Delivering integrated upstream oil and gas industry training
## Contents

- Introduction
- Glossary
- Petroleum Chemistry
- A Brief Oil and Gas History
- Some Useful Conversions
- SPE Petroleum Reserves Categorisation
- Esanda Course Offering
Introduction

Esanda is an independent upstream oil and gas consultancy specialising in industry specific training and field development planning services. Our operations are supported by our UK and Australia offices.

Esanda provides upstream professional development training courses, workshops and coaching/mentoring services throughout the world which is delivered by a core team of industry experts, each with over 30 years' experience.

We cover the gamut of upstream industry topics; geology, geophysics, reservoir engineering, drilling, facilities, costing, commercial, financial and accounting.

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**Glossary**

**Abandonment** End of production, plug and abandon wells, dismantle and remove all material and equipment

**Acidising** Treatment of reservoir with hydrochloric or hydrofluoric acid to improve performance

**AFC** Approved For Construction

**AFD** Approved For Design

**AFE** Approved For Expenditure

**AHV** Anchor Handling Vessel

**Alkane** Any of various saturated open-chain hydrocarbons having the general formula \( \text{C}_n \text{H}_{2n+2} \), the most abundant of which is methane (CH4)

**Alkene** Any unsaturated aliphatic hydrocarbon with the general formula \( \text{C}_2 \text{H}_{2n} \) such as ethylene, also known as olefins

**Alluvial** Fan Pattern of sedimentary deposit frequently laid down by streams or rivers which spread out into plains

**Annulus** Space between two concentric objects such as between the wellbore and casing

**Anoxic** Lack or absence of oxygen

**Anticline** An arched shape fold in which rock layers are upwardly convex

**API** American Petroleum Institute

**API gravity** Density measurement for oil. API gravity = \( 141.5 / \text{specific gravity} \) – 131.5

**Aquifer** Water-bearing rock strata

**Aromatics** Relating to an organic compound containing at least one benzene ring (C6 ring) or similar ring-shaped component. Naphthalene and TNT are aromatic compounds. Notable for their distinctive, usually fragrant smell

**Artificial lift** Sucker rod-pumps (nodding donkeys), gas lift, hydraulic pumps, and submersible electric pumps, used to aid the production of oil as reservoir pressure declines

**Asphalt** Solid petroleum residue, similar to bitumen, tar and pitch

**Associated gas** Natural gas which is dissolved in crude oil in the reservoir

**Bar** Unit of pressure

**Bara** bar, absolute pressure

**Barg** bar, gauge pressure

**Barrel** 42 US Gallons

**Bbl** Blue barrel, 42 US Gallons

**bbl/d** barrel of oil per day (see also Mbbl/d and MMbbl/d)

**bbl/MMscf** barrels per million standard cubic feet

**bcf** billion cubic feet (109)

**BH** Bottom Hole

**BHA** Bottom Hole Assembly

**BHP** Bottom Hole Pressure

**Bit** The cutting/boring element used in drilling wells, consisting of a cutting and a circulating element

**Bitumen** Form of heavy, solid petroleum. See Asphalt

**Block** Subdivided areas for the purpose of licensing to a company for exploration or production rights

** Blow down** Process of releasing pressure. Producing a gas cap after oil production has concluded

**Blowout** Uncontrolled release of fluids from the well bore

**Blowout preventer** See BOP

**BOD** Basis Of Design

**BOE** Barrels of Oil Equivalent (6,000 scf of gas equivalent to 1 bbl of oil)

**BOP** Blowout preventer, arrangement of valves and rams installed at wellhead to prevent sudden escape of fluids from reservoir

**Bopd** Barrels of oil per day

**Borehole** Refers to the face of the rock outside or below the casing

**Bottom-hole** Deepest part of a well

**Bottom-Hole Assembly (BHA)** Includes drill bit, drill collars, stabilizers and other drilling components

**Bottom-Hole Pressure (BHP)** Formation pressure at reservoir depth

**Bottom-hole pump** Pump installed in the wellbore, to increase productivity. (Also downhole pump)

**Bpd** Barrels per day

**Bridge plug** Down hole packer assembly used in a well to seal off or isolate a particular formation for testing, acidizing, cementing

**BS&W** Basic Sediment and Water

**Btu** British thermal unit
**Bubble point** The pressure and temperature at which the first bubbles of gas come out of solution

**Bwpd** Barrels of water per day

**Caliper** Tool for checking casing in a well for deformation

**CALM** Catenary Anchor Leg Mooring

**Calorific value** Quantity of heat produced by complete combustion of a unit weight of a material

**Cantilevered jackup** Jackup drilling unit where the drill rig is mounted on two cantilevers – see also Jackup

**CAPEX** Capital expenditure

**Cap rock** Impermeable layer of rock providing a seal to contain the reservoir fluids

**Casing** Steel pipe placed in the well and cemented in place

**Catenary** The natural curve assumed by a chain or cable suspended between two points (e.g. an anchor chain).

**cc** Cubic centimetre (cm³)

**CCR** Central Control Room

**CCS** Carbon Capture and Storage

**Cellar deck** Deck beneath the working floor of a drilling rig or below the main deck of an offshore platform

**Centipoise (cP)** A unit of measurement for viscosity

**Check valve** A non-return valve, allowing flow in only one direction

**Choke** Device incorporating an orifice that is used to control fluid flowrate or downstream system pressure

**Christmas tree (Xmas Tree)** The set of valves, spools, pressure gauges and chokes fitted to the wellhead of a completed well to control production

**Clastic Rock** Rock which has been formed from sediment of other rocks e.g. sandstone, shale, conglomerates, etc.

**Cloud Point** The temperature at which paraffin waxes solidify and give a cloudy appearance to the oil which they form part

**CNG** Compressed Natural Gas

**CO₂** Carbon dioxide

**Concession** Licence, lease, or other permit for exploration and/or production in an area or block

**Condensate** Low density, high API gravity liquid hydrocarbon phase that generally occurs in association with natural gas

**Conductor casing** Generally the first string of casing in a well

**Conductor pipe** A short string of large diameter casing used to keep the wellbore open and prevent it from caving in. It is usually put into the well first

**Coning** At excessive rates the reduction in reservoir pressure may tend to draw up underlying water or overlying gas towards the well in a cone like shape

**Continental Shelf** The area at the edge of a continent from the shoreline to a depth of 200m, where the continental slope begins

**Conventional** A reservoir in which buoyant forces keep hydrocarbons in place below a sealing caprock. Reservoir and fluid characteristics of conventional reservoirs typically permit oil or natural gas to flow freely into wellbores

**Core** A cylindrical sample taken from a formation for geological analysis

**Coring** The process of cutting a vertical, cylindrical sample of the formations

**Cp** Centipoise, a unit of measurement of dynamic viscosity (See Centipoise)

**CPF** Central Processing Facility

**CPU** Central Processing Unit

**CRA** Corrosion Resistant Alloy

**Cretaceous** Rock formed in the last period of the Mesozoic era, between the Jurassic and the Tertiary periods, during which chalk deposits were formed.

**Crude Oil** An unrefined mixture of naturally occurring hydrocarbons

**Cuttings** Small chips of rock retrieved from a well by the circulation of the mud, studied/logged by well-site geologist

**Daisy chaining** Subsea wells connected in series by flowlines

**Darcy** Unit of measurement of rock permeability, the extent to which fluid will flow through it

**DCF** Discount Cash Flow
DCQ Daily Contract Quantity
DCS Distributed Control System
DDCV Deep Draught Caisson Vessel
Dead Oil Oil containing no natural gas
DEG Diethylene glycol
Degasser A separator which removes entrained gases from liquids (oil or water)
Dehydrator Equipment for the removal of water from oil or gas
Dehydration Removal of water from oil or gas to meet an end user specification
Delineation well An appraisal well, drilled to determine the boundary of a discovered reservoir
Density Mass divided by volume, kg/m³, lb/ft³ etc.
Density log Measurement of density, a guide to porosity
Depletion Progressive reduction in reserves as a result of production
Depth map Relief map of sub-surface structure, contours relating to depths from surface datum level, (i.e. sea level)
Derrick A large load-bearing structure, used for drilling
Development well A well drilled to allow production
Deviated well Well diverted from the vertical
Dew point Temperature and pressure condition at which liquids first condense from a gas
Dewpointing Removal of heavier hydrocarbons from a gas stream to meet end user specifications
Diaper Up-thrust intrusion of lower-density rocks through overlying formations, e.g. a salt dome

### Distillation Tower

**Petroleum Fractions**

<table>
<thead>
<tr>
<th>Number of carbons</th>
<th>Boiling point range</th>
<th>Uses</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gases</td>
<td>1–4</td>
<td>0–30°C</td>
</tr>
<tr>
<td>Naphthas</td>
<td>5–10</td>
<td>30–180°C</td>
</tr>
<tr>
<td>Kerosenes</td>
<td>10–16</td>
<td>180–260°C</td>
</tr>
<tr>
<td>Gas oils</td>
<td>16–60</td>
<td>260–350°C</td>
</tr>
<tr>
<td>Lubricants</td>
<td>&gt;60</td>
<td>350–575°C</td>
</tr>
<tr>
<td>Fuel oil</td>
<td>&gt;70</td>
<td>&gt;490°C</td>
</tr>
<tr>
<td>Asphalt</td>
<td>&gt;80</td>
<td>&gt;580°C</td>
</tr>
</tbody>
</table>

Directional drilling Intentional deviation of a wellbore from the vertical
Discovery well A successful wildcat or exploration well
Distillates The products of distillation
Distillation The process of heating and “flashing” or boiling off successive fractions, component hydrocarbon, from a crude oil feedstock, or a product of earlier distillation
Down Hole Down a well
Downstream Generally refers to crude oil refining, petrochemicals, marketing and distribution
Downtime A period when equipment is unserviceable or out of operation for maintenance etc.
DP Dynamic Positioning
Draft The vertical distance between the bottom of a vessel floating in water and the waterline.
Drawdown The difference between the static and the flowing bottom hole pressures
Drawworks The hoisting mechanism in a drilling rig
Drilling fluid Circulating fluid, removes cuttings from wellbore to surface, cools the bit and counteracts downhole formation pressure. See mud
Drilling mud Specially compounded liquid circulated through the wellbore during rotary drilling operations. See mud
Drilling rig Comprises derrick, draw-works, lifting tackles and blocks, Kelly and rotary table, mud pump and mud circulation system, blowout preventer, and a system for handling drillpipe and casing
Drill pipe Heavy, seamless tubing used to rotate the drill bit and circulate the drilling fluid
1. Crown Block
2. Catline Boom and Hoist Line
3. Drilling Line
4. Monkey board
5. Travelling Block
6. Top Drive
7. Derrick or Mast
8. Drill Pipe
9. Doghouse or drillers shack
10. Blowout Preventer
11. Water Tank
12. Electric Cable Tray
13. Engine Generator Sets
14. Fuel Tanks
15. Electrical Control Room
16. Mud Pump
17. Bulk Mud Components Storage
18. Mud Pits
19. Reserve Pits
20. Mud Gas Separator
21. Shale Shakers
22. Choke Manifold
23. Pipe Ramp
24. Pipe Racks
25. Accumulator
Drill Ship

**Drill ship** Self-propelled ship with an offshore drilling unit

**Dry Gas** Natural gas, methane and ethane, with small amounts of heavier hydrocarbon fractions

**Dry Hole** Unsuccessful well, also called a “Duster”, containing no or uncommercial quantities of hydrocarbon

**DST** Drill Stem Test

**DSV** Diving Support Vessel

**Duster** A dry well drilled during exploration. See dry hole

**Dynamic positioning** A satellite monitoring system used to control the action of thrusters/propellers to maintain a vessel on location without deploying anchors

**EDU** Electrical Distribution Unit

**EFL** Electrical Flying Lead

**EH** Electro-Hydraulic

**EHDM** Electro-Hydraulic Distribution Manifold

**E/H MUX** Electro-Hydraulic Multiplexed

**9k,k,mpi** Environmental Impact Assessment

**EIS** Environmental Impact Statement

**Emulsion** Suspension of one liquid in another, e.g. oil in water

**Enhanced oil recovery** Assisted extraction of oil either by installing equipment into the production tubing or by injecting water, gas or steam into the reservoir

**EMP** Environmental Management Plan

**EMS** Environmental Management Study

**EPC** Engineering, Procurement and Construction

**EPIC** Engineering, Procurement, Installation and Construction

**EPU** Electric Power Unit

**ERD** Extended Reach Drilling

**ESP** Electric Submersible Pump

**ESS** Expandable Sand Screen

**EWT** Extended Well Test

**Fault** A break in subsurface strata

**FBHP** Flowing Bottom Hole Pressure

**FEED** Front End Engineering Design, early phase of field development engineering

**FFD** Full Field Development

**Fiscal metering** Measurement of oil, gas or condensate for taxation purposes

**FID** Final Investment Decision

**Fixed installation** A fixed offshore structure involved in the production of oil and gas

**Flare** Vent for burning off unwanted gas or hydrocarbons which due to process upsets cannot be safely retained in process vessels

**Flare stack** Elevated tower containing piping for the discharge and burning of waste gas

**Flash drum** Pressure vessel used to reduce pressure of oils and other liquids to encourage vapourisation of dissolved gases

**Flash** To vaporize or “boil off” a hydrocarbon gas by reducing pressure or heating

**Flash Point** Lowest temperature at which a vapour will burn when ignited.

**FLNG** Floating Liquefied Natural Gas Facility

**Floater** Floating substructure for drilling or production

**Flowing Bottom Hole Pressure** Bottom hole pressure (reservoir) measured at a given flow rate.

**hxFlowline** Pipe from the Xmas tree through which produced fluid travels to a manifold, processing equipment or storage

**Flowline Bundle** A combined assembly of production flowlines, hydraulic and/or electrical control lines

**Flowmeter** Used to measure the rate of flow of a fluid
Formation Reservoir rock
Formation Damage Reservoir damage due to plugging with mud, crumbling under pressure or high flow rate, etc.
FPF Floating Production Facility
FPP Floating Production Platform
FPS Floating Production System
FPSO Floating Production, Storage and Off-loading (vessel)
FPDSO Floating Production, Drilling, Storage and Off-loading (vessel)

Fracturing Fracturing formation adjacent to well bore to improve well productivity (flow) by applying hydraulic pressure downhole
Free-water knockout Removing any water that is not emulsified with the oil, usually in a vessel
FSO Floating Storage and Off-loading (vessel)
FSU Floating Storage Unit
FTP Flowing Tubing Pressure
FWHP Flowing Well Head Pressure
FWHT Flowing Well Head Temperature
FWKO Free Water Knock Out. See free water knockout
Gamma ray log Log of the total natural radioactivity. Shales and clays are responsible for most natural radioactivity, so the gamma ray log often is a good indicator of such rocks
Gas Cap Free gas at the top of a reservoir
Gas Cap Drive Primary production utilising the pressure and expansion of the gas cap to drive the oil to the surface
Gas Chromatography Laboratory method of separating and analysing the components of hydrocarbon mixtures
Gas Column See Oil Column/Gas Column
Gas Condensate Light hydrocarbons in gas which condense into liquid when brought to the surface
Gas Injection Gas is injected if there is no market for it, as a means of recovering condensate in certain reservoirs or until oil production is complete and then gas blowdown (production) can take place
Gas lift Process of lifting liquids from a well by injecting gas into the wellbore to reduce the density of the liquid, i.e. making it lighter
Gas/Oil Ratio (GOR) Ratio of gas to oil in reservoir, scf/bbl
GBS Gravity base structure
GCR Ratio of Gas to condensate in a reservoir, bbl/MMscf
Geochemical Survey Analysis of the hydrocarbon-bearing potential of an area by studying shallow cores and subsurface water for evidence of seepage or kerogens
Geology The study of the history of the earth and its rocks
Geophysicist A Geophysicist in the oil and gas industry usually specialises in the interpretation of seismic survey data
Geothermal Gradient Increase of temperature with depth in the earth’s crust, (Approximately 1 F° per 70 feet).
GI Gas Injection
GIS Geographic Information System
GJ Gigajoules
GLR Gas Liquid Ratio
GOC Gas Oil Contact
GoM Gulf of Mexico
GOR Gas Oil ratio. See Gas oil ratio
GPD Gallons per day
GPH Gallons per hour
GPM Gallons per minute
Grass-Roots Development project which is built from scratch on a green field site
Gravel Pack Unconsolidated formations may require the wellbore in the producing zone to be filled with fine gravel which supports the formation and prevents sand production into the well
Gravimeter Device used to measure the variations in the gravitational field between 2 or more points
Gravity Platform/Structure Offshore platforms which rely on weight alone to keep them stable and in place
Gravity survey  Exploration method measuring the intensity of the earth’s gravity in order to detect geological structures

GRP  Glass Reinforced Plastic

GTL  Gas To Liquid

GWC  Gas Water Contact

H2S, H2S  Hydrogen sulphide, toxic sour gas.

Hawser  Heavy rope for mooring or towing

HAZAN  Hazard analysis

HAZID  Hazards in design analysis

HAZOP  Hazard and operability analysis

Header  Pipe in which several pipes feed fluid into or from

HC  Hydrocarbon

HDPE  High density polyethylene

Heat Exchanger  Process vessel equipment which passes fluid through pipes or plates to heat or cool another fluid (without mixing)

Helipad  Helicopter landing deck or landing area

HFO  Heavy Fuel Oil

HIPPS  High Integrity Pipeline Protection System

Horizon  Formation at a given depth is identified by geological age, e.g. “Middle Jurassic Horizon”

Horizontal Drilling  Wells drilled up to 90° from the vertical, “horizontal”, to the reservoir strata in order to increase well productivity

HPHT  High Pressure High Temperature

HPU  Hydraulic Power Unit

HSE  Health, Safety, Environment

HUC  Hook-Up and Commissioning

Hydrates  Ice like crystals formed of water and methane in well bores or pipelines under certain pressure and temperature conditions. Problematic in that they can cause blockages that prevent continual production

Hydrocarbons  Organic compounds formed of hydrogen and carbon atoms

Hydrocyclone  Separation device utilising centrifugal force to remove oil from water

Hydrofrac  See Fracturing

Hydrophones  Instruments used for detecting and returning sound waves in offshore seismic operations.

Hydrostatic  Pressure/Head pressure exerted by a column of liquid at a given depth

Hydrostatic  Testing Pressure-testing vessels and piping systems with the use of water to a specified pressure

ID  Internal Diameter

IEA  International Energy Agency

Igneous rock  Rock mass formed by solidification of molten material into/onto the earth’s crust e.g. Granite

Impermeable  Rock Rock that will not allow hydrocarbons to flow through it

Inert Gas  Chemically unreactive gas

Infill Drilling  Production wells drilled between existing wells to increase recovery of hydrocarbons.

Injection Well  Well through which water/gas is injected to maintain pressure and improve ‘sweep’ recovery of reserves. Or for the return of gas to the reservoir if it has no market

Injector  See injection well

In Place  Total hydrocarbon content of a reservoir, as distinct from ‘Reserves’ which can be ‘recovered’ or produced

Instrument/Intelligent Pig  Pipeline pig fitted with monitoring/gauging devices to check pipe integrity, wall thickness and or damage

IOC  International Oil Company

IP  Institute of Petroleum

IPE  International Petroleum Exchange

IR  Injection Rate

IRR  Internal Rate of Return

ISO  International Standards Organisation

ITT  Invitation To Tender

Jacket  Steel framework supporting platform topsides

Jack-Up Rig  Drilling rigs/barges which once floated to location raise their legs clear of the water by ‘jacking’ themselves up

JIP  Joint Industry Project

JOA  Joint Operating Agreement

Joint Venture  A common form of risk-sharing in Oil and Gas operations, especially during exploration and production

JT  Joule  Thompson -Change in temperature when gas expands from a high pressure to low pressure, such as across a valve, aids in the cooling and condensation of hydrocarbon liquids from gas

J-tube  Open-ended J section of pipe attached to a jacket structure or to a pipelay vessel providing a means of installation and protection for flexible flow lines and umbilicals

J-T valve  Joule-Thompson valve. Throttle valve using pressure reduction of a gas stream for NGL removal. See JT

Jurassic  Rock formed in the second period of the Mesozoic era, between the Triassic and the Cretaceous periods. (from the French, after the Jura mountains)
JV Joint Venture. See Joint venture
K 103, kilo, thousand (Europe)
Kelly A long square or hexagonal steel bar with a hole drilled through the middle for a fluid path
Kerogen Organic material (originating from phytoplankton and zooplankton) from which oil or gas matures with time through burial, temperature and pressure
Kerosene Liquid mixture consisting mainly of alkane hydrocarbons with boiling points in the range 150° to 300°C, used as aircraft fuel, in domestic heaters, and as a solvent
Kitchen Term for rock rich in organic sediments and in which under the right conditions become a source of hydrocarbons
Kick-Out Drum Tank or vessel used to separate water from oil or liquids from gas
KO Kick Off (deviated well)
kPa kilopascals, measure of pressure
kW Kilowatt, measure of electrical power
LAT Lowest Astronomical Tide
Lay barge Barge used in the construction and placement of underwater pipelines
Licence A right to explore for and/or produce hydrocarbons issued by a Government agency
Lifting Collection of a shipment of crude oil etc. at the point of sale
Lithification The process by which unconsolidated materials are converted into coherent solid rock, by compaction or cementation
Lithology The study of rocks
Live Oil Crude oil containing volatile gases
LNG Liquefied Natural Gas (CH4)

Log Systematic recording of well data
LMRP Lower Marine Riser Package
LPG Liquefied Petroleum Gas, essentially propane and butane
LTS Low Temperature Separator
LWD Logging While Drilling
M Thousand (oilfield), Roman M=1,000, M in metric and some other fields relates to million. Care must be taken to ensure that the value is understood
Magnetic survey Exploration method measuring the changing magnetic intensity in the earth to indicate the existence of hydrocarbon reservoirs
Magnetometer Instrument used to measure magnetic fields
Mat/Mattress A structure placed on poorly consolidated, soft or unstable seabed as a footing for jackup rigs, flowlines and subsea equipment
Maturity Function of burial pressures/temperatures, and time determining whether source of hydrocarbons will provide oil or gas
Maximum exposure Maximum negative cash flow of a project
MBbls Thousand barrels. See M
Mcf Thousand cubic feet. See M
MCM Manifold Control Module
Mcm/d Million cubic metres per day. See M
Md Millidarcies (unit of permeability)
MD Measured Depth (well)
Measurement While Drilling (MWD) The evaluation of physical properties, pressure, temperature and wellbore trajectory in 3D while drilling
MEG Monoethylene glycol
MEOH Methanol
Metamorphic rock Rock formed by mineralogical, chemical and structural alterations caused by processes within the earth's crust. Marble is a metamorphic rock
MFM Multiphase Flow Meter
Midstream Transportation to market or refinery
Migration Movement of hydrocarbons from source rock either into a reservoir or seeping to the earth's surface
Millidarcy See Darcy
Miocene Rocks formed in the fourth epoch of the Tertiary period, between the Oligocene and the Pliocene, see Tertiary
MM Million (oilfield), Roman M=1,000, MM = 1,000*1,000 = 1,000,000, M in metric and some other fields relates to million. Care must be taken to ensure that the value is understood
MMbbl/d Million barrels of oil per day
MMboe Million barrels of oil equivalent. See BOE
MMBTU Million British Thermal Units
MMcf Million cubic feet
MMcf/d Million cubic feet per day
MMSCF Million standard cubic feet
MMSCFD Million standard cubic feet per day
MOD See Money Of the Day
MODU Mobile Offshore Drilling Unit.
Module A self-contained, liftable package forming part of a facility, e.g. accommodation module, compression module, drilling module, etc.
Money of the Day Nominal or current value. This is the money, which as coins, bank notes and cheques, changes hands all over the world in exchange for goods and services. Its purchasing power will change with time
Monopod Small offshore platform, usually resting on a single conductor, usually in shallow water
Moonpool A hole in the hull of a ship through which operation can take place
MSL Mean Sea Level
MSV Multi-Service Vessel
MTD Measured Total Depth
Mud Drilling fluid, mixture of water, or oil distillate, and ‘heavy’ minerals such as bentonite or barites
Mudline The seabed, or bed of any body of water
Multilateral Multiple boreholes drilled from an existing single bore well
Multiphase Fluid consisting of oil, gas and or water
Multiple Completion Well perforated and completed to produce from more than one formation/zone
MWD Measurement While Drilling
N Newton (unit of force)
NACE National Association of Corrosion Engineers (USA)
Napthenics Any of a group of hydrocarbon ring compounds of the general formula, CnH2n, derivatives of cyclopentane and cyclohexane, found in certain petroleums.
Natural Depletion Reservoir production by use of its natural pressure
Natural Gas Natural Gas is primarily methane which can contain some ethane and small quantities of propane, butane, etc. which can be condensed from the natural gas (methane) and are known as Natural Gas Liquids (NGLs)
Neutron log Normally synonymous with a neutron porosity log, however, the term is sometimes broadened to include an activation log. Guide to rock porosity
NGL Natural Gas Liquid, mixture of hydrocarbon liquids which include ethane, propane, butane and pentane condensed from natural gas
NGO Non-Government Organisation
Nodding Donkey The colloquial name for conventional onshore wellhead production beam pumps
NOC National Oil Company
Nominal Money of the day or current value. This is the money, which as coins, bank notes and cheques, changes hands all over the world in exchange for goods and services. Its purchasing power will change with time
NPI Net Profit Interest
NPS Nominal Pipe Size
NPSH Net Pump Suction Head
NPV Net Present Value
Obligation Well Well required to be drilled as part of a concession agreement
OD Outside Diameter
O&G Oil and Gas
Oil and gas separator Production equipment used to separate liquid and gas components as well as water from oil
Oil Column/Gas Column The vertical distance between highest and lowest known oil or gas in a reservoir
Oil/Water Contact The lower end of the column in a reservoir with underlying water
Oligocene Rock formed in the third epoch of the Tertiary period. See Tertiary
Open Hole An uncased section of well borehole.
Operator The company or organisation responsible for conducting operations on a concession
Pig

bullet-shaped, cylindrical or spherical capsules which are inserted into pipeline flow, with the primary purpose of scraping clean wax and other build-ups to prevent blockages.

PI Productivity Index

PDQ Production Drilling and Quarters platform, see also Production Platform/Facility

Perforate Pierce casing wall and cement by using a perforating gun charged with explosives

Phase One of two or more fluids as in a production fluid (i.e. oil, gas or water)

Oil and Gas Separator

OPEX Operating expenditure

Organic Substances derived from living organisms, such as oil in the natural state.

Outcrop The appearance of a rock formation at the surface.

OWC Oil-water contact

P&A Plug and abandon

Paraffin Any member of the Alkane series. See Alkanes

Passive Margin Offshore continental Plates, a tectonic boundary where two plates are moving away from each other

Pay Zone/Horizon A formation containing producible hydrocarbons

Payback The point at which all costs of leasing, exploring, drilling and operating have been recovered from production of a well or wells as defined by contractual agreement

Perforation Holes shot through the casing in the pay zone (producing zone)

Perforating Gun tool loaded with explosive charges which are shot into the pay zone

Permeability The ability of fluid to flow through a rock

Petroleum Literally ‘rock oil’. A complex mixture of naturally occurring hydrocarbons found in rock

Petrochemicals Petrochemicals are chemical feedstocks and intermediates derived from petroleum

Petrology/Petrophysics The study of rocks, their origin, chemical and physical properties and distribution
**Pressure Maintenance** Process of maintaining reservoir pressure during production by water/gas injection

**Pressure Vessel** Vessel built to hold fluids under pressure

**Produced water** Formation water removed from the oil and gas

**Production** Extraction of hydrocarbon reserves

**Production Casing String** Innermost steel lining of a well cemented in place and perforated for production in the pay zone, note the production tubing is inserted inside this casing. (See production tubing string)

**Production Plateau** Period during which field is producing at its maximum production rate

**Production Platform/Facility** Production platforms are of varying types depending on environment (water depth etc. and reservoir needs). The production facility allows the oil and gas to be processed and exported or reinjected as required

**Production Separator** Main process vessel used for the separation of oil, gas and water, see also oil and gas separator

**Production Sharing Contract (PSC)** Contract in which part of the return to the host government is delivered as produced hydrocarbons, which is calculated after deduction of production and other agreed costs

**Production Testing** Production test looks at the capability to produce (productivity) of a well and its effects on the reservoir produced, this may be undertaken prior to final commitment of development expenditures etc.

**Production Tubing String** Pipe installed inside the production casing of a well

**Productive Horizon** A pay zone. See also Horizon

**Productivity Index** (PI) A mathematical means of expressing the ability of a reservoir to deliver fluids to the wellbore

**Proppants** Sand, gravel or other particles or “beads” used in hydraulic fracturing of a formation, the proppant allows fluid to flow by wedging into the fractures/cracks created by fracturing

**PSA** Production Sharing Agreement

**PSC** Production Sharing Contract

**psi** pounds per square inch - pressure

**psia** pounds per square inch, absolute - pressure

**psig** pounds per square inch gauge - pressure

**PUQ** Production Utilities Quarters, see also production platform/Facility

**Qualitative risk assessment** Assessment based on operational experience, engineering standards and judgement

**QRA** Quantitative Risk Assessment – includes calculations to assist with the identification of risks and to determine the frequency, magnitude and consequence of hazardous events

**Raw Gas** Natural gas prior to processing

**Real (Real Terms, RT)** Constant value of money (imaginary money), this was introduced to overcome the varying purchasing power of money of the day, which keeps the purchasing power the same at different moments in time

**Recovery Factor** The ratio between the volumes of oil and/or gas produced and producible from a reservoir and the oil and/or gas originally in place

**Reef** Reservoir, usually limestone which was deposited in marine conditions, usually elongated

**Reservoir** Subsurface porous & permeable rock body in which oil and or gas is stored

**Reservoir Pressure** The pressure at reservoir depth in a shut-in well

**Resistivity log** A log of the resistivity of the formation made by an electrode device such as a laterolog, in this sense the term is used to distinguish the log from an induction measurement, which responds more directly to conductivity

**Rig** Term describing the equipment needed for drilling a well, see also drilling rig

**ROI** Return On Investment

**ROP** Rate Of Penetration (drilling)

**Rotary table** Principal component of rotating, or rotary machine, which turns the drill stem and supports the drilling assembly, see also drilling rig

**ROV** Remotely Operated Vehicle

**RVP** Reid Vapour Pressure
SALM Single Anchor Leg Mooring; a compliant monopod version of the SBM tanker-loading buoy, used in deeper water

Salt dome A dome that is caused by an intrusion of rock salt into overlying sediments

Satellite well Usually a single well drilled offshore to produce from the fringes of a reservoir or adjacent small reservoir

SBM Single Buoy Mooring, a single point buoy mooring for loading and unloading tankers

SBV Standby Vessel

Scf Standard cubic feet

Scf/bbl Standard cubic feet per barrel

Scf/d Standard cubic feet per day

Scf/STb Standard cubic feet per stock tank barrel. See GOR

SCM Subsea Control Module

Scrubber Separator for removing liquids/solids from gas stream

SCS Subsea Control System

SCU Surface Control Unit

Scuff Standard cubic feet

SDU Subsea Distribution Unit

Seal Impermeable fault/stratum of rock beneath or behind which hydrocarbons can accumulate. See also reservoir

Secondary recovery Production of fluids from a reservoir by water/gas injection used for pressure maintenance

Sedimentary rock Rock composed of weathered materials transported by wind or water that have undergone lithification, e.g. sandstone, shale and limestone

Seep Fault or pathway where hydrocarbon migrates to the surface/atmosphere

Seismic survey Exploration method in which strong, low-frequency sound waves are generated on the surface or in the water to find subsurface rock structures that may contain hydrocarbons

Semi-submersible Floating offshore production and or drilling unit, which can include living quarters, storage space, etc. They can be either self-propelled or towed to a site and either anchored or dynamically positioned. Semi submersibles are more stable than drill ships and used extensively to drill wildcat wells in rough waters such as the North Sea

Separator Cylindrical vessel used to separate the components in streams of mixed fluids. See also oil and gas separator

Semi Submersible Drilling Rig

Service contract Duration often fixed, company does not receive any of the oil produced, but gets a fixed fee per barrel, above the reimbursement of the costs it incurs

Service well See injection well

Shale Fine-grained, muddy sedimentary rock with low porosity

Shale shaker Vibrating screen used to remove cuttings from the circulating fluid (mud) in rotary drilling operations

SHEQ Safety, Health, Environment and Quality

Shut-in pressure The pressure in a shut-in, non-flowing well or the static pressure

Shuttle tanker Oil tanker used to transport oil from larger vessels to port

SI System Internationale (International System of Units)

Side-tracked well Well that has been re-drilled from an intermediate depth

Sidewall coring Coring samples taken from the side walls of a well bore using a special tool

Single point mooring system Offshore system to which stabilised oil can be routed and an export tanker can moor for the oil to be offloaded for export

Skid Steel framework used to contain equipment or mount equipment on for transport

Skimmer Equipment for removing the surface layer of oil from an oil spill, or from an effluent water separator tank.

Slop tank Tank for the temporary storage of water that is contaminated with oil

Sonic log A type of acoustic log that displays travel time of P-waves versus depth. Sonic logs are typically recorded by pulling a tool on a wireline up the wellbore. The tool emits a sound wave that travels from the source to the formation and back to a receiver

Sour oil/gas Oil or gas with a relatively high content of sulphur compounds such as hydrogen sulphide
Source rock Sedimentary rock with organic deposits that form into hydrocarbons

SPAR A cylindrical/partially submerged offshore drilling/production platform, well adapted to deepwater

Splash zone The part of an offshore structure that is regularly exposed alternately to atmosphere and water or spray and therefore highly prone to corrosion

Spontaneous potential A log of the natural difference in electrical potential, in millivolts, between an electrode in the borehole and a fixed reference electrode on the surface. The most useful component of this difference is the electrochemical potential since it can cause a significant deflection opposite permeable beds

Spread Any complete set of equipment and ancillary vessels or vehicles for a designated task e.g. diving spread

Spud To begin drilling

SSIV Subsea (safety) isolation valve

SSV Surface safety valve

SSSV Surface controlled subsurface safety valve OR Subsea safety valve

Stab To make a connection by inserting (stabbing) one device into another

Stabilised crude oil Crude oil which has had the volatile gas (at normal surface conditions) removed from it to meet commercial sale specifications. Also known as stock tank oil

Start up Production from a commissioned and tested installation

Steam injection/flooding Used to lower the viscosity of residual/heavy oil in the reservoir and aid it in flowing to the well

STOIIP Stock Tank Oil Initially In Place

STP Standard Temperature and Pressure

Subsea blowout preventer Blowout preventer placed on the seabed for use by a floating offshore drilling rig, see also BOP

Subsea template Template placed on seabed to facilitate drilling of wells, the wells are drilled through the template and completed by mounting the subsea Xmas trees

SUDU Subsea Umbilical Distribution Unit

SUTA Subsea Umbilical Termination Assembly

SUTU Subsea Umbilical Termination Unit

SV Support Vessel

Swab Valve Subsea tree mounted valve used during workover

Sweet Pertaining to crude oil or natural gas lacking appreciable amounts of sulphur or sulphur compounds

Syncline A downward, trough-shaped configuration of folded, stratified rocks. Compare with anticline

Tanker Any mobile storage unit for the bulk transport of crude oil, gas or products

Tar See Asphalt

Tariff Volume-based or tonnage-based rental charge, e.g. pipeline tariff, processing tariff

Tar sands Sands impregnated with oil in the form of asphalt or bitumen which are mined

Tcf Trillion cubic feet

TD Total Depth i.e. the drilled depth in a well at any one time

Tectonics The process of formation and evolution of the earth’s solid surface crust. (See also Plate tectonics.)

TEG TriEthylene Glycol

Template Structural framework where subsea wellheads are grouped

Tension-leg platform A compliant offshore drilling or production platform which resembles a semisubmersible and is attached to the seabed with tensioned steel hawser tubes or tubes. The buoyancy of the platform applies tension to the hawser tubes or tubes

Tertiary Period or rock system divided into Palaeocene, Eocene, Oligocene, Miocene and Pliocene epochs or series

THFP Tubing Head Flowing Pressure

THP Tubing Head Pressure

Tie-in Connecting one pipeline to another or to equipment, also known as tie-back

TLP Tension Leg Platform

Topsides Installation on substructure consisting of the decks, accommodation and process equipment required for production, see also production Platform/Facility
Trap | Rock strata that are arranged so that petroleum accumulates in them
---|---
Trunk lines | Long distance pipelines, as distinct from field, gathering or branch lines
Tubing | Small-diameter pipe that is run into a well to serve as a conduit for the flow of oil and gas to the surface
Tubing head | The tubing head is installed at the wellhead on the production tubing, sealing off the annulus between the casing and the tubing, and carries the connections for production flowlines
Tubing hanger | Incorporated in a tubing head (similar to a casing hanger)
Turnkey contract | Fixed price contract for construction, drilling a well, etc., contractor takes on risk for non-completion
Turret moored | A production turret (a cylindrical buoy) is built into a cavity similar to a moon-pool in a floating ship-shaped production facility, this is connected to the wells by flexible pipelines and then moored in place, the ship/facility is free to rotate or “weather-vane” around the turret maintaining an optimum profile to wind and sea. The turret can also be externally attached
TUT | Topside Umbilical Termination
TUTU | Topside Umbilical Termination Unit
TVD | True Vertical Depth; the vertical distance below surface datum reached by a deviated well
TVDSS | True Vertical Depth Subsea

Uillage | Unused/available storage in a tanker, pipeline or plant
Unconventional | Currently refers to oil and gas resources whose porosity, permeability, fluid trapping mechanism, or other characteristics differ from conventional sandstone and carbonate reservoirs. Coalbed methane, gas hydrates, shale gas, fractured reservoirs, and tight gas sands are considered unconventional resources
Upstream | Exploration, development and production
USG | United States Gallons
UTA | Umbilical Termination Assembly
UTM | Universal Transverse Mercator. A worldwide grid system of rectangular coordinates that uses metric (SI) units
Vapour pressure | The pressure exerted by the vapour of a substance, and also the pressure required to prevent a liquid from vaporising
Vent | Pipe/fitting on a vessel that can be opened to atmosphere
Vent stack | Open pipe and framework for discharging vapours into the atmosphere at a safe location without combustion
VFD | Variable Frequency Drive
Viscosity | Property of fluids/slurries indicating their resistance to flow, defined as the ratio of shear stress to shear rate
VIV | Vortex Induced Vibration
VLCC | Very Large Crude Carrier
VOC | Volatile Organic Compounds
Volatility | Readiness with which a liquid converts to its gas state
VP | Vapour Pressure
VSD | Variable Speed Drive
WAAC | Weighted Average Cost of Capital
WAP | Wax Appearance Point
WAT | Wax Appearance Temperature
Water drive | Hydrocarbon reservoir in contact with underlying water table, the formation pressure will drive the water into the rock pores vacated by produced oil, thus maintaining reservoir pressure and aiding production
Watering out | When the proportion of water in production from a well is so high that it must be shut in (up to 95%)
Water injection | The injection of water in order to maintain reservoir pressure and boost production
Water re-injection: Disposal of produced water into a disposal well as opposed to dumping to the environment (not for boosting the reservoir pressure).

Water saturation: Proportion of water in the pore spaces of a reservoir. See Porosity.

Water separation: Removal of water from oil or gas, techniques available are e.g. settling (gravity), heating and electrostatic precipitation (especially for breaking water-oil emulsions).

Water table: The level in the earth below which rock pores are saturated with water.

Wax: Paraffin waxes are found in crude oil, sometimes making up a significant proportion of it and require special treatment to allow the oil to flow freely at surface conditions.

WD: Water Depth.

Weather window: Period of relatively good weather when operations can take place.

Well: Steel-lined boreholes drilled to search for, exploit and produce hydrocarbon reservoirs.

Well completion: Preparing a well for the production of oil and gas.

Wellhead: The "Wellhead" is descriptive of a location or function (including the Xmas tree and hang offs) rather than a specific item of equipment. Permanent equipment used to secure and seal the casings and production tubing and to provide a mounting for the Xmas tree.

Wellhead platform: Offshore platform designed to support only wellheads (including Xmas trees) and associated piping, production fluids are then transferred to a nearby production platform or onshore for processing.

Wellhead separator: The first process vessel in a production operation, operating at or near wellhead pressures.

Well logging: Recording of information of subsurface formations. Logging includes records kept by the driller and records of mud and cutting analyses, core analyses, drill stem tests, and electric, acoustic and radioactivity logging.

Well permit: Regulatory permission to drill a well.

Well program: The engineering design and technical/operational plan for drilling, completing and testing a well.

Well testing: Testing of an exploration or appraisal well to aid the estimation of reserves in communication with the well and well productivity. Testing in a production well also monitors the effects of cumulative production on the formation.

Wet gas: Natural hydrocarbon gas containing significant amounts of natural gas liquids.

Wet tree: Xmas tree installed on seabed and exposed to water, see also Christmas tree.

WI: Water injection.

Wildcat: Well drilled in an area where no oil or gas production exists. With modern exploration methods and equipment, about one wildcat out of every seven proves productive, but not necessarily economic.

Wireline: Small-diameter metal line used in wireline operations; also called slick line. A system in which a flexible cable and reel is used to lower a log or maintenance equipment into a well, rather than a rigid drill string, offering considerable savings of equipment, manpower and time.

WO: Workover.

Workover: Maintenance job on a well to replace equipment and or stimulate production.

Workover rig: Usually a smaller portable version which can be used on installations which do not have a permanent rig.

WOW: Waiting on weather.

Xmas tree: See Christmas tree.

Zone: Interval between two depths in a well containing reservoir or other distinctive characteristics.

Subsea (Wet) Christmas Tree
## Petroleum Chemistry

<table>
<thead>
<tr>
<th>Normal Paraffins (Alkanes)</th>
<th>Boiling point</th>
<th>Branched-Chain Paraffins (Alkenes)</th>
<th>Boiling point</th>
</tr>
</thead>
<tbody>
<tr>
<td>CH₄ Methane</td>
<td>-161°C</td>
<td>C₄H₁₀ Isobutane</td>
<td>-12°C</td>
</tr>
<tr>
<td>C₂H₆ Ethane</td>
<td>-89°C</td>
<td>C₆H₁₄ 2,2-Dimethylbutane</td>
<td>50°C</td>
</tr>
<tr>
<td>C₃H₈ Propane</td>
<td>-42°C</td>
<td>C₆H₁₄ 2,3-Dimethylbutane</td>
<td>58°C</td>
</tr>
<tr>
<td>C₄H₁₀ Butane</td>
<td>-0.5°C</td>
<td>C₆H₁₄ 2-Methylpentane</td>
<td>60°C</td>
</tr>
<tr>
<td>C₅H₁₂ Pentane</td>
<td>36°C</td>
<td>C₇H₁₆ 2-Methylhexane (Isoalkane)</td>
<td>90°C</td>
</tr>
<tr>
<td>C₆H₁₄ Hexane</td>
<td>69°C</td>
<td>C₇H₁₆ 3-Methylhexane (Anteisoalkane)</td>
<td>92°C</td>
</tr>
<tr>
<td>C₇H₁₄ Heptane</td>
<td>98°C</td>
<td>C₈H₁₈ 2,2,4-Trimethylpentane (Iso-octane)</td>
<td>99°C</td>
</tr>
</tbody>
</table>
## Petroleum Chemistry

<table>
<thead>
<tr>
<th>Napthenes (Cycloparaffins)</th>
<th>Boiling point</th>
<th>Aromatics</th>
<th>Boiling point</th>
</tr>
</thead>
<tbody>
<tr>
<td>$C_6H_{12}$ Methylcyclopentane</td>
<td>72°C</td>
<td>$C_6H_6$ Benzene</td>
<td>80°C</td>
</tr>
<tr>
<td>$C_6H_{12}$ Cyclohexane (Side View)</td>
<td>81°C</td>
<td>$C_7H_8$ Toluene</td>
<td>111°C</td>
</tr>
<tr>
<td>$C_8H_{16}$ Ethylcyclohexane</td>
<td>132°C</td>
<td>$C_8H_{10}$ Paraxylene</td>
<td>138°C</td>
</tr>
<tr>
<td>$C_9H_{18}$ 1,1,3-Trimethylcyclohexane</td>
<td>137°C</td>
<td>$C_{10}H_{12}$ Isopropylbenzene</td>
<td>152°C</td>
</tr>
<tr>
<td>$C_{10}H_{18}$ Decalin</td>
<td>187°C</td>
<td>$C_{20}H_{12}$ 3,4-Benzpyrene</td>
<td>&gt;500°C</td>
</tr>
</tbody>
</table>
## Gas and Gas Condensate Categories

| Gas Category               | Compositions   | Temperature
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Water</td>
<td></td>
<td>Impurities</td>
</tr>
<tr>
<td>CO₂ &amp; H₂S</td>
<td></td>
<td>LNG @ ~ 161°C</td>
</tr>
<tr>
<td>Nitrogen</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Methane</td>
<td>Natural Gas</td>
<td>C1</td>
</tr>
<tr>
<td>Ethane</td>
<td></td>
<td>C2</td>
</tr>
<tr>
<td>Propane</td>
<td></td>
<td>C3</td>
</tr>
<tr>
<td>Butane</td>
<td></td>
<td>C4</td>
</tr>
<tr>
<td>Pentane, Hexane, Etc</td>
<td></td>
<td>C5+</td>
</tr>
</tbody>
</table>

Impurities -> LNG @ ~ 161°C -> LPG -> NGLs
A Brief History of Oil and Gas

40,000 BC Natural bitumen found on stone tools from Neanderthal sites in Syria
5,000 BC Ancient Egyptians use bitumen to create their mummies – mumiyah Arabic for bitumen
2,000 BC Herodotus claims that asphalt was used in the tower of Babylon with bitumen recovered from the banks of local rivers
600 BC Ancient Greeks observe the “eternal fires” in Absheron peninsula (in modern Azerbaijan)
350 AD Chinese use bamboo drill strings to drill oil wells up to 300 m
1,000 Arabic geographer, Al-Mas’udi observes oil seeps in southern Europe and the Middle East. He dubs the Absheron peninsula bilad al-naffata (the land of the naphtha fountain)
1,000 15,000 inhabitants of Baku mostly involved in the extraction and export of oil. A primitive industry with hand dug wells at natural seeps collected in simple containers. Persian chemists facilitated the extraction by the technological breakthrough of distillation of the crude to separate Kerosene. Such technology was not available to Western Europe until 1200 AD
1,200 Oil production in Azerbaijan reaches almost 100 bbl/day creating an export market for oil
1,632 Natural oil springs found in New York
1750s Industrial revolution takes hold and powered by coal
1753 Seneca Indian trading oil seep products
1790 Nathanial Carey skims oil from seeps near Titusville, Pennsylvania
1846 Abraham Gessner develops process to refine liquid fuel from coal, bitumen and shale – kerosene. A cleaner and cheaper alternative to whale oil
1848 Well drilled to 21m at Bibi-Heybat in Azerbaijan
1853 Ignacy Lukasiewicz invents the modern kerosene lamp, a boon for the modern oil industry
1855 Ignacy Lukasiewicz opens first industrial refinery in the world in Ulaszowice
1859 Colonel Drake drills the first oil well for George Bissell’s Rock Oil Company and strikes oil on August 27 at a depth of 21m at Oil Creek where there were natural oil seeps. This was one of the first rotary drilled wells. The phrase Creekology referring to the exploration methods of the day, basically looking for and following oil seeps in creeks
1861-1865 American Civil War. 1 Modern barrel of oil is equivalent to around 23,000 human energy slave hours
1865 Civil war is over and oil costs 59 cents per gallon
1870 John D Rockefeller sets up Standard Oil. Kerosene costs 26 cents per gallon
1873 Nobel brothers enter Baku and are in the Russian oil business
1877 Whaling industry is in disarray
1878 Thomas Edison invents the incandescent light bulb, now the oil industry is in disarray
1890 Royal Dutch was formed by Henri Deterding and Jean Baptist August Kessler to focus on the Dutch East Indies
1892 Samuel Samuels, of Shell fame, commissions the Murex, the world’s first oil tanker
1895 Oil is 7 cents a gallon
1896 First known offshore (saltwater) oil well is drilled at the end of a 300 ft wharf in Summerland, California
1896 Model T Ford is put into production and due to its popularity creates a new dawn in the oil industry
1900 In the United States there were 8,000 registered automobiles, by 1920 there were 8,500,000
1901 Jan10 Spindletop drilled to a depth of 347m produces a gusher of 100,000 bpd
1901 William Knox D’Arcy acquires a Persian concession
1907 Shell Transport and Trading Company and The Royal Dutch Petroleum Company merge to create Royal Dutch Shell
1908 Oil discovered in Persia leading to the creation of Anglo-Persian, later to become BP
1911 Standard Oil ordered to be broken up into 34 smaller companies under the Sherman Antitrust Act
1914 Oil asserts itself for the allies and in the mechanisation of the battlefield. The shortfall in German supplies hindered their war efforts
1922 Venezuela - Los Barroso discovered
1929 Onset of the Great Depression
1932 Oil discovered in Bahrain
1932-1933 Anglo-Iranian concession cancelled
1933 Standard of California (SOCAL, now known as Chevron) wins concession in Saudi Arabia
1938 Oil discovered in Saudi Arabia and Kuwait
1939 World War II
1940 United States limits oil supplies to Japan
1941 United States embargoes oil to Japan. Japan attacks Pearl Harbour
1945 WWII ends Germany and Japan basically run out of fuel
1951 Iranians nationalise Anglo Iranian – First post-war oil crisis
1956 Suez crisis – Second post-war oil crisis
1956 Nigeria and Algeria discover oil
1958 Iraqi revolution
1959 Groningen natural gas field discovered and developed in the Netherlands.
1960 OPEC is founded
1967 Six Day war, closes Suez Canal – Third post-war oil crisis
1968 Alaskan North Slope, oil is discovered
1968 Ba’athists seize Iraqi power
1969 Gaddafi seizes power in Libya
1969 North Sea oil discovered
1969 Santa Barbara oil spill
1973 Yom Kippur War – Fourth post-war oil crisis. Oil rises from $2.90 to $11.65 in 3 months.
1974 International Energy Agency (IEA) founded
1975 First oil production from North Sea fields
1975 Saudi, Kuwaiti and Venezuelan concessions come to an end
1977 Alaskan North Slope oil comes to market
1979 Three Mile Island nuclear plant accident
1979 – 1981 Iranian hostage crisis. Oil rises from $13 to $34 – Fifth post-war oil crisis
1980 Iraq goes to war with Iran
1982 OPEC quotas
1983 OPEC cuts price to $29/bbl
1983 Crude oil futures floated on NYMEX
1986 Oil price collapse
1986 Chernobyl (USSR) nuclear accident
1988 Iraq Iran war ends
1989 Exxon Valdez tanker oil spill
1990 Iraq invades Kuwait – Sixth post-war oil crisis
1998 Oil price $10/bbl
1998 Piper Alpha oil rig disaster, 167 oil rig workers died
2003 Iraq war
2007 Oil price $147/bbl
2010 Deepwater Horizon oil spill, 11 fatalities, 16,000 miles of coastline affected and over 8,000 animals reported dead
2016 Oil price drops below $30/bbl

A Brief History of Oil and Gas References

1. Penn Museum website - www.penn.museum
2. The View from the Mountain, grandemotte.wordpress.com
3. Anglopolish.com
5. The Prize – Daniel Yergin

Useful Conversions

<table>
<thead>
<tr>
<th>Volume</th>
</tr>
</thead>
<tbody>
<tr>
<td>Barrel of Oil (bbl) = ~42 US Gallons</td>
</tr>
<tr>
<td>= ~ 159 litres</td>
</tr>
<tr>
<td>= ~ 0.159 m³</td>
</tr>
<tr>
<td>= ~ 0.136 Tonnes of oil equivalent (toe)</td>
</tr>
<tr>
<td>= ~ 5,660 SCF natural gas</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Energy</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tonne of oil equivalent = ~ 10,000,000 Btu</td>
</tr>
<tr>
<td>SCF natural gas = ~ 1,025 Btu</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Natural Gas</th>
</tr>
</thead>
<tbody>
<tr>
<td>Essentially &gt;90% Methane</td>
</tr>
<tr>
<td>Calorific Value – 1,000 Btu/SCF</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Conversion of Gas to Liquid Products</th>
</tr>
</thead>
<tbody>
<tr>
<td>100 MMSCFD = ~ 730,000 tonnes/y of LNG</td>
</tr>
<tr>
<td>= ~ 2,100 t/d of LNG</td>
</tr>
<tr>
<td>1 million tonnes LNG = ~ 2.2 million m³ LNG</td>
</tr>
<tr>
<td>= ~ 140 MMSCFD gas</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Conversion of Gas to Energy</th>
</tr>
</thead>
<tbody>
<tr>
<td>100 MMSCFD = ~ 4,200 MBtu/h</td>
</tr>
</tbody>
</table>
The Oil and Gas Window

<table>
<thead>
<tr>
<th>Oil/Gas Window</th>
<th>Depth (km)</th>
<th>Temp(°C)</th>
<th>Spore Colour Index</th>
<th>Vitrinite Reflection</th>
<th>Subsurface Process</th>
</tr>
</thead>
<tbody>
<tr>
<td>Kerogen</td>
<td>1</td>
<td>30</td>
<td>2</td>
<td>1</td>
<td>Immature (small quantities of early methane, biogenic)</td>
</tr>
<tr>
<td></td>
<td>2</td>
<td>60</td>
<td>4</td>
<td>0.5</td>
<td>Initial maturity (zone of oil generation)</td>
</tr>
<tr>
<td></td>
<td>3</td>
<td>90</td>
<td>5</td>
<td>1.2</td>
<td></td>
</tr>
<tr>
<td></td>
<td>4</td>
<td>120</td>
<td>6</td>
<td>2.0</td>
<td>Condensate/Wet gas</td>
</tr>
<tr>
<td></td>
<td>5</td>
<td>150</td>
<td>8</td>
<td>5.0</td>
<td>High temperature methane</td>
</tr>
<tr>
<td></td>
<td>6</td>
<td>250</td>
<td>10</td>
<td></td>
<td>Metamorphic</td>
</tr>
</tbody>
</table>

Diagenesis
Katagenesis
Metagenesis
Metamorphic

Selected Energy Densities

*Energy density* by Scott Dial - Own work Data Source: Energy density, Lithium-ion battery. Licensed under Public Domain via Commons https://commons.wikimedia.org/wiki/File:Energy_density.svg#/media/File:Energy_density.svg
SPE Reserves Categorisation

“The estimation of petroleum resource quantities involved the interpretation of volumes and values that have an inherent degree of uncertainty. These quantities are associated with development projects at various stages of design and implementation. Use of a consistent classification system enhances comparisons between projects, groups of projects, and total company portfolios according to forecast production profiles and recoveries. Such a system must consider both technical and commercial factors that impact the project’s economic feasibility, its productive life and its related cash flows.”

Source: SPE - Petroleum Resource Management System

Reserves are Like Fish Analogy

**Proved Developed:** The fish is in the boat. You have weighed him. You can smell him and you will eat him.

**Proved Undeveloped:** The fish is on your hook in the water by the boat and you are ready to net him. You can tell how big he looks (they always look bigger in the water).

**Probable:** There are fish in the lake. You may have caught some yesterday. You may even be able to see them, but you have not caught any today.

**Possible:** There is water in the lake. Someone may have told you there are fish in the lake. You have your boat on the trailer but you may go play golf instead.

However, these humorous definitions do not recognize the impact of the price of fish.
Esanda Training
Course List

For open course dates and locations visit
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info@esandaengineering.com
to discuss your specific in-house training
and development requirements
Introductory and Cross Discipline
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Fundamentals of Oil and Gas Exploration and Production
Unconventional Oil and Gas Developments Overview
Fundamentals of LNG and the Value Chain
Oil and Gas Overview
Upstream Familiarisation for Administration Staff
Introduction to Hydrocarbons - An overview of Oil and Gas
Introduction to Petroleum Engineering

Economics, Financial, Commercial & Accounting
A View of Where the Oil and Gas Industry is Heading
Designing a Corporate Strategy and Assessing It’s Effectiveness
Introduction to International Petroleum Economics
Petroleum Economics
Petroleum Economics and Risk Analysis
Decision Making in the Upstream Oil and Gas Sector
Establishing International Joint Venture and Strategic Alliances in the Oil & Gas Industry
Upstream Oil and Gas Production Forecasting and Economics
New Ventures Management
International Oil & Gas Joint Operating and Profit Sharing Agreements
Accounting in the Oil and Gas Industry – Introduction
Accounting in the Oil and Gas Industry – Intermediate
Accounting in the Oil and Gas Industry – Advanced
Accounting in the International Oil and Gas Industry
Accounting Workshop
Financial Management in the Oil and Gas Industry
Financial Statements & Methods of Payment
Letter of Credit Opening Methods
Design and Implementation of Computerised Financial Systems
Accounting for Upstream Energy & Joint Ventures
Authorisation for Expenditures
Well Costing AFE Development
Budgeting Process for E & P Companies
Capital Expenditure and AFE Controls - Intermediate
Managing in the Current Oil Price Environment
Oil and Gas Contracts and Negotiations

Petroleum Project Analysis and Economics - Advanced
Risk Analysis, Prospect Evaluation and Exploration Economics
Upstream E&P Accounting Intermediate
Well Costing and Cost Control - Advanced

Costing
Upstream Oil and Gas Development Lifecycle Costing
Cost Engineering
IHS QUESTOR Oil and Gas Cost Analysis – IHS Specialist Course
Strategic Opex Management

Geology
Fundamentals of Stratigraphy and Sedimentology
Fundamentals of Global Tectonics
Fundamentals of Petroleum Geology (with and without Field Trips)
Basin Evaluation
Practical Techniques of Geological Modelling: A Geostatistical Approach
Advanced Structural Geology in the Field
Basic Geoscience
Basic Geodynamics
Mapping Techniques
Basic Field Geology
Clastic Sedimentology and Facies Analysis
Carbonate Sedimentology and Facies Analysis
Foredeep Migration
Basin Analysis Workshop: An Integrated Approach
Production Geology
Sequence Stratigraphy
Petroleum System Modelling
Operations Geology
Introduction to Dataset Evaluation and Regional Interpretation
Play Fairway Analysis
Prospect Generation and Risk Analysis
GIS and GPS Data Visualisation and Input
Multidisciplinary Approach in the Field - Walking along a crustal profile across the Sicily Fold and Thrust Belt
Basic Geology - Northern Apennines - Stratigraphy & Tectonics
A complex intertwining of palaeographic domains and multiple thrust belts across the Southern Apennines
Deformed Foreland Basins: Migration of Apenninic Foredeep Through Space and Time
Well Site Geology
Applied Biostratigraphy for Petroleum Systems
Applied Stratigraphic Concepts
Carbonate Reservoirs
Clastic Sedimentology
Geodynamics and Structural Styles in Exploration
Reservoir Characterisation
Petroleum Exploration
Petroleum Geology
Petroleum Geology, Exploration, Risking and Economics
Play Assessment and Prospect Evaluation
Structural Geology

Geophysics
Introduction to Petroleum Geophysics
Fundamentals of Petroleum Geophysics
Seismic Interpretation and Petroleum Geology
AVO and Seismic Inversion
Seismic Introduction
Seismic Interpretation
Seismic Acquisition and Processing
Seismic Interpretation - Practical
Potential Field and SCEM applied to Hydrocarbon Exploration
Seismic Interpretation on Workstation
Integrated Seismic Interpretation in the Field
Mapping and Depth Conversion
Fundamentals of Seismic Interpretation
Cased Hole Logging and Formation Evaluation
Reflection Seismic Survey

Petrophysics
Introduction to Petrophysics
Sedimentary Petrology
Rock Lab - Thin Sections
Capillarity in Rocks
Open Hole Log Interpretation
Special Core Analysis (SCAL)
Formation Evaluation by Means of Log Analysis
Well Log and Mud Log Analysis
Mud Logging
Basic Well Log Interpretation
Well Log Interpretation
Cased Hole Logging & Production Log Evaluation
Fundamentals of Applied Petrophysics

Advanced Petrophysics
Introduction to Formation Evaluation
Cased Hole Formation Evaluation - Advanced
Facies Analysis and Rock Typing
Pore Pressure and Well Control
Log Analysis Fundamentals
Shaly-Sand Petrophysics
Formation Evaluation and Log Analysis
Nuclear Magnetic Resonance Petrophysics (NMRP)
Pore Pressure Prediction
Integration of Petrophysics and Core Analysis

Reservoir Engineering
Basic Reservoir Engineering for Production operations
Staff
Fundamentals of Reservoir Engineering
Reservoir Management
Reservoir Simulation
Reservoir Model Design
Enhanced Oil Recovery
Artificial Lift – Well Optimization and Diagnostics
IOR with emulsified polymers
EOR with gas lift
Applied Reservoir Engineering
Integrated Reservoir Engineering
PVT
Reservoir Appraisal & Development
Artificial Lift Methods
Well Performance (NODAL) Analysis
Introduction to Integrated Production Modelling,
Unconventional Integrated Asset modelling
Advanced Integrated Asset Modelling
Practical Reservoir Simulation, history matching best practices
PVT and EOS modelling workshop
Advanced Wellbore modelling
Effective Use of Relative Permeability Data
Digital Field Setup & Management
Reserves Estimation
Field Development Planning

Field Development Planning
Field Development Planning
Facilities Field Development Planning
Marginal Fields’ Development Strategies
Drilling & Well Engineering
Wellhead Operations
Well Testing Operations
Well Production Control and Management
Well Servicing
Directional Drilling, Horizontal and Side-tracking
Introduction to Drilling & Completions Operations
Drilling Fluids
Advanced Drilling Technology
Primary Cementing
Fishing Operations
Drilling Methods and Equipment
Well Equipment (Casing, Tubing, Wellhead)
Pumps (Rig/mud pumps, cementing units)
Drilling Calculations
Stuck Pipe Prevention
Casing Cementing - Current Leading Practice and New Techniques
Directional Drilling
Drilling Fluids and Solids control
Fundamentals of Well Control
Advanced Hydraulic Fracturing
Advanced Stimulation
Stimulation & Sand Management
Well Test Design & Analysis
Hydraulic Fracturing for Shale Oil & Gas
Hydraulic Fracture Design and Analysis with 3D Simulators
Completions Design for FDP
Formation Damage Prevention, Remediation, and Control
Matrix and Fracture Acidizing
Horizontal Well Completions and Fracturing
Advanced Well Cementing
Practical Well Test Interpretation
Advanced Well Test Interpretation
Production Logging Tools
Asphaltene, Paraffin, and Scale Control
Coil Tubing (CTU) Operations
Nitrogen Engineering for O&G Operations
Advanced Sand Control
Advanced Hydraulic Fracturing with 3D Models
Advanced Well Completions
Damage Control - The Neglected Part of Drilling and Operating Safely
HPHT Drilling Operations
Offshore and Deepwater Drilling Operations
Pore Pressure and Fracture Gradient Prediction
Well Control and Associated Surface Equipment
Well Stimulation: Matrix and Fracture Acidising

Oil and Gas Processing and Facilities Engineering
Oil and Gas Facilities Fundamentals: Onshore, Offshore, FPSO and Subsea
Offshore Facilities Fundamentals, Offshore, FPSO and Subsea
FPSO Fundamentals
Subsea Facilities Fundamentals
Gas Production, Transmission and Storage Overview
Oil Processing
Gas Processing
Production Facilities - Design Engineering
Production Facilities - Process Engineering
Process and Project Drawings - PDFs, P&IDs and Mechanical Drawings
Understanding P&IDs
Process Plant Fundamentals
Surface Production Operations
Plant Shutdown, Commissioning and Start-up
Relief Systems
Flare, Blowdown and Pressure Relief Systems
Heat Exchangers
Oil and Gas Process Troubleshooting
Xmas Tree Inspection, Maintenance and Pressure Testing
Water Treatment and Disposal
Chemical Injection - Oil and Gas Process
Applied Water Technology in Oil and Gas Production
Corrosion Management in Production/Processing Operation
FSRU Project Development and Operation
Gas Processing and Conditioning
Means of Personnel Transfer
Oil Production and Processing Facilities
Onshore Pipelines Design and Construction
Tanker Familiarisation

Health, Safety and Environment
Xmas Tree and Wellhead Safety
Oil and Gas Field - Internal Audit
Introduction to Process Safety
Introduction to HSSE Case
Process Safety Management Techniques
HSE in the Workplace
HSE in Drilling and Workover
Safety Audit and Hazards Identification
Accident and Incident Investigation, Reporting and Management
Behavioural Based Safety
HSE in Construction
Environmental Awareness and EMS Overview
Permit to Work (Control of Work/Safe Systems of Work
Hazardous Substances in the Workplace
Introduction to Emergency Management
Health & Safety Representative – Offshore Oil and Gas
Safe Supervisory Skills
HSSE Basics
Introduction to Safety Case

Project Management and Operations
Plant Readiness Program
Faultless Start-up
Commissioning and Start-up
Troubleshooting and Process Operations
The Turnover and completions program
Project Management for Suppliers
Achieving Operational Readiness
Scoping Systems and Subsystems for Start-up
Project Management in the Upstream Oil and Gas Industry
Maintenance Management
Shutdown Planning and Optimisation
CMMS (Computerised Management Maintenance Systems) Set Up
Major Emergency Management
Oilfield Operations Overview
Asset Integrity Management
Risk Management
Hazard Awareness and Risk Assessment
Bow-Ties, Barriers and Major Accident Events Accredited by the Intl. Association of Drilling Contractors (2 day short format, 3 day long format)
Advanced Energy Project Management

Enterprise Risk Management for the Energy Industry
Tripod Beta Accident Investigation Course
PMP Exam preparation
Information Security Strategy & How to Build It
Introduction to Data Management

Soft Skills
Supervisory Skills
Crisis Management
Leadership Skills for Supervisors
Workplace Communications
Internal Communications
Communication, Presentation and Persuasion Skills for Engineers and Technical Professionals
Presentation Skills
Leadership and Management
Team Building
Web and Intranet Writing
Crisis Communication
Writing and Presentation Skills for Engineers and Technical Staff

Downstream
Introduction to the Downstream Petroleum Industry
Introduction to the Petrochemicals Industry
Introduction to Petroleum Refinery Processing
Introduction to Condensate Fractionation Plant
Basic Principles of Catalytic Reforming Process, Chemical Reactions and Thermodynamics
Catalyst Reforming Parameters
Catalytic Reforming Plant Design
Fundamentals of Petroleum Refinery Equipment Process Design
Gasoline and Diesel Blending for Refiners and Traders
Storage Tanks
Pumps - Design, Application and Operation
Refinery Piping
Economic Fundamentals of the Petroleum Industry and Refinery
Water Treatment for Refining and Petrochemical Operations
Environmental, Health, and Safety Guidelines for Petroleum Refineries
Crude Oil Shipping and Tankers
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Field Development Planning
Drilling & Well Engineering
Oil and Gas Processing and Facilities Engineering
Health, Safety and Environment
Project Management and Operations
Soft Skills
Downstream