COURSE OVERVIEW DE0763
Petrophysics for Other Disciplines (E-Learning Module)

Course Title
Petrophysics for Other Disciplines
(E-Learning Module)

Course Reference
DE0763

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)
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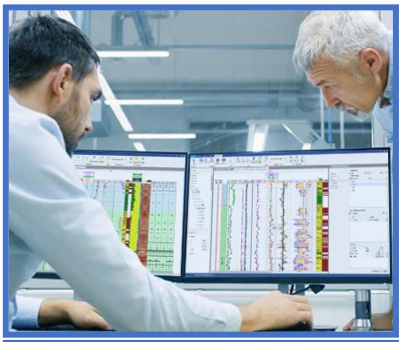
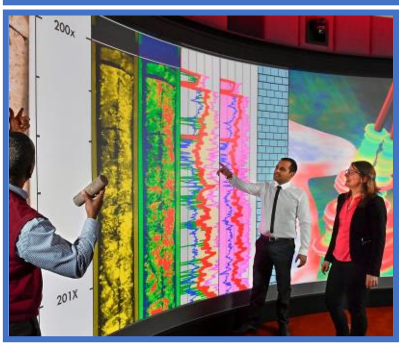
Course Description





This E-Learning course is designed to provide participants with a detailed and up-to-date overview of petrophysics. It covers the determination of porosity using routine core analysis and the effect of compaction on porosity; the bulk volume, pore volume and grain volume; the schematic diagram of helium porosimeter apparatus; the Boyle's law porosimeter, porosity concepts, log measurement and core measurements in shaly sandstone; the Darcy`s law, schematic diagram of Darcy`s apparatus and Kozeny-Carman model; the ideal gas flow, high velocity flow, measurement of permeability and constant head permeameter; the measurement of permeability-measurement of air permeability and fluid flow through porous media; and the schematic of linear flow through a core sample and electrical property tests.

During this course, participants will learn the listing of electrical properties of rocks; the electrical properties and formation factor (F, FF, FRF); the cementation exponent plot of resistivity and porosity at stressed (i.e. reservoir) conditions; the resistivity of partially water-saturated rocks and electrical circuit of resistance; the effects of conductive solids, apparent formation factor and water resistivity for clayey and clean sands; the graph of rock conductivity (Co) and brine conductivity (Cw); the effects of overburden pressure on resistivity; and the capillary pressure measurement methods porous plate and disk method (restored state).

Course Objectives

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

- Apply and gain an in-depth knowledge on petrophysics for other disciplines
- Determine porosity using routine core analysis including the effect of compaction on porosity
- Measure bulk volume, pore volume and grain volume as well as describe the schematic diagram of helium porosimeter apparatus
- Discuss Boyle's law porosimeter, porosity concepts, log measurement and core measurements in shaly sandstone
- Explain Darcy`s law, schematic diagram of Darcy`s apparatus and Kozeny-Carman model
- Identify the ideal gas flow, high velocity flow, measurement of permeability and constant head permeameter
- Apply measurement of permeability, measurement of air permeability and fluid flow through porous media
- Illustrate schematic of linear flow through a core sample and perform electrical property tests
- Review listing of electrical properties of rocks, electrical properties and formation factor (F, FF, FRF)
- Discuss the cementation exponent plot of resistivity and porosity at stressed (i.e. reservoir) conditions
- Measure resistivity of partially water-saturated rocks and electrical circuit of resistance
- Identify the effects of conductive solids, apparent formation factor and water resistivity for clayey and clean sands
- Describe graph of rock conductivity (Co) and brine conductivity (Cw) as well as recognize the effects of overburden pressure on resistivity
- Apply capillary pressure measurement methods porous plate and disk method (restored state)

Who Should Attend

This course provides an overview of all significant aspects and considerations of petrophysics for geoscientists, petrophysicists, petroleum reservoir and drilling engineers, geologists and geophysicists whose job requires a more extensive knowledge of petrophysical engineering.

Course Fee

As per proposal

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.

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

- Porosity
- Porosity Determination Using Routine Core Analysis
- Effect of Compaction on Porosity
- Bulk Volume Measurement
- Pore Volume Measurement
- Schematic diagram of Helium Porosimeter Apparatus
- Pore Volume Measurement - Boyle's Law
- Boyle's Law Porosimeter
- Pore Volume Measurement
- Grain Volume Measurement
- Porosity Concepts, Log Measurement and Core Measurements in shaly Sandstone
- Permeability
- Darcy`s Law
- Schematic Diagram of Darcy`s Apparatus (1856)
- Kozeny-Carman Model
- Klinkenberg Effect
- Klinkenberg Effect – Modified
- Ideal Gas Flow

- High Velocity Flow
- Measurement of Permeability
- Constant Head Permeameter
- Hassler
- Measurement of Permeability-Measurement of Air Permeability
- Permeability Baffles and Conduits at Different Scales (Giga, Mega, Macro and Meso)
- Darcy's Law
- Fluid Flow Through Porous Media
- Schematic of Linear Flow through a Core Sample
- Linear Flow
- Electrical Properties
- Electrical Property Tests
- Listing of Electrical Properties of Rocks
- Electrical Properties - General
- Formation Factor (F, FF, FRF)
- Formation Factor – F – Criteria for Proper Equation Selection
- Impedance Analyser
- Formation Factor – F - Data reporting Requirements
- Formation Factor – F - Advantages & Disadvantages
- Resistivity
- Resistivity Index
- Cementation Exponent m
- Cementation Exponent Plot of Resistivity vs. Porosity at Stressed (i.e. Reservoir) Conditions
- Saturation Exponent n
- Resistivity of Partially Water-Saturated Rocks
- Resistance Measurements
- The Electrical Circuit of Resistance Measurements
- Tortuosity
- Effects of Conductive Solids (Conductive Clays No Shales!)

- Effects of Conductive Solids (Clays)
- Apparent Formation Factor vs. Water Resistivity for Clayey and Clean Sands
- Effects of Conductive Solids (Clays) - CEC
- Graph of Rock Conductivity (Co) vs. Brine Conductivity (Cw)
- Effects of Overburden Pressure (On Resistivity)
- Effects of Overburden Pressure on Formation Factor - F
- Wettability
- Capillary Pressure
- Primary Drainage Curve
- Imbibition Curve
- Capillary Pressure Measurement Methods Porous Plate / Disk Method (Restored State)
- Sample Requirements
- Required Input Data for Lab
- Porous Plate (Diaphragm) Pressure Cell for Measurement of Capillary Pressure
- Advantages-General
- Disadvantages-General
- Advantages-Batch Cell
- Disadvantages-Batch Cell
- Advantages-Individual Cell
- Disadvantages-Individual Cell
- Capillary Pressure Measurement Methods – Centrifuge Method (High Speed)
- Purpose of Centrifuge Test
- Capillary Pressure Measurement Methods – Mercury Injection (Purcell Method; MICP Method)
- Advantages – Low Pressure Mercury Injection (LPM)
- Disadvantages – Low Pressure Mercury Injection (LPM)
- Advantages – High Pressure Mercury Injection (HPMI)
- Disadvantages – High Pressure Mercury Injection (HPMI)
- Dynamic Method
- Mercury Injection Method

- Porous Plate Method
- Centrifuge Method
- Comparison of PC Methods
- Summary of Equilibrium Times for PC Tests
- Industry Standard
- Porous Plate Method Equilibrium Water Saturation versus Time
- Negative Effects of Short Equilibration Times in the Porous Plate Method
- Converting Data from Laboratory Conditions to Reservoir Conditions
- Idealized Contact for Wetting Fluid and Spherical Grains
- Imbibition and Drainage Capillary Pressure Curves
- Capillary Pressure Apparatus
- Capillary Pressure Definition
- Mercury Injection Drainage and Imbibition Data
- Cumulative Pore Size Distribution from Mercury Injection
- Differential Pore Size Distribution from Mercury Injection
- Porous Plate Measurement Arrangement
- Air-Brine Capillary Pressure from Porous Plate Measurements
- Oil-Brine Capillary Pressure Curve
- Hassler Cell Arranged for Capillary Pressure Measurement
- Wettability
- Interfacial Tensions for Water-Oil-Solid System at Equilibrium
- Adhesion Tension
- Positive
- Negative
- Wettability and Wetting Index (WI)
- Spreading Wetting
- Measurement of Wettability
- Measurements on Core Samples
- Measurement of Wettability -Contact Angle Method (Imaging Method)
- Contaminations

- Measurement of Wettability – Contact Angle
- Sessile Drop Method
- Surface Roughness Effects on Measured Contact Angle
- Modified Sessile Drop Method
- Schematic of a Goniometer Experimental Set-Up
- Table Listing the Contact Angle Wettability Classification
- Listing of Advantages and Disadvantages of the Contact Angle Method
- Measurement of Wettability Amott Method (Amott-Harvey)
- Schematic of Amott Cell for Imbibition of Water and Imbibition of Oil
- Schematic of the Amott Test for Imbibition and Secondary Drainage
- Table Listing the Amott Wetting Indices: Water Wet, Oil Wet and Neutral Wet
- Listing of Data Requirements for the Amott Wettability Method
- Listing of Advantages and Disadvantages of the Amott Wettability Method
- Measurement of Wettability the Centrifuge Method (USBM Method)
- Overview of USBM (Centrifuge) Wettability Method
- Measurement of Wettability – Wettability Index - Centrifuge Method (USBM Method)
- Effect of Wettability on the Area Ratio of Capillary-Pressure Curves: Neutral System
- Data Reporting Requirements for the USBM Method
- Advantages and Disadvantages of the USBM Method
- Measurement of Wettability Combined Amott-USBM Method
- Overview and Purpose of the Combined Amott-USBM Method
- Curve Example of the Combined Amott-USBM Method
- Measurement of Wettability - Combined Amott-USBM Method
- Curve Example of the Modified Combined Amott-USBM Method
- Alteration of Wettability
- Measurement of Wettability - Electrical Properties
- Reservoir Geomechanics
- Sample Selection
- Equotip

- Sample Orientation
- Sample Saturation
- Unconfined Compressive Strength Tests (UCS)
- Cross Plot of Axial Stress vs. Axial Relationships Used for Young's Modulus
- Cross Plot of Axial Stress vs. Axial Strain Relationships Used for Poisson's Ratio
- Post-Test Photograph of Test Plug Showing Clear Shear Failure Surfaces
- Data Requirements for Unconfined Compressive Strength Tests (UCS)
- Advantages and Disadvantages Associated with UCS Tests
- Triaxial Compression Strength Tests
- Schematic Diagram of the Triaxial Test Apparatus
- Photograph of the Triaxial Test Apparatus
- Cross Plot of the Volumetric Strain vs. the Isostatic Confining Stress Indicating the Rock Behavior during Isostatic Loading
- Cross Plot of the Volumetric Strain vs. Time Indicating the Rock Behavior During Isostatic Loading
- Cross Plot of Axial Stress vs. Axial Indicating the Peak Strength and the Residual Strength
- Triaxial Testing Results from Three Weak Rock Types
- Schematic Diagram of Multi-Stage Triaxial Test (MST) Test
- Data Requirements for Triaxial Compressive Strength Tests (SST & MST)
- Advantages and Disadvantages of Triaxial Compressive Strength Tests (SST & MST)
- Triaxial Testing of Shales
- Thick-Wall Cylinder Tests (TWC)
- Tensile Strength Tests (TT)
- Direct Test
- Brazilian Disk Test (Indirect Test)
- Tensile Strength Tests (TT)
- Acoustic Travel Time (ATT) or Acoustic Velocity tests
- Differential Strain Curve Analysis (DSCA) Tests
- Pore Volume Compressibility Tests
- Particle Size Analysis Tests

- Water Saturation
- Dean-Stark apparatus
- Typical Dean-Stark Method Set-Up in a Laboratory
- Data Requirements Checklist for Dean–Stark Extraction Method
- Weighing Core Plugs
- Soxhlet Distillation Extractor
- Photograph of Retort Apparatus
- Advantages & Disadvantages of Fluid Saturation Determination by the Retort Method
- Clays & Clay Damage
- Table Listing the Characteristics of the Clay Mineral Present in Clayey Sandstones
- Table Listing the Principal Clay Groups and their Characteristics
- Cation Exchange Capacities (CEC) of Common Authigenic Clays
- Comparison of 'Hot Shot' and Fully Cleaned Porosity (A) and Grain Density and (B) Grain Density Measurements
- Schematic of Authigenic Clay Structures and Morphology
- Schematic of Common Mineral Lattice Structures and Morphology
- Mode of Occurrences of Authigenic Clays in the Pore Structure of a Clayey Sandstone Reservoir, Namely Laminar, Structural and Dispersed
- Mode of Occurrences of Authigenic Clays in Sandstones
- Three Models of Authigenic Clay Formation on the Pores of A Reservoir Bridging the Pore System
- SEM Photomicrograph of Pore-Filling Smectite in Shaly Sand
- Core Plug with High Smectite Content was Exposed to Formation Water After Drying
- SEM Photomicrograph of Fibrous Illite Bridging Across Pores in Shaly Sand
- SEM Photomicrograph of Fibrous Illite Lining Sand Grains, North Sea, UK
- SEM Photomicrograph of Kaolinite Booklets Loosely Adhering to Quartz Grains (Discrete Habit)
- SEM Photomicrograph Indicating Damage to Illite on Evaporative Drying
- Diffuse Double Layer of Water Molecules in Smectite
- Pore and Clay Ion Mobility in Shaly Sand

- Example Poroperm Relationships for Different Clay Morphologies in Sandstones
- Permeability Enhancement as a Result of Drying on Three Illite Sandstone Samples
- Porosity Concepts, Log Measurement and Core Measurements in Shaly Sandstone
- Comparison of Air Permeabilities Measured After Humidity Oven Drying (HOD) and After Conventional Oven Drying (COD)
- Water Production Curve with Retort Cleaning Method for Shaly Sand Reservoir
- Comparison of Retort Fluid Summation Porosities and Helium Plug Porosities in a Shaly Sand
- Comparison Between the Resistivity Response of a Clean Sandstone vs. a Clayey (Shaly) Sandstone
- Comparison of the Response Between the Porosity and Air Permeability of Various Authigenic Clays
- Relationship of Specific Area vs. Cation Exchange capacity (CEC) and the Reservoirs Irreducible Water Saturation (Swirr, Swir)
- Graph of Klinkenberg Permeability vs. Brine Permeability for Clay Rich Samples
- Listing of Methods for Determining the Volume of Clay (Vcl)
- Viscosity
- Steady-State Velocity Profile of a Fluid Entrained Between Two Flat Surfaces
- Shear Stress vs. Shear Rate for a Newtonian Fluid
- Effect of Pressure and Temperature on Viscosity
- Methods for Measuring Viscosity Capillary Type Viscometer
- Two Types of Ostwald Viscometers
- Falling Ball Viscometer
- Schematic Diagram of the Falling Ball Viscometer
- Rotational Viscometer
- Schematic Diagram of the Rotational Viscometer
- API Gravity
- Physical Properties of Various Hydrocarbons and Water
- Comparison of °API Gravity and Specific Gravity at 60 °F and Atmosphere Pressure
- Viscosity Ratio as a Function of Pseudo-Reduced Pressure

- Viscosity of Gases (μga) at One Atmosphere as a Function of Temperature in °F.
- Density
- Measurement of Density
- Schematic Diagrams of (a) Hydrometer, (b) Pycnometer, (c) Bicapillary Pycnometer
- Bicapillary Pycnometer