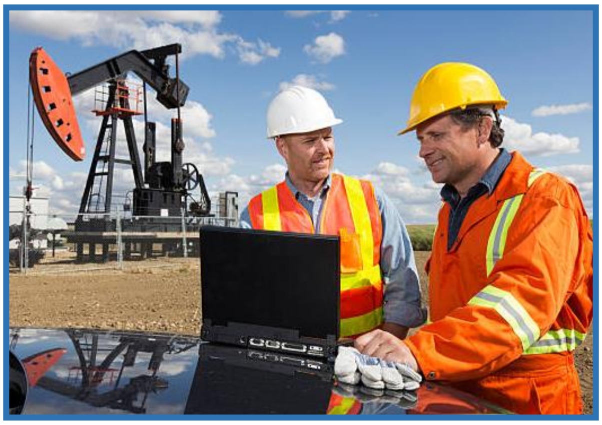
COURSE OVERVIEW DE0347
Artificial Lift Methods
(E-Learning Module)

Course Title
Artificial Lift Methods (E-Learning Module)



Course Reference
DE0347

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)

3.0 CEUs (30 PDHs) AWARD

Course Description

This E-Learning is designed to provide participants with a detailed and up-to-date overview of artificial lift methods. It covers the artificial lift system, phase behavior, inflow performance, water drive, recoverable reserves and ideal flow assumptions; the inflow performance prediction and well & reservoir inflow performance; the factors that affect oil production and apply oil production processes, well bore fluid calculations and artificial lift methods and equipment; the oil production processes, primary recovery, thermal EOR methods and well optimization process; and the electrical submersible pumps (ESP), hydraulic pumps, systematic approach and artificial lift method.

During this interactive course, participants will learn the operating gas lift valve, orifice valves, operating principle of the venturi, checks, latches and mandrels; the design considerations, parameters selection, choose the best correlation and gas lift design methods; the effect of variables on gas lift process, compressor systems; the factor to consider when designing a compressor; the production optimization; the factor affecting pump selection, cable configuration, conductor - size selection and insulation selection; and typical hydraulic pumping systems, artificial lift, production characteristic and fluid properties.

Course Objectives

After completing the course, the employee will:-

- Apply and gain a good working knowledge on artificial lift methods
- Basic knowledge of artificial lift, techniques, systems, procedures and processes
- Ability to identify requirements for anticipated artificial assistance to production, maximizing recovery in a cost-effective manner
- Ability to select and design of the proper production method (natural flow, gas lift, electrical submersible pumps, progressive cavity pumps, rod pumps, hydraulic pumps, among others)
- Recognize artificial lift system, phase behavior, inflow performance, water drive, recoverable reserves and ideal flow assumptions
- Carryout inflow performance prediction and well & reservoir inflow performance
- Identify the factors that affect oil production and apply oil production processes, well bore fluid calculations and artificial lift methods and equipment
- Illustrate oil production processes, primary recovery, thermal EOR methods and well optimization process
- Discuss electrical submersible pumps (ESP), hydraulic pumps, systematic approach and artificial lift method
- Describe operating gas lift valve, orifice valves, operating principle of the venturi, checks, latches and mandrels
- Employ check assembly, installation, removal, running procedures and pulling operation
- Illustrate design considerations, parameters selection, choose the best correlation and gas lift design methods
- Identify the effect of variables on gas lift process, compressor systems and the factor to consider when designing a compressor
- Apply production optimization, recognize the factor affecting pump selection, cable configuration, conductor - size selection and insulation selection
- Recognize typical hydraulic pumping systems, artificial lift, production characteristic and fluid properties

Who Should Attend

This course provides an overview of all significant aspects and considerations of artificial lift methods for engineers with limited experience in the subject. Experienced engineers will also benefit from this course as it will serve as a refresher for their knowledge.

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 **3.375 CEUs** (Continuing Education Units) or **33.75 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

- Artificial Lift System
- Objectives
- Pressure Losses
- Phase Behavior – Pressure in the Production System
- From the reservoir to the separator (Oil reservoir):
- Important for the phase behavior
- Phase Behavior- Single compound behave like (propane, water)
- Phase Envelope /Phase Diagram
- Reservoir HC fluid Classification
- Heavy Oils
- Black Oils
- Volatile Oils
- Liquid volume curve for typical black oils
- Liquid volume curve for typical volatile oil
- The system
- Inflow Performance
- Fluid
- Pressure
- Reservoir
- Solution Gas Drive
- Solution-Gas Drive in Oil Reservoirs- Typical Production Characteristics

- Gas Cap Drive
- Gas-Cap Drive in Oil Reservoirs
- Gas Cap Drive- Main Producing Characteristics
- Water Drive
- Water Drive in Oil Reservoirs- Edgewater Drive
- Water Drive in Oil Reservoirs Bottomwater Drive
- Strong Water Drive-Main Producing Characteristics
- Water Drive in Oil Reservoirs -Typical Production Characteristics
- Water Drive in Oil Reservoirs -Effect of Production Rate on Pressure
- Recoverable Reserves
- Inflow Performance Relationship
- Inflow Performance-Radial Flow
- Semi (Pseudo) Steady State Inflow (using average reservoir pressure)
- Ideal Flow Assumptions
- Inflow Performance – Productivity Index
- Darcy Inflow
- Productivity Index
- Example
- Solution
- Darcy's Law
- Darcy's Law for Radial Flow into a Wellbore
- Unsuccessful Stimulation Job
- Successful Stimulation Job
- Inflow Performance
- What will this do to the flow of oil?
- Inflow Performance Prediction
- Darcy IPR Curve
- Well & Reservoir Inflow Performance
- VOGEL
- Vogel IPR Curve
- Straight line VS Vogel – Graphically
- Example of straight line and vogel IPR Mode
- Vogel IPR

- Inflow Performance Relationship – IPR
- Combined IPR
- Fetkovich Multiple Rate Tests
- Multipoint Data
- Fitkovitch IPR Curve
- Ideal Flow Assumptions
- Non-Ideal Flow
- Non-ideal Laminar Flow
- Inflow Performance
- Outflow Performance
- Factors that affect Oil Production
- Well & Reservoir Inflow Performance
- Oil Production Processes
- Outflow Performance and Multiphase Flow
- Surface Pressure
- Oil Production Processes
- Outflow Performance Relationship
- How do we calculate the outflow pressures?
- Flow Regimes
- Out Flow Performance-Multiphase Flow Patterns and Maps
- Outflow Performance
- Holdup and the Minimum Stable Rate
- The System
- Inflow Performance Curve
- Tubing Curve
- System Graph
- System Graph – Nodal Analysis
- What's the best tubing size?
- What reservoir pressure will the well die?
- Outflow Performance and Multiphase Flow
- Well Bore Fluid Calculations
- Exercise 1a
- Exercise 1b

- Exercise 2
- Correlations
- Out Flow Performance-Multiphase Flow Correlations
- Out Flow Performance-Vertical Lift Performance Curves
- Reservoir Match
- Out Flow Performance - Typical Outflow Performance Curves
- How Wells Flow
- Qualifying well flow performance
- Effect of Tubing Size on Outflow
- Effect of Skin on IPR
- Effect of Pressure Depletion on IPR
- The Oil Rate – Initial Conditions
- Pressure Depletion Effect on Oil Rate
- The Oil Rate – Initial Conditions
- Declining Oil Rate – Options?
- Improving Well Performance – Inflow
- Improving Well Performance – Inflow - Shifting Reservoir Inflow Curve Up
- Improving Well Performance – Outflow
- Improving Well Performance – Outflow -Shifting Reservoir Inflow Curve Up
- How Wells Flow - Quantifying Well Flow Performance
- Solution
- More
- Course Recap
- Artificial Lift Overview of Methods and Equipment
- Oil Production Processes
- Primary Recovery
- Thermal EOR Methods
- Non-thermal EOR Methods
- Well & Reservoir Inflow Performance (Successful design depends upon prediction of flow rate)
- Factors Effecting VLP
- Inflow and Outflow Performance
- Well Performance - Pressure gradient plots

- IPR Change After Some Reservoir Depletion
- What Happens When TPC and IPR Curves no longer meet?
- Artificial Lift
- Factors that Cause Reduction of Flow
- Artificial Lift
- Lift — When Needed?
- Artificial Lift - Why?
- Stimulation and Artificial Lift
- The Principle of Artificial Lift
- Artificial Lift Decreases BHP& Increase Rate
- Artificial Lift
- Artificial Lift Options
- Artificial Lift Inflow Performance Relation
- Typical Scope of Production Engineer
- Well Optimization Process
- Identifying the Well Potential
- Dead Well
- Artificially Lifted Well – Downhole Pump
- Artificially Lifted Well – Gas Lift
- Conversion to ESP
- Popular Lift Types
- Lift Mechanisms
- Gas Lift
- Beam Pumping (or Sucker Rod Pumps)
- PCP (Progressive Cavity Pump)
- Electrical Submersible Pumps (ESP)
- Hydraulic Pumps
- Systematic Approach
- Course Recap
- Gas Lift
- Gas Lift Concept
- Types of Gas Lift
- Gas Lift System

- Relative Advantages and Disadvantages of Gas Lift Systems
- Types of Gas Lift Applications
- Continuous Flow Gas Lift – Mechanisms
- Why does Oil Rate Decrease?
- Gas Lift as an Artificial Lift Method
- Intermittent Flow Gas Lift
- Intermittent Lift - Single point intermittent lift
- Intermittent Lift – Multipoint Intermittent Lift
- Gas Lift System Considerations
- Troubleshooting
- Gas Lift Method
- Continuous Flow Unloading Sequence
- Unloading Sequence
- Recommended Practices Prior to Unloading
- Unloading Procedures
- GL Well Unloading Sequence
- Unloading Procedure
- Tubing and Casing Pressure Records
- Gas-Lift Valves
- Gas Lift Equipment
- Gas Lift Valve Mechanics
- Types of gas lift valve, each available in 1" & 1-1/2" sizes
- Production Pressure Operated Valves
- Valve Opening & Closing Pressures
- Pressure and Force Relationship
- Gas Lift Valves Close in Sequence
- GL Equipment Overview: Unloading Valves
- Operating Gas Lift Valve
- Orifice Valves
- Operating Principle of the Venturi
- Checks, Latches & Mandrels
- Check Assembly
- Latch

- Side Pocket Mandrel
- Mandrel Component
- Installation and Removal
- Kickover Tool
- Running Procedures
- Pulling Operation
- Design Considerations
- Parameters Selection
- Horse Power Requirement
- Choose the Best Correlation
- Gas Lift Design Methods
- Collect Well Data for Design
- Artificial Lift Gas Lift Valve Spacing Example
- Integrating Gas Lift/Gas Compression Systems
- Two Pen Chart Pressure Recordings
- Effect of Variables on Gas Lift Process
- Water cut
- Injection pressure and Gas Volume
- Effect of PI
- Compressor Systems
- Open systems
- Semi-closed system
- Closed rotated system
- Closed Rotative Gas Lift System
- Factor to Consider When Designing a Compressor
- Gas Pressure Loss
- Separator To Compressor
- Compressor To Well
- Wellbore Losses
- Single Well Optimisation
- Production Optimization
- Gas Lift Well's Optimization
- Gas Lift Optimization

- Gas Optimum Per Field
- Gas Lift Well – Troubleshooting
- Heading - Instabilities – Slugging
- Tubing Heading
- Casing/Annulus Heading
- Reasons for Surging
- Surging Solving
- Rod Pumps
- Beam Pump
- Sucker Rod Pumping
- Factor Affecting Pump Selection
- Beam Pumping Unit
- Conventional Beam Pump
- Prime Mover
- Internal Combustion Engine
- Horsepower
- Available Fuel
- Equipment Life and Cost
- Installation
- Electrical Motor
- Motor Requirements
- Gear Box
- Saddle Bearing
- Rod String
- Polished Rod
- Stroke Length
- Stuffing Box and Polished Rod
- Lubricator
- Rod String
- API Grade D
- API Grade K
- API Grade K
- Course Recap

- ESP
- Historical Perspective
- The Basic ESP System
- Head
- Head Curve
- However Pump △ P is proportional to density
- System Components
- Centrifugal Pumps
- Mixed Flow Stage
- Radial Flow Stage
- Floater Pump
- Compression Pump
- When to use Compression Pump
- System Components
- ESP – Motor
- System Components
- ESP – Motor Selection
- Main Components
- Stator
- Stator – Housing
- Stator — Housing Size
- Stator - Stator Core: Lamination
- Stator – Winding
- Rotor
- ESP Protector
- Protector Functions
- Intakes and Gas Separators
- Standard Intake
- Gas Separators
- Why Gas is separated?
- Key Parameters Determining Amount of Gas
- Alternatives to Handle Gas Problem
- Static (Reverse Flow) Gas Separator

- Dynamic Gas Separators
- Gas Separators Efficiency
- Some Factors Impacting the Natural and Mechanical Separation
- Wellbore Orientation
- Gas Handling Device Principle
- Types of Gas Handling Device
- AGH Application
- Types of Gas Handling Device
- Gas Separator-Handling Device Performance Comparison
- Typical ESP Application
- ESP – Power Cable
- ESP Cable
- Electrical Submergible Cable
- Cable Configuration
- ESP – Power Cable Components
- Conductor – Selection
- Conductor – Types
- Solid
- Stranded (Round)
- Compacted
- Conductor - Size Selection
- Insulation Selection
- Insulation Types
- Barrier Selection
- Jacket Selection
- Jacket Types
- Armor Selection
- Armor Profile Types
- ESP Surface Equipment — Components
- Transformers
- Transformers – Single Phase
- Motor Controller
- Switchboard

- Switchboard — Components
- Variable Speed Drive (VSD)
- Junction Box / Vent Box
- Surface Cable
- Wellhead Penetrator
- Wellhead Penetrator / Pack Off
- Coiled Tubing Deployed Pumping Systems (CTDPS)
- ESP Completion
- ESP Optimization
- Pump Recommended Operating Range
- Pump Performance Curve
- Handling Corrosive Environment
- Production of Fluid with Tendency to form Scale
- ESP Power Cable Incorporating Capillary Tube
- Producing Viscous Fluid
- ESP System
- Ratings
- Basic Pump Sizing
- Pump sizing by Hand
- Model in Pipesim as Comparison
- Relative Advantages and Disadvantages of ESP Systems
- Progressing Cavity Pumps
- Rotation
- PCP Description
- Introduction to PC Pumps – History
- Introduction to PC Pumps - Top drive System
- Introduction to PC Pumps - Bottom Drive System
- PC Pumps Application
- Introduction to PC Pumps - Market Summary
- PCP Market Share
- Advantages
- Disadvantages
- Applications

- PCP
- Progressing Cavity Pump Basics - Stage Ratings
- Progressing Cavity Pump Basics - Stages vs Depth
- Progressing Cavity Pump Basics - Competitors
- PCP Speed
- Hydraulic Pump
- Hydraulic Pumping
- Hydraulic Market Share ($MM)
- Two Styles of Hydraulic Pumps
- Jet Pumps
- Hydraulic Piston Pump
- Comparison of Capabilities
- Jet Pump Application Range
- Piston Pump Application Range
- Jet Pumping
- Theory
- Features
- Nozzle and Throat Sections
- Nozzle to Throat Sizes
- Relative Advantages and Disadvantages of Jet Pumping Systems
- Jet Pump Completion
- Hydraulic Piston Pump
- Open Power Fluid System
- Closed Power Fluid System
- Piston Pumps
- System
- Basics of Hydraulic Pumping
- Typical Hydraulic Pumping Systems
- Hydraulic Piston Pump
- Portable Testing Units - (Both Are Utilizing Reciprocating Power Fluid Pumps)
- Unitized Power Fluid Conditioning
- Rules of Thumb for Hydraulic Pumping Systems

- Essential Well Data for Design
- Cyclone Solids Separator
- Multi-well RedaHPS Installation
- Surface Pressure and Flow Control
- Artificial Lift Selection
- Lift – when needed?
- The Decision to Go to Gas Lift
- Important Remarks
- Lift Systems
- AL Methods vs. Wells
- Artificial Lift Market
- Capabilities by Product Type
- Artificial Lift Selection
- Artificial Lift Systems
- Onshore Directional / Horizontal Wells
- Offshore Directional / Horizontal Wells
- Onshore Vertical Wells with high water production
- Offshore Vertical Wells with high water production
- Multiple completions
- Production location
- Power/Fuel source
- Factors Affect on Artificial Lift Selection
- Production Characteristics
- Fluid Properties
- Viscosity
- Other properties with minor effect
- Hole Characteristics
- Depth
- Tubing and Casing Sizes
- Open-hole or perforated completion
- Straight Hole, Deviated hole, Dog-leg
- Reservoir & Depletion Plan
- Reservoir Type

- Log Recovery Plan
- Surface Facilities
- Separator Pressure
- Surface Flow Line
- Surface Choke
- Location
- Offshore
- Onshore
- Spacing
- Power Sources Available
- Operating Problems
- Emulsions
- Down-hole Temperature
- Operating Problems
- Surface Climate
- Operating Personnel
- Services Available
- Relative Economics
- Initial Capital investment
- Operating Expense
- Artificial Lift Selection Matrix
- Artificial Lift – Application Ranges
- Artificial Lift – System Efficiency
- Artificial Lift – Selection
- Artificial Lift Methods
- Performance Optimisation
- Gas Lift is Preferred For
- Pumping is Preferred For
- Artificial Lift Design Considerations and Overall Comparisons
- Normal Operating Considerations
- Comparison of Artificial Lift
- AL Development Strategies