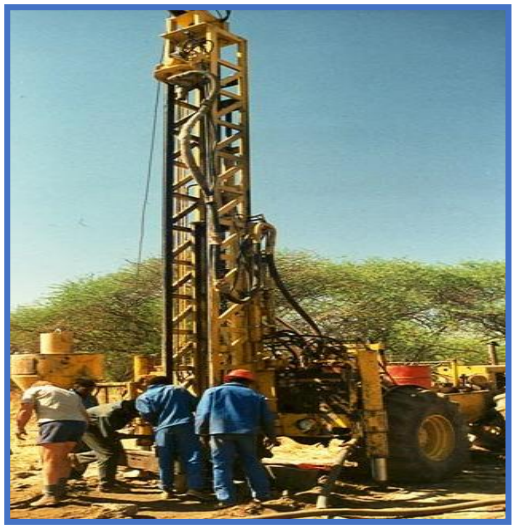
COURSE OVERVIEW DE0135
Formation Damage: Causes, Prevention, and Remediation
(E-Learning Module)

Course Title
Formation Damage: Causes, Prevention, and Remediation (E-Learning Module)



Course Reference
DE0135

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

Formation damage is an expensive headache to the oil and gas industry. It is an undesirable operational and economic problem that can occur during the various phases of oil and gas recovery from subsurface reservoirs including drilling, production, hydraulic fracturing, and workover operations. Formation damage assessment, control and remediation are among the most important issues to be resolved for efficient exploitation of hydrocarbon reservoirs.

Formation damage may be caused by many factors, including physico chemical, chemical, biological, hydrodynamic, and thermal interactions of porous formation, particles, and fluids, and the mechanical deformation of formation under stress and fluid shear. These processes are triggered during the drilling, production, workover, and hydraulic fracturing operations. Formation damage indicators include permeability impairment, skin damage, and decrease of well performance.

A verified formation damage model and carefully planned laboratory and field tests can provide scientific guidance and help develop strategies to avoid or minimize formation damage.

Properly designed experimental and analytical techniques, and the modeling and simulation approaches can help understanding diagnosis, evaluation, prevention, remediation, and controlling of formation damage in oil and gas reservoirs.

This course is designed to provide a comprehensive overview of the various types of formation damage problems encountered in petroleum reservoirs. The factors and processes causing these problems will be described in detail. The design of a team effort necessary in the field will be explained. The course covers the theory and modeling of common formation damage problems, laboratory testing for diagnosis and effective treatment, and tailor-fit-design of optimal strategies for mitigation of reservoir formation damage. The course includes field case histories and simulated scenarios demonstrating the consequences of formation damage in petroleum reservoirs.

Course Objectives

At the end of this course, the Trainee will be able to:-

- Apply and gain an in-depth knowledge on formation damage covering its causes, prevention and remediation
- Explain the purpose of the water flooding process
- Describe the requirements for water quality and target volumes
- Describe water specifications such as TSS (Total Suspended Solids), OIW (Oil in Water), Dissolved Oxygen, etc
- Explain the KOC operational procedures and standards for collecting samples from various wellheads and waterlines for delivery to the laboratory for analysis
- Apply KOC operational procedures and standards for routine sampling
- Report abnormalities and off spec results in order to take appropriate actions
- Describe the purpose of chemical injection in the water treatment process
- Evaluate, prevent, remediate and control the formation damage which can save or cost millions in profit
- Acquire a state-of-the-art knowledge and valuable insights into the nature of processes and operational practices causing formation damage
- Implement new strategies designed to minimize the impact and avoid formation damage in petroleum reservoirs with the newest drilling monitoring and detection techniques

Who Should Attend

This course is intended for production and completion engineers responsible for well maintenance and production performance. Further, the course is essential for geologists, geochemists, physicists, chemists, petroleum engineers, chemical engineers, drilling and reservoir engineers, managers and supervisors interested in minimizing the formation damage impact of drilling, completion, production, injection and stimulation operations. The course is also important for field laboratory staff and management

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

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 Contents

- Overview of Formation Damage
- Summary
- Introduction
- Definitions
- Formation Damage Impact
- Introduction
- Common Formation Damage Problems, Factors, and Mechanisms
- Team for Understanding and Mitigation of Formation Damage
- Objectives
- End of this Section
- Geological and Physical Reservoir Characteristics
- Formation Damage
- Background
- Formation Porosity
- What is Porosity “Φ” ?
- Formation Porosity
- Formation Permeability
- Effect Grain Size in Permeability
- Oil Reservoirs
- Traps General –Structural Trap Example

- Stratigraphic Traps Example
- Causes of Low Productivity Wells.
- Skin Effect
- Reservoir Model of Skin Effect
- Reservoir Pressure Profile
- The Cost-Impact of Formation Damage on Well Production
- Effect of Skin on the IPR Curve
- Phase Diagram
- Reservoir Drive Mechanism
- Water Drive
- Main Producing Characteristics
- Gas Cap Drive
- Main Producing Characteristics
- Solution Gas Drive
- Main Producing Characteristics
- End of this Section
- Mineralogy and Mineral Sensitivity of Petroleum—Bearing Formations*
- Summary
- Introduction
- Origin of Petroleum-Bearing Formations
- Constituents of Sedimentary Rocks
- Composition of Petroleum-Bearing Formations
- Why Are Clays Important ?
- Chemical Composition of Clays
- Composition of Petroleum-Bearing Formations
- Mineral Sensitivity of Sedimentary Formations
- Building Blocks
- Clay Structures
- Comparison of Structures
- Charges on Clay Particles
- *Ion Exchange Properties of Clays*
- Mineral Sensitivity of Sedimentary Formations
- Cation Exchange
- Hydration of Cations

- Clay Hydration
- Potassium Inhibition
- Clay Swelling
- Mineral Sensitivity of Sedimentary Formations
- Mechanism of Clay Swelling
- Models for Clay Swelling
- Osmotic Repulsive Pressure
- Conclusions
- Clay Dispersion and Migration
- Clays in Sandstones
- Clays
- Primary Types of Clays - Illite
- Primary Types of Clays - Kaolinite
- Primary Types of Clays - Smectite
- Mixed Layer Clays
- Primary Types of Clays - Chlorite
- Formation Damage Analysis
- Formation Protection Summary
- SEM Micrograph
- Rotliegendes Formation - Good Reservoir Rock
- Rotliegendes Formation Magnification - Good Reservoir Rock
- Chalk Formation Magnification - Good Reservoir Rock
- SEM Micrograph - Center Cocolite Fossils Fragment
- Formation Damage During Drilling Phase
- Contents
- Introduction
- Function of Drilling Fluids
- Drilling Fluids Composition
- Protection of Formation Productivity
- Drilling Mud Cake and Solids Invasion into Formation Pores
- Causes and Damage Mechanism
- Invasion Profile
- Filter Cake Formation
- Formation Damage Mechanisms During Drilling

- Formations Impairment due to Clay Swelling
- Formation Impairment Due To Polymer Absorption
- Causes and Damage Mechanism
- Damage Caused by Drilling Fluid
- Ways to Avoid and to Minimize
- End of this Section
- Causes, Classification and Diagnosis of Formation Damage
- Contents
- Introduction
- Wellbore Damage
- Formation Damage
- Basic Causes for Formation Damage
- Effect of Formation Damage on Well Productivity
- Formation Damage Indicators
- Formation Damage Consequences
- Plugging Associated with Fluid Filtrate
- Plugging Associated with Solids
- Classification of Formation Damage Problem
- Diagnosis of Formation Damage
- Cause of Formation Damage
- Sources of Formation Damage
- Damage Characterization
- Clay Migration
- Guide to Emulsion Diagnosis
- Other Indicators
- Damage Quantified Through - Skin Factor & Productivity Index
- Skin
- Reservoir Model of Skin Effect
- Radial Production and Skin (Darcy's Law)
- Reservoir Pressure Profile
- Productivity Index
- Flow Efficiency
- Formation Damage During Well Operations
- Cost of Formation Damage

- End of this Section
- Formation Damage During Completion Phase
- Contents
- Introduction
- Causes and Types of Damage During Completion Phase
- Causes
- Damaged Around Perforation Formed During the Perforation Process
- Prevention of Formation Damage During Completion Phase
- Formation Damage During Workover Phase
- Contents
- Introduction
- Production history shows formation damage created by well killing
- Workover history shows when formation damage occurred
- Workover history identifies causes of formation damage
- The following are some of the operations could cause formation damage during this maintenance workover
- Mitigation of Formation Damage During Workover Operations
- Workover Techniques to Minimize Formation Damage
- End of this Section
- Formation Damage During Production Phase
- Contents
- Introduction
- Sources of Formation Damage – Fines Movement
- Fine Migration
- Fines Movement is Controlled by
- Causes of Damage During Production Phase
- Damage Caused by Production
- Injection Operations
- Prevention and Mitigation of Formation Damage
- Source of Formation Damage – Completion and Workover Fluids
- Paraffin’s & Asphaltenes
- Contents
- Components of Crude
- Introduction

- Deposition
- Paraffins
- Paraffin Deposition
- Paraffin Related Production Loss
- Asphalt Tars
- Asphaltene Deposits
- Factors Governing Asphaltene Deposition
- Introduction
- Paraffines and Asphaltenes Deposition
- Paraffines and Asphaltenes Removal
- Tubing Scale Removal: Conventional Solutions
- Water Jetting vs Abrasive Jetting
- Solution: Sterling Beads
- Scale Blaster Jetting Head Module
- Deposition Mitigation
- Scale Deposition
- Contents
- Introduction & Discussion
- Common Scales
- Introduction & Discussion
- Causes and Tendency of Scale
- Iron Scales
- Prediction and Identification of Scale
- Scale Removal
- Removal Methods
- Scale Prevention
- Conclusion
- End of this Section
- Common Damage & Remedy
- Formation Damage Causes
- Formation Damage Characterization
- Cause of Formation Damage
- Formation Damage
- Scale

- Solids / Particles Effects in Porous
- Drilling Damage
- Perforations
- Completion Fluids Damage
- Water Block Damage
- Damage Due to Production
- Damage Quantified through Skin Factor & Productivity Index
- Skin
- Radial Production and Skin (Darcy's Law)
- Geometric Skin
- Flow through Perforation
- Geometric Skin – Partial Penetration
- Partial Penetration
- Geometric Skin – Deviated Wellbore
- Geometric Skin – Well with Hydraulic Fracture
- Completion Skin
- Gravel Pack
- Productivity Index
- Flow Efficiency
- Summary
- Common Damage Types
- Emulsion
- Formation Damage
- Potential Sources of Formation
- Common Formation Damage Mechanisms
- Extraneous Materials
- Organic Deposition
- Mitigation Methods
- Treatment Fluids
- Stimulation
- What Is Well Stimulation?
- Well Stimulation
- Objectives of Acid Stimulation
- Stimulation Techniques

- Matrix Acidizing
- Chemical Stimulation Without Acid
- Selection of Candidates for Stimulation
- Damage Causes and Acid Types
- There are Four Main Types of Acid
- Acidizing
- Overuse of Additives
- Stimulation Treatment Process
- Final Remarks
- Hydraulic Fracturing Technique
- Fracturing Treatment Selection
- Requirements for a Fracturing Fluid
- Type of Fracturing Fluid
- End of this Section