COURSE OVERVIEW DE0857
Well Stimulation
(E-Learning Module)

Course Title
Well Stimulation (E-Learning Module)

Course Reference
DE0857

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 course is designed to provide participants with a detailed and up-to-date overview of well stimulation. It covers the formation damage, damage characterization, areas of damage, fines migration and clay swelling; the mineral scale-related production loss, solubility of various minerals, scale deposition, common ions in formation brines and the scaling process; the various types of iron scales and the factors governing paraffin and asphaltene deposition; the organic deposits, mixed deposits and bacteria; the induced-particle plugging and damage sample testing and diagnosis; the effect of formation damage on well production; and the sources and origins of formation damage.

Further, the course will also discuss the typical relationships between mud type, cost and risk of formation damage; the fluid loss during the drilling process; the formation damage mechanisms during drilling; the pore size dimensions and the combined interaction between the factors which affect the solids and filtrate invasion profile into the formation; the perforations, origins of formation damage stimulation, injection and well productivity; the Darcy's law for radial flow into a wellbore; the linear flow model; and the formation damage characterization and prevention.

During this course, participants will learn the risks of formation damage, completion productivity, drilling damage, perforation damage and fluids damage; the well productivity, drilling fluid selection, perforating, selection and treatment of completion fluids and stimulation; the key considerations in selecting stimulation method; the completion and workover fluids, basic workover fluid functions and types of fluids; the optimum completion design procedure and perforating under-balance to overcome total skin damage; the nodal analysis, acidizing techniques, economic formation stimulation, matrix acidizing and acid fracturing; the oil well stimulation, hydraulic fracturing stimulation, fracturing treatment selection and laboratory tests of formation samples for fracturing treatment guidelines; the hydraulic fracturing fluids, porosity and permeability tests, oil compatibility tests, gel break tests and fracture conductivity tests; the physical properties of proppants, fracture orientation, core testing, dynamic down-hole testing and fracture geometry and orientation evaluation; the design variables and bottomhole treating pressure; the post-fracture well-test analysis, bilinear flow analysis procedure, linear flow analysis procedure, pseudoradial flow analysis procedure and type-curve analysis; the damaged-fracture type curve and the limitations of type curve analysis; and the well stimulation, stimulation economics candidate selection, fracture gradient determination and evaluation of stimulation job.

Course Objectives

Upon the successful completion of this course, participants will be able to:-

- Apply and gain an in-depth knowledge on cost management and maintenance management
- Describe formation damage, damage characterization, areas of damage, fines migration and clay swelling
- Discuss mineral scale-related production loss, solubility of various minerals, scale deposition, common ions in formation brines and the scaling process
- Identify the various types of iron scales and the factors governing paraffin and asphaltene deposition
- Characterize organic deposits and discuss mixed deposits and bacteria, induced-particle plugging and damage sample testing and diagnosis
- Recognize the effect of formation damage on well production and the sources and origins of formation damage
- Describe the typical relationships between mud type, cost and risk of formation damage
- Illustrate fluid loss during the drilling process and explain the formation damage mechanisms during drilling
- Identify pore size dimensions and the combined interaction between the factors which affect the solids and filtrate invasion profile into the formation
- Discuss perforations, the origins of formation damage stimulation, stimulation, injection and well productivity
- Explain Darcy's law for radial flow into a wellbore and illustrate linear flow model
- Apply formation damage characterization & prevention and recognize the risks of formation damage, completion productivity, drilling damage, perforation damage and fluids damage

- Maximize well productivity and carryout drilling fluid selection, perforating, selection and treatment of completion fluids and stimulation
- Implement key considerations in selecting stimulation method and identify completion and workover fluids, basic workover fluid functions and types of fluids
- Illustrate optimum completion design procedure, classify formation and determine perforating under-balance to overcome total skin damage
- Employ nodal analysis, acidizing techniques, economic formation stimulation, matrix acidizing and acid fracturing
- Apply oil well stimulation, hydraulic fracturing stimulation, fracturing treatment selection and laboratory tests of formation samples for fracturing treatment guidelines
- Recognize hydraulic fracturing fluids and apply porosity and permeability tests, oil compatibility tests, gel break tests and fracture conductivity tests
- Identify the physical properties of proppants and carryout fracture orientation, core testing, dynamic down-hole testing and fracture geometry and orientation evaluation
- Select design variables and analyze bottomhole treating pressure
- Carryout post-fracture well-test analysis, bilinear flow analysis procedure, linear flow analysis procedure, pseudoradial flow analysis procedure and type-curve analysis
- Discuss damaged-fracture type curve and the limitations of type curve analysis
- Apply well stimulation, stimulation economics candidate selection, fracture gradient determination and evaluation of stimulation job

Who Should Attend

This course covers systematic techniques on well stimulation for petroleum industry professionals who are involved in the important activities of reservoir evaluation, development and management and for those who require invaluable skills in the application of the techniques described for the successful exploitation of oil and gas reservoirs.

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

- Formation Damage Overview
- Organization
- Damage Characterization
- Areas of Damage
- Fines Migration & Clay Swelling
- Silt and Clays = Fines
- Fines Migration
- Swelling Clays: Smectite
- How are Clays Identified?
- Problems Associated
- Scales
- (Quiz – 1)
- Mineral Scale-Related Production Loss
- Solubility of Various Minerals (in Distilled Water)
- (Quiz – 2)
- Scale Deposition
- Incompatible Waters
- Common Ions in Formation Brines
- The Scaling Process
- Calcium Sulfate
- Barium Sulfate Precipitation
- Types of Iron Scales
- Iron Scale Precipitation
- Scales Sources
- Organic Deposits
- Paraffin-Related Production Loss
- Paraffin Deposition
- Factors Governing Paraffin Deposition
- (Quiz – 3)
- Asphaltene Deposition
- (Quiz – 4)

- (Quiz – 5)
- (Quiz – 6)
- (Quiz – 7)
- Asphalt Tars
- Asphaltene Deposits
- Factors Governing Asphaltene Deposition
- Characteristics of Organic Deposits
- Mixed Deposits & Bacteria
- (Quiz – 8)
- (Quiz – 9)
- (Quiz – 10)
- Induced-Particle Plugging
- (Quiz – 11)
- Exercise – 1
- Damage Sample Testing and Diagnosis
- Emulsion
- (Quiz – 12)
- Exercise – 2
- Wettability Changes
- Relative Permeability: Oil & Water Wet Formation
- Water Block
- The Formation Damage Skin
- Exercise – 3
- Average well skin values for some North Sea fields
- (Quiz – 13)
- (Quiz – 14)
- (Quiz – 15)
- Effect of Formation Damage on Well Production
- Sources of Formation Damage
- Drilling / Cementing / Completion
- Skin
- Drilling
- Origins of Formation Damage (Drilling)

- Formation Damage: Drilling Operations
- Typical relationships between mud type, cost and risk of formation damage
- Formation damage filter cake control
- Question: Which Mud Gives Better Production?
- Answer:
- Fluid loss during the drilling process
- Quiz – 16:
- Formation Damage Mechanisms During Drilling
- The Magnitude of Permeability Reduction from Both Types of Formation/Fluid Interaction Will Depend On
- Pore Size Dimensions
- Quiz – 17:
- Pore Size Dimensions
- Combined Interaction Between the Factors Which Affect the Solids and Filtrate Invasion Profile Into the Formation
- Origins of Formation Damage (Cementing)
  (Limited Invasion Due to Time and Fluid Composition Effects)
- Formation Damage During Cementing
- Completion Skin (Scomp)
- Perforations
- Quiz – 18:
- Origins of Formation Damage (Completion/Workover Fluids)
- Origins of Formation Damage (Gravel Packing)
- Origins of Formation Damage (Production)
- Formation Damage: Production and Profitability
- Quiz – 19:
- Dew and Bubble Point Issues: Pressure and Rate
- Quiz – 20:
- Origins of Formation Damage Stimulation
- Quiz – 21:
- Stimulation
- Origins of Formation Damage (Injection Operations)
- Injection
- Summary: Damage Characterization

- Corrosion
- Idealized Production Behaviour of an Oilfield
- Actual Production Behaviour of an Oilfield
- Well Productivity
- Quiz – 22
- Exercise - 4
- Quiz – 23
- Exercise - 4
- Well Productivity
- Quiz – 24:
- Quiz – 25:
- Well Productivity
- Quiz – 26:
- Well Productivity
- Quiz – 27:
- Well Productivity
- Darcy's Law for Radial flow into a Wellbore
- Linear Flow Model
- Exercise - 5
- Linear Flow Model
- Permeability Averages for Radial Flow
- Productivity Ratio
- Class Problem # 1
- Solution
- Darcy's law for radial flow into a wellbore:
- Production Engineering
- IPR
- What Affects IPR?
- Effect of Skin on IPR
- Effect of Pressure Depletion on IPR
- Why we do this?
- System Graph – Nodal Analysis
- COURSE RECAP

- Formation Damage Characterization & Prevention
- Risks Of Formation Damage
- 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
- Collapse Loads
- Completion and Workover Fluids
- Basic Workover Fluid Functions
- Types Of Fluids
- Prepared Salt Water
- (Quiz – 28)
- Optimum Completion Design
- Formation Definitions
- Completion Design Procedure
- Classify Formation
- Determining Perforating Under-Balance to Overcome Total Skin Damage
- Underbalance Used on TCP in Oil Zones in Sandstone
- System Graph – Nodal Analysis
- Nodal Analysis
- Outflow Vertical Lift Performance
- Outflow theoretical
- Outflow Actual
- VLP
- Vertical Lift Performance – Specific Gravity – API
- Composite Specific Gravity

- Pressure Gradient
- Exercise 1A
- Exercise 1B
- VLP
- VLP - Friction Loss
- Out Flow Performance
- System Graph
- Example
- Result
- Example
- Result
- Acidizing Techniques
- Economic Formation Stimulation
- Stoichiometry
- Mineral Acids
- Organic Acids
- Acetic Acid
- Formic Acid
- Powdered Acids
- Acid Mixture
- Retarded Acid Systems
- Chemical Composition of Carbonates
- Equilibrium Acid-Carbonate Reactions
- Stoichiometrv of Acid-Sandstone Reactions
- Equilibrium in Acid-SS Reactions
- Carbonate Acidizing
- Classification and Origin of Carbonates
- Types of Acid Stimulation
- Acid Reaction of Carbonates
- Equilibrium Reaction Equation
- Reaction Rate Equation
- Acids Used in Carbonate Acidizing
- Matrix Acidizing

- Acids Used in Matrix Treatment
- 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
- Retarded Acid
- 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

- 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
- Fracture Initiation.
- Fracture Extension
- Fracture Geometry
- Fluid Injection Into the Fracture
- Volume Efficiency Of A Hydraulic Fracture
- Fluid Flow Along the Fracture Length
- Fluid Leakoff
- Hydraulic fracturing fluids
- Structural and Chemical Analysis of Formation Samples
- Porosity and Permeability Tests
- Fluid Flow Tests
- X-Ray Diffraction Analysis
- Evaluating Fluid-Rock Interactions
- Regained Gas Permeability Tests
- Evaluating Fluid Properties
- Oil Compatibility Tests
- Gel Break Tests
- Fracture Conductivity Tests
- Factors Influencing Hydrocarbon Production
- Cementing Material in Sandstones
- Fluid Retention
- Iron Compounds
- Fluid Residue
- Clays
- Fracture Conductivity
- Fines in the Fracture
- Gel Filter Cake Residue

- Chemical and Fracturing Fluid Properties
- Fracturing Polymers
- Guar
- Guar Derivatives (refined guar)
- Cellulose Derivatives
- Polyacrylamides
- Cross-linking Agents
- pH Control Chemicals
- Gel Breakers
- Surfactants
- Wetting Properties
- Emulsions
- Foams
- Clay Stabilizers
- Alcohol
- Biocides
- Fluid Loss Additives
- Summary
- Hydraulic Fracturing Proppants
- Proppant Movement
- Tail-in Using Thin Fluids
- Suspended Proppants
- Physical Properties of Proppants
- Acid Solubility
- Silt and Fine Particles
- Crush Resistance
- Fracture Conductivity Test
- Fracture Closure Stress
- Proppant Bed Damage
- Pretreatment Data Requirements
- Various Sources of Data
- Fracture Geometry and Orientation Evaluation
- Logging Considerations for Fracture Geometry

- Fracture Orientation
- Core Testing
- Dynamic Down-hole Testing
- Fracture Geometry and Orientation Evaluation
- Conclusions
- Production increase
- Calculations for Vertical Fracture Production Increase
- Calculating the Production Increase Ratio
- High-pressure Pumping Equipment
- Surface Lines and Manifolding
- Control Center
- Practical Fracturing Treatment Design
- Fracture Design Variables
- Selecting Design Variables
- Analysis of Bottomhole Treating Pressure
- Real-time Treating Pressure Analysis in Field Operations
- Manufacturing
- Step-rate Tests
- Pump-in / Flow back Test
- Postfrac Analysis
- Inadequate Initial Response
- Rapid Production Decline
- Pump-in/Shut-in Tests
- COURSE RECAP
- Hydraulically Fractured Wells
- Ideal Hydraulic Fracture
- Flow Regimes in Fractures
- Fracture Linear Flow
- Bilinear Flow
- Formation Linear Flow
- Elliptical Flow
- Pseudoradial Flow
- Estimate Flow Period Duration

- Depth Of Investigation
- Hydraulic Fracture With Fracture Face Damage
- Post-Fracture Well-Test Analysis
- Bilinear Flow Method
- Bilinear Flow Analysis Procedure
- Bilinear Equivalent Time
- Bilinear Flow Analysis Equations
- Bilinear Flow Analysis
- Limitations of Bilinear Flow Analysis
- Linear Flow Analysis
- Linear Flow Analysis Procedure
- Linear Flow Analysis Equations
- Limitations of Linear Flow Analysis
- Pseudoradial Flow Diagnostic Plot
- Pseudoradial Flow Analysis Procedure
- Pseudoradial Flow Analysis
- Limitations of Pseudoradial Flow Analysis
- Type-Curve Analysis: Dimensionless Variables
- Type-Curve Analysis: Hydraulically Fractured Wells
- Type-Curve Analysis: Interpreting Match Points
- Type-Curve Analysis: Cinco Type Curve
- Damaged-Fracture Type Curve
- Type-Curve Analysis: Wellbore-Storage Type Curve
- Limitations of Type Curve Analysis
- Well Stimulation
- Stimulation Economics Candidate Selection
- Financial Data
- Fracture Gradient Determination
- R - FACTOR
- Summary of Results
- Evaluation of Stimulation Job