widely recognized as the standard of good practice internationally. As a result of our Authorized Provider membership status, Haward Technology is authorized to offer IACET CEUs for its programs that qualify under the **ANSI/IACET 1-2013 Standard**.

  Haward Technology's courses meet the professional certification and continuing education requirements for participants seeking **Continuing Education Units** (CEUs) in accordance with the rules & regulations of the International Association for Continuing Education & Training (IACET). IACET is an international authority that evaluates programs according to strict, research-based criteria and guidelines. The CEU is an internationally accepted uniform unit of measurement in qualified courses of continuing education.

  Haward Technology Middle East will award **3.0 CEUs** (Continuing Education Units) or **30 PDHs** (Professional Development Hours) for participants who completed the total tuition hours of this program. One CEU is equivalent to ten Professional Development Hours (PDHs) or ten contact hours of the participation in and completion of Haward Technology programs. A permanent record of a participant's involvement and awarding of CEU will be maintained by Haward Technology. Haward Technology will provide a copy of the participant's CEU and PDH Transcript of Records upon request.

- British Accreditation Council (BAC)

  Haward Technology is accredited by the **British Accreditation Council** for **Independent Further and Higher Education** as an **International Centre**. BAC is the British accrediting body responsible for setting standards within independent further and higher education sector in the UK and overseas. As a BAC-accredited international centre, Haward Technology meets all of the international higher education criteria and standards set by BAC.

Course Fee
As per proposal

Course Contents

- Acid Stimulation Techniques & Production Enhancement
- Reservoir Characteristics
- Formation Damage
- Formation Porosity
- Primary Porosity
- Secondary Porosity
- Effective Porosity
- Total Porosity
- Effective Porosity
- What is Porosity “Φ” ?
- Total Porosity
- Effective Porosity
- Formation Permeability
- Permeability of a Formation
- Impermeable Formations
- Absolute Permeability
- Effective Permeability
- Rock Properties
- Capillary Pressure (P_c)
- Completion Planning for Pressure Res. Rock Capillary Effect
- Effect Grain Size in Permeability
- Oil Reservoirs
- Structural Traps
- Stratigraphic Traps
- Traps General –Structural Trap Example
- Stratigraphic Traps Example
- Oil Reservoirs
- "Static" Data
- “Dynamic" Data
- Geological Factors affecting Oil Reservoirs Properties

- Causes of Low Productivity Wells
- Skin Effect
- Reservoir Model of Skin Effect
- Reservoir Pressure Profile
- Damage Quantified through Skin Factor & Productivity Index
- Reservoir Pressure Profile
- The Cost-Impact of Formation Damage on Well Production
- Effect of Skin on the IPR Curve
- Phase Diagram
- Formation Volume Factor "Bo"
- Formation Volume Factor (FVF) "Bo"
- Oil Viscosity "μo"
- Solution Gas-Oil Ratio "Rs"
- Solution Gas Oil Ratio - Typical Shape
- Reservoir Pressure > Oil Bubblepoint Pressure
- Reservoir Pressure < Oil Bubblepoint Pressure
- Phase Diagram
- Productivity Index
- Flow Efficiency
- Reservoir Drive Mechanism
- Dissolved Gas Drive
- Gas Cap Drive
- Water Drive
- Water Drive - Main Producing Characteristics
- Solution Gas Drive - Main Producing Characteristics
- Formation Damage Overview
- Organization
- Damage Characterization
- Areas of Damage
- Fines Migration & Clay Swelling
- Migratory Silt and Clay
- Silt and Clays = Fines
- Fines Migration

- Swelling Clays: Smectite
- How are clays identified?
- Problems Associated
- Scales
- Mineral Scale-Related Production Loss
- Solubility of Various Minera (in Distilled Water)
- Scale Deposition
- Incompatible Waters
- Common Ions in Formation Brines
- The Scaling Process
- Calcium Carbonate Precipitation
- Calcium Sulfate
- Barium Sulfate Precipitation
- Types of Iron Scales
- Iron Scale Precipitation
- Scales Sources
- Organic Deposits
- Paraffin-Related Production Loss
- Paraffins
- Paraffin Deposition
- Factors Governing Paraffin Deposition
- Asphaltene Deposition
- Asphalt Tars
- Properties
- Asphaltene Deposits
- Sludge
- Factors Governing Asphaltene Deposition
- Characteristics of Organic Deposits
- Mixed Deposits & Bacteria
- Induced-Particle Plugging
- Emulsion
- Wettability Changes
- Relative Permeability: Oil & Water Wet Formation

- Water Block
- The Formation Damage Skin
- The natural flow producing system
- The Formation Damage Skin
- Skin factor increases with a larger damage radius and damage ratio klk_d
- Effect of formation damage on well production
- The Formation Damage Skin
- Flow efficiency decreases with increasing formation damage skin
- Sources of Formation Damage
- Drilling / Cementing / Completion
- Skin
- Drilling
- Origins of Formation Damage (Drilling)
- Formation Damage: Drilling Operations
- Formation properties
- Open hole time
- Overbalance
- Borehole Dynamics
- Fluid loss during the drilling process
- Leak Off Volume and Depth of Invasion
- Formation Damage Mechanisms during Drilling
- Fluid Loss
- Formation impartment due to water block
- Addition of third phase reduces gas flow
- Formation Damage Mechanisms during Drilling
- Clay Swelling
- Pore Size Dimensions
- Origins of Formation Damage (Cementing) (limited invasion due to time and fluid composition effects)
- Formation Damage During Cementing
- Well Geometry Skin ($S_{geometry}$)
- Completion Skin (S_{comp})
- Perforations

- Origins of Formation Damage (Completion/Workover Fluids)
- Origins of Formation Damage (Gravel Packing)
- Formation damage: Production and Profitability
- Dew and Bubble Point Issues: Pressure and Rate
- Origins of Formation Damage Stimulation
- Stimulation
- Origins of Formation Damage (Injection Operations)
- Injection
- Summary: Damage Characterization
- Formation Damage Characterization & Prevention
- Risks Of Formation Damage
- Two rules of thumb for estimating pore size of sandstones
- Completion Productivity
- Drilling Damage
- Perforation Damage
- Fluids Damage
- Sand Fill
- Maximizing Well Productivity
- Drilling Fluid Selection
- Perforating
- Selection And Treatment Of Completion Fluids
- Stimulation
- Key considerations in selecting stimulation method method
- Table 2: Key considerations in selecting stimulation method
- Collapse Loads
- Completion And Workover Fluids
- Basic Workover Fluid Functions
- Types Of Fluids
- Prepared Salt Water
- Optimum Completion Design
- Formation Definitions
- Completion Design Procedure
- Classify Formation

- Determining Perforating Under-balance to Overcome Total Skin Damage
- Underbalance Use on TCP in Oil Zones in Sandstone
- Determining Perforating Under-balance to Overcome Total Skin Damage
- Acidizing Techniques
- Matrix Stimulation
- Economic Formation Stimulation
- Stoichiometry
- Mineral Acids
- Organic Acids
- Acetic Acid
- Formic Acid
- Powdered Acids
- Acid Mixture
- Retarded Acid Systems
- Chemical Composition of Carbonates
- Classification and Origin of Carbonates
- Equilibrium Acid-Carbonate Reactions
- Matrix Stimulation of Carbonates
- Types of Acid stimulation
- Acid Reaction of Carbonates
- Equilibrium Reaction Equation:
- Reaction Rate Equation:
- Acids used in Carbonate Acidizing:
- Matrix Acidizing
- Acid Reactivity
- Organic Acids
- Matrix Acidizing
- Wormhole Penetration vs. Skin
- Injection Rates: Dissolution patterns
- Impact of Pump Rate and Temperature
- Wormhole Pattern from Radial Flow
- Matrix Acidizing
- Acids Used in Matrix Treatment

- Wormhole Growth for Various Rates
- Pore Level Model
- Placement
- Selection of Matrix Acidization Candidates
- Design of a Matrix Treatment
- Acid Fracturing
- Response of Carbonates to Acid Fracturing
- Treatment Design
- Sandstone Acidizing
- Mechanics of Acid Attack
- Limitations on Volume of Acids
- Emulsion Problems
- Recent Progress in SS Acidizing
- Properties of Commercial Mud Acids
- Alternate Design Procedure For SS Acidizing
- Corrosion Inhibitors
- Friction Reducers
- Diverting System-Matrix Acidizing
- Fluid loss control-Acid Fracturing
- Surfactants and Demulsifiers
- Treatment of Emulsion Blocks and Adverse Wettability
- Complexing Agents of Iron
- Oil Well Stimulation
- Gas Wells
- Water Injection Wells
- Acid-Mutual Solvent Volume Requirements
- Mistakes Found in the Application of the Acid-Mutual Solvent Method
- Hydraulic Fracturing Stimulation
- Four Steps of Treatment and Their Respective Functions
- Surface Equipment Layout
- Fracture Geometry
- Fracture Width Equations
- Fracturing Treatment Selection

- Laboratory tests of formation samples for fracturing treatment guidelines
- Laboratory Studies
- Description of tests and core needed.
- Porosity & Permeability Measurement
- Helium Porosimeter
- N2 Permeameter
- Description of tests and core needed.
- Solubility Tests
- Scale Identification & Organic Deposits
- Water Analysis
- Sludge Testing
- Description of tests and core needed.
- Thin Sections
- SEM / EDAX
- SEM Inside Chamber
- SEM Output
- Core Flow Tests
- Flow Test
- Description of tests and core needed.
- Formation Properties Affecting the Orientation and Growth Pattern of Hydraulic Fractures
- Hydraulic Fracturing Fluids
- Storage and Mixing Requirements
- Horizontal versus Vertical Fracture
- Introduction to Sand Control
- Sand Production
- Cause of Sand Production
- Rock Classification
- What Is The Range of Strengths For Sanding Formations ?
- Factors Affecting Sand Production
- Pore Pressure and Stress
- Sand Production Prediction
- Reasons for Sand Control

- Sand Control Methods
- Restrictive Production Rate
- In Situ Consolidation
- Sand Consolidation
- Advantages of Resin Consolidation
- Disadvantages of Resin Consolidation
- How Much Resin is Enough?
- Resin Coated Gravel
- Drill Out
- Advantages of Resin Coated Gravel
- Gravel Packing
- Common Equipment
- Fluid Flow Path
- Cased Hole - Internal Gravel Pack
- Open Hole - External Gravel Pack
- Cased Hole GP Considerations
- Poor Perforation Pack Efficiency
- Open Hole GP Considerations
- Treatment Design
- Gravel Selection
- Obtaining Formation Sample
- Gravel Size Selection
- Screens and Selection
- Wire Wrap
- Wire Spacing
- Evolution of Well Screen Filter Materials
- Wire Wrapped Screens
- Double Wire Wrapped Screens
- Pre-Pack Screens
- Johnson's SUPERFLO
- Halliburton's (Purolator) PoroPlus
- Pall's Stratapac
- EXCLUDER (Baker)

- Petroline's Expandable Sand Screen
- Perforating
- Natural Sand Packing (Screens)
- Horizontal Completion (Natural Sand Packing)
- Natural Sand Packing
- Screenless Completions
- Screenless Completions What Can We Do Now?
- Fracturing
- Effect of Fracturing on Near Well Pressure
- "Classic" Fracturing
- "Ideal" Fracturing for Sand Control
- Screenless Completions Problem
- Fluid Selection
- Sand Control Fluids
- Brines
- High Rate Water Pack
- Viscous Fluids
- Leakoff Control Additives
- Polymers
- Viscoelastic Surfactant
- Particulates
- Leakoff Control-Summary
- Specialty Products
- PERFPAC* Service
- Perforate
- Flowback Well
- Tools Set in Gravel/Frac Pack Position
- AllPAC/AllFRAC (SM)
- AllPAC Shunt System
- SandCADE Simulation
- Paraffin's & Asphaltenes
- Paraffines and Asphaltenes Characteristics
- Formation Damage

- Paraffin and Asphaltene Prevention
- Deposition Mitigation
- Crystal modifiers
- Polymers
- Plastic pipe and plastic coatings
- Asphaltene Inhibitors
- Downhole heaters
- Paraffin and Asphaltene Removal
- Scale Deposition
- Scale Deposits
- Causes of Scaling
- Composition of Scales
- Calcium carbonate ($CaCo_3$)
- Gypsum $CaSO_4 . 2H_2O$ & Anhydrite $CaSO_4$
- Barium Sulfate Ba SO_3 and Strontium Sulfate $SrSO_4$
- Sodium Chloride NaCl
- Iron Scales
- Solubility of Various Scale in Distilled Water
- Prediction of Scaling Tendency
- Identification of Scale
- Scale Removal
- Removal Methods
- Mechanical Removal Methods
- Chemical Removal Methods
- Water Soluble Scale
- Acid Soluble Scale
- Acid Soluble iron scale
- Acid insoluble scale
- Inhibition of Scale
- Inhibition of scale precipitation by inorganic polyphosphates
- Inhibition of Scale with Poly-organic Acid
- $CaCO_3$ Scale Can be prevented by Pressure maintenance
- Inhibition of Scale with Organic Phosphates and Phosphonates

- Inhibiting Scale with Polymers
- Conclusions
- Scale Deposits
- Causes of Scaling
- Action to Solve Scale Problems