DOWNLOAD PDF DRILLING OIL AND GAS FIELD DEVELOPMENT TECHNIQUES

Chapter 1 : Development Process for Oil and Gas Production

This book describes the main areas of technology that are directly or indirectly related to drilling boreholes, especially wells that are designed to produce oil. The reader will find a discussion of the concepts that are indispensable in scheduling and designing boreholes, along with the relevant equipment.

Arunkumar Ranganathan Infosys Increased use of machine learning technology is driving growth in artificial intelligence AI adoption. Oil and gas is one of the key industries expected to reap rewards from AI, though adoption is slow compared to other sectors. The energy exploration sector is acutely aware of the need to identify new assets for exploration while increasing production at existing oil and gas fields. Crucially, companies must ensure the safety of personnel on sites and protect the environment at all times. Increasingly, manual processes are proving unsuitable in the field, but advanced technology solutions such as AI can support growth and eliminate health and safety issues to a large extent. Oil is found in the minds of men Risky as it may be, successful exploration requires a combination of visionary theory, technical innovation and commitment â€" and a bit of luck to be in the right place at the right time. Geoscientists have the knowledge and experience to locate reserves. As resources become more scarce, AI systems hold the key to pinpointing new drilling sites. Geoscientists retain a wealth of information and asset knowledge but transferring this expertise to the wider organization, and the industry, is ineffective. AI systems play a crucial role in enabling scientists and engineers to remain productive irrespective of their experience. AI offers a robust data interpretation process that can assist with critical knowledge transfer and decision making. It enables higher productivity and creates opportunities for advancement. While AI has been in use in the upstream lifecycle over the last two decades, there remains a skeptical belief amongst traditionalists that there is no better substitute for the human brain. Regardless of the business maturity level, AI systems have the ability to automate and optimize data-rich processes. They eliminate duplication of effort and mitigate business risks. As a result, they enhance productivity and minimise the cost of operation. Organizations that have reengineered their strategy and operational models to include AI elements have seen a positive business transform across the enterprise. Use of AI systems will remove redundancy, reducing the cost per barrel. For example, seismic processing requires the design of various data filtering techniques to enhance signal to noise ratio. These are used in both forward and inverse modeling. By adjusting the parameters within the learning sets and iterative routines, geoscientists can quickly eliminate repeatable procedures and apply this to real-time data for faster feedback. Establishing processing parameters is an iterative process that improves accuracy. Geological modeling that relies on data alone is meaningless unless the geologist can apply their knowledge to refine the model. For example, the Kriging method is used to interpolate geological models between wells, which helps to refine the process by analyzing additional data input such as seismic lines, well log data, core and cuttings data. The use of AI techniques helps ensure the process is repeatable in a consistent fashion, as well as enabling the automation of the actual physical task, freeing up staff resource. It also helps preserve the integrity of the analysis even if the geoscientist fails to acquire data in new wells. Once the foundation is set, fuzzy logic systems can then be applied to support petroleum engineering processes including petrophysics, reservoir characterization, enhanced recovery, infill drilling and well simulation. Eliminate costly risks in drilling Drilling is a highly expensive and risky investment. Applying AI in the operational planning and execution stages significantly improves the success rate across the various stages of drilling including: Additionally, geoscientists can better assess variables such as the rate of penetration ROP improvement, well integrity, operational troubleshooting, drilling equipment condition recognition, real-time drilling risk recognition, and procedural decision making. AI techniques can also be applied in other activities such as reservoir characterization, modeling and field surveillance. Fuzzy logic, artificial neural networks and expert systems are used extensively across the industry to accurately characterize reservoirs in order to attain optimum production level. However, there is still a lot of scope to develop new techniques to optimize field development and production costs, prolong field life and increase the recovery factor. Gaining popularity AI techniques are most commonly applied in processing and interpreting well log data. In determining the parameters for multi-well processes, facies analysis is performed using quality reservoir data according to the number of wells covering the entire reservoir section. This process involves patter recognition, semi-supervised clustering and grouping. The data interpretation highlights important geological features such as faults, folds, unconformity and boundaries. This information provided by the AI system is crucial because geoscientists sometimes fail to acquire this critical insight due to poor well conditions and other external factors. AI techniques enable field experts to automate the system using available data to generate pseudo open whole logs in new wells, either using the Monte Carlo method or case hole logs. Training the system and feeding in well data will enable geoscientists to obtain more accurate log systems. The use of AI in the oil and gas industry is gaining popularity but overall adoption remains relatively low compared to other sectors. There are plenty of opportunities to develop AI systems to further optimize, automate and improve business and operational efficiencies. Combined with the use of data analytics, there is much value to be gain in the AI market that industry leaders are yet to explore.

Chapter 2 : Drilling Rig Technologies

Booktopia has Drilling: Oil and Gas Field Development Techniques, Oil and Gas Field Development Techniques by Jean-Paul Nguyen. Buy a discounted Hardcover of Drilling: Oil and Gas Field Development Techniques online from Australia's leading online bookstore.

History[edit] an early oil field exploitation in Pennsylvania, around The earliest known oil wells were drilled in China in CE. By the 10th century, extensive bamboo pipelines connected oil wells with salt springs. The ancient records of China and Japan are said to contain many allusions to the use of natural gas for lighting and heating. Petroleum was known as Burning water in Japan in the 7th century. Through Islamic Spain , distillation became available in Western Europe by the 12th century. These places were described by Marco Polo in the 13th century, who described the output of those oil wells as hundreds of shiploads. When Marco Polo in visited Baku, on the shores of the Caspian Sea, he saw oil being collected from seeps. He wrote that "on the confines toward Geirgine there is a fountain from which oil springs in great abundance, in as much as a hundred shiploads might be taken from it at one time. In , the first modern oil well was drilled on the Absheron Peninsula north-east of Baku, by Russian engineer F. The earliest oil wells in modern times were drilled percussively, by repeatedly raising and dropping a cable tool into the earth. In the 20th century, cable tools were largely replaced with rotary drilling , which could drill boreholes to much greater depths and in less time. Until the s, most oil wells were vertical, although lithological and mechanical imperfections cause most wells to deviate at least slightly from true vertical. However, modern directional drilling technologies allow for strongly deviated wells which can, given sufficient depth and with the proper tools, actually become horizontal. This is of great value as the reservoir rocks which contain hydrocarbons are usually horizontal or nearly horizontal; a horizontal wellbore placed in a production zone has more surface area in the production zone than a vertical well, resulting in a higher production rate. The use of deviated and horizontal drilling has also made it possible to reach reservoirs several kilometers or miles away from the drilling location extended reach drilling , allowing for the production of hydrocarbons located below locations that are either difficult to place a drilling rig on, environmentally sensitive, or populated. Life of a well[edit] Planning[edit] Before a well is drilled, a geologic target is identified by a geologist or geophysicist to meet the objectives of the well. For a production well, the target is picked to optimize production from the well and manage reservoir drainage. For an exploration or appraisal well, the target is chosen to confirm the existence of a viable hydrocarbon reservoir or to learn its extent. The target the end point of the well will be matched with a surface location the starting point of the well , and a trajectory between the two will be designed. When the well path is identified, a team of geoscientists and engineers will develop a set of presumed properties of the subsurface that will be drilled through to reach the target. These properties include pore pressure , fracture gradient, wellbore stability, porosity , permeability , lithology , faults , and clay content. This set of assumptions is used by a well engineering team to perform the casing design and completion design for the well, and then detailed planning, where, for example, the drill bits are selected, a BHA is designed, the drilling fluid is selected, and step-by-step procedures are written to provide instruction for executing the well in a safe and cost-efficient manner. After the hole is drilled, sections of steel pipe casing , slightly smaller in diameter than the borehole, are placed in the hole. Cement may be placed between the outside of the casing and the borehole known as the annulus. The casing provides structural integrity to the newly drilled wellbore, in addition to isolating potentially dangerous high pressure zones from each other and from the surface. With these zones safely isolated and the formation protected by the casing, the well can be drilled deeper into potentially more-unstable and violent formations with a smaller bit, and also cased with a smaller size casing. Modern wells often have two to five sets of subsequently smaller hole sizes drilled inside one another, each cemented with casing. To drill the well Well Casing The drill bit, aided by the weight of the drill string above it, cuts into the rock. There are different types of drill bit; some cause the rock to disintegrate by compressive failure, while others shear slices off the rock as the bit turns. Drilling fluid , a. The principal components of drilling fluid are usually water and clay, but it also typically contains a complex mixture of fluids, solids and chemicals that must be carefully tailored to provide the correct physical and chemical characteristics required to safely drill the well. Particular functions of the drilling mud include cooling the bit, lifting rock cuttings to the surface, preventing destabilisation of the rock in the wellbore walls and overcoming the pressure of fluids inside the rock so that these fluids do not enter the wellbore. Some oil wells are drilled with air or foam as the drilling fluid. Mud log in process, a common way to study the lithology when drilling oil wells The generated rock " cuttings " are swept up by the drilling fluid as it circulates back to surface outside the drill pipe. The fluid then goes through " shakers " which strain the cuttings from the good fluid which is returned to the pit. Watching for abnormalities in the returning cuttings and monitoring pit volume or rate of returning fluid are imperative to catch "kicks" early. A "kick" is when the formation pressure at the depth of the bit is more than the hydrostatic head of the mud above, which if not controlled temporarily by closing the blowout preventers and ultimately by increasing the density of the drilling fluid would allow formation fluids and mud to come up through the annulus uncontrollably. This process is called making a connection, or "tripping". Joints can be combined for more efficient tripping when pulling out of the hole by creating stands of multiple joints. A conventional triple, for example, would pull pipe out of the hole three joints at a time and stack them in the derrick. Many modern rigs, called "super singles", trip pipe one at a time, laying it out on racks as they go. This process is all facilitated by a drilling rig which contains all necessary equipment to circulate the drilling fluid, hoist and turn the pipe, control downhole, remove cuttings from the drilling fluid, and generate on-site power for these operations. Completion is the process in which the well is enabled to produce oil or gas. In a cased-hole completion, small holes called perforations are made in the portion of the casing which passed through the production zone, to provide a path for the oil to flow from the surrounding rock into the production tubing. These maintain structural integrity of the wellbore in the absence of casing, while still allowing flow from the reservoir into the wellbore. Screens also control the migration of formation sands into production tubulars and surface equipment, which can cause washouts and other problems, particularly from unconsolidated sand formations of offshore fields. After a flow path is made, acids and fracturing fluids may be pumped into the well to fracture , clean, or otherwise prepare and stimulate the reservoir rock to optimally produce hydrocarbons into the wellbore. Finally, the area above the reservoir section of the well is packed off inside the casing, and connected to the surface via a smaller diameter pipe called tubing. This arrangement provides a redundant barrier to leaks of hydrocarbons as well as allowing damaged sections to be replaced. Also, the smaller cross-sectional area of the tubing produces reservoir fluids at an increased velocity in order to minimize liquid fallback that would create additional back pressure, and shields the casing from corrosive well fluids. In many wells, the natural pressure of the subsurface reservoir is high enough for the oil or gas to flow to the surface. However, this is not always the case, especially in depleted fields where the pressures have been lowered by other producing wells, or in low permeability oil reservoirs. Installing a smaller diameter tubing may be enough to help the production, but artificial lift methods may also be needed. Common solutions include downhole pumps, gas lift, or surface pump jacks. Many new systems in the last ten years have been introduced for well completion. Multiple packer systems with frac ports or port collars in an all in one system have cut completion costs and improved production, especially in the case of horizontal wells. By this time, the oil rigs and workover rigs used to drill and complete the well have moved off the wellbore, and the top is usually outfitted with a collection of valves called a Christmas tree or production tree. These valves regulate pressures, control flows, and allow access to the wellbore in case further completion work is needed. From the outlet valve of the production tree, the flow can be connected to a distribution network of pipelines and tanks to supply the product to refineries, natural gas compressor stations, or oil export terminals. As long as the pressure in the reservoir remains high enough, the production tree is all that is required to produce the well. If the pressure depletes and it is considered economically viable, an artificial lift method mentioned in the completions section can be employed. Workovers are often necessary in older wells, which may need smaller diameter tubing, scale or paraffin removal, acid matrix jobs, or completing new zones of interest in a shallower reservoir. Such remedial work can be performed using workover rigs â€” also known as pulling units, completion rigs or "service rigs" â€” to pull and replace tubing, or by the use of well intervention techniques utilizing coiled tubing. Depending on the type of lift system and wellhead a rod rig or flushby can be used to change a pump without pulling the tubing. Enhanced recovery methods such as water flooding, steam flooding, or CO2 flooding may be used to increase reservoir pressure and provide a "sweep" effect to push hydrocarbons out of the reservoir. Such enhanced recovery techniques are often called " tertiary recovery ". Abandonment[edit] A well is said to reach an "economic limit" when its most efficient production rate does not cover the operating expenses, including taxes.

Chapter 3 : Artificial Intelligence in Upstream Oil and Gas - Oil + Gas Monitor

Drilling - Oil and Gas Field Development Techniques Details This book describes the main areas of technology that are directly or indirectly related to drilling boreholes, especially wells that are designed to produce oil.

Well development occurs after exploration has located an economically recoverable field, and involves the construction of one or more wells from the beginning called spudding to either abandonment if no hydrocarbons are found, or to well completion if hydrocarbons are found in sufficient quantities Production is the process of extracting the hydrocarbons and separating the mixture of liquid hydrocarbons, gas, water, and solids, removing the constituents that are non-saleable, and selling the liquid hydrocarbons and gas. Production sites often handle crude oil from more than one well. Oil is nearly always processed at a refinery; natural gas may be processed to remove impurities either in the field or at a natural gas processing plant. Finally, site abandonment involves plugging the well s and restoring the site when a recently-drilled well lacks the potential to produce economic quantities of oil or gas, or when a production well is no longer economically viable. Advanced Drilling Technologies Traditionally oil and gas wells are vertically drilled. Technological advancements have allowed operators to save time, reduce operational costs, and lessen their environmental impact. New drilling technologies include the following techniques: The cost for building horizontally drilled wells was only 2. Horizontal drilling starts with a vertical well that turns horizontal within the reservoir rock in order to expose more open hole to the reservoir. Horizontal wells are attractive because they 1 can be used in situations where conventional drilling is impossible or cost effective, 2 reduce surface disturbance by requiring less wells to reach the reservoir, and 3 can produce as much as 15 to 20 times as much oil and gas compared to a vertical well. Multilateral Drilling Sometimes oil and natural gas reserves are located in separate layers underground. Multilateral drilling allows operators to branch out from the main well to tap reserves at different depths. This dramatically increases production from a single well and reduces the number of wells drilled on the surface. Extended Reach Drilling Extended reach drills allow producers to reach deposits that are great distances away from the drilling rig. This can help producers tap oil and natural gas deposits under surface areas where a vertical well cannot be drilled, such as under developed or environmentally sensitive areas. Wells can now reach out over 5 miles from the surface location and, dozens of wells can be drilled from a single location, reducing surface impacts. Complex Path Drilling Complex well paths can have multiple twists and turns to try to hit multiple accumulations from a single well location. Using this technology can be more cost effective and produce less waste and surface impacts than drilling multiple wells. Benefits of Directional Advanced Drilling Technologies: Unconventional Natural Gas See our Coalbed Methane page for a detailed description on this unconventional gas technology and the BMPs that help to regulate it. Unconventional oil resources are produced by methods other than the traditional oil well. These resources include oil sands, tar sands, heavy oil, and oil shale, but are beyond the scope of this website. Unconventional natural gas development is characterized by unique geologic attributes that make the reservoirs more challenging to produce. The formations are generally tighter or have a lower permeability and include tight gas, shale gas, hydrates,and coalbed methane. Improving the Process A variety of new technologies and practices can be implemented to minimize the environmental footprint of development. In the following sections and links, we spotlight some examples in the Intermountain West. Consolidating Facilities Development of each well requires certain basic processes, facilities, equipment, and personnel. That said, innovators have realized that, at least in some situations, the overall environmental footprint in a field can be reduced by consolidating some of these. Examples of consolidation include: Drilling from a few to a few dozen wells from a single pad Corridors: Consolidation Drawbacks Multiple well pads Requires less roads and infrastructure, leading to a smaller disturbance per well and reduced overall production footprint Can eliminate disturbance in particularly sensitive areas Reduced drilling and completion time, which reduces rig rental costs Reduced need for service crews, decreasing traffic and associated emissions and operating costs Increased efficiency of hydrocarbon recovery from the chosen reservoir Higher concentration of surface disturbance and waste generation Batch processing of multi-well pads requires that all wells on the pad be drilled and completed before the results of the first well are known, delaying the start of production Common Corridors.

Chapter 4 : Drilling - Oil and Gas Field Development Techniques - Knovel

(1) exploration, (2) well development, (3) production, and (4) site abandonment. Exploration involves the search for rock formations associated with oil or natural gas deposits, and involves geophysical prospecting and/or exploratory drilling.

Directional drilling can be used to reach targets that cannot be drilled with a vertical well. For example, it may not be possible to get a drilling permit for a well located within a populated area or within a park. However, a well could be drilled just outside of the populated area or park and then steered directionally to hit the target. What is Directional Drilling? Most wells drilled for water, oil, natural gas, information or other subsurface objectives are vertical wells - drilled straight down into the earth. However, drilling at an angle other than vertical can obtain information, hit targets, and stimulate reservoirs in ways that cannot be achieved with a vertical well. In these cases, an ability to accurately steer the well in directions and angles that depart from the vertical is a valuable ability. When directional drilling is combined with hydraulic fracturing , some rock units which were unproductive when drilled vertically can become fantastic producers of oil or natural gas. B Drain a large area from one drill pad Minimize footprint: One drilling pad can be used to drill a number of wells. This reduces the footprint of drilling operations. In the University of Texas at Arlington drilled 22 wells on a single platform. These wells are draining the natural gas from about acres beneath the campus. Over a year lifetime, the wells are expected to produce a total of billion cubic feet of natural gas. The alternative would be to drill many wells, each requiring a drilling pad, pond, access road and gathering line. Directional and horizontal drilling have been used to reach targets beneath adjacent lands, reduce the footprint of gas field development, increase the length of the "pay zone" in a well, deliberately intersect fractures, construct relief wells, and install utility service beneath lands where excavation is impossible or extremely expensive. Below is a list of six reasons for drilling non-vertical wells. They are graphically illustrated by the six drawings on this page. A Hit targets that cannot be reached by vertical drilling. Sometimes a reservoir is located under a city or a park where drilling is impossible or forbidden. This reservoir might still be tapped if the drilling pad is located on the edge of the city or park and the well is drilled at an angle that will intersect the reservoir. B Drain a broad area from a single drilling pad. This method has been used to reduce the surface footprint of a drilling operation. In , the University of Texas at Arlington was featured in the news for drilling 22 wells on a single drill pad that will drain natural gas from acres beneath the campus. Over a year lifetime, the wells are expected to produce a total of billion cubic feet of gas. This method significantly reduced the footprint of natural gas development within the campus area. C Increase the length of the "pay zone" Maximize pay zone: If a vertical well is drilled through a foot-thick reservoir rock, then natural gas or oil can seep into the well through 50 linear feet of "pay zone. Some horizontal wells have over one mile of pay zone penetration. D Improved production in a fractured reservoir Fractured reservoir: Some reservoirs have most of their pore spaces in the form of fractures. Successful wells must penetrate fractures to have a flow of natural gas into the well. In many geographic areas there is a dominant fracture direction along which most of the fractures are aligned. If the well is drilled perpendicular to the plane of these fractures, then a maximum number of fractures will be penetrated. C Increase the length of the "pay zone" within the target rock unit. If a rock unit is fifty feet thick, a vertical well drilled through it would have a pay zone that is fifty feet in length. However, if the well is turned and drilled horizontally through the rock unit for five thousand feet, then that single well will have a pay zone that is five thousand feet long - this will usually result in a significant productivity increase for the well. When combined with hydraulic fracturing , horizontal drilling can convert unproductive shales into fantastic reservoir rocks. D Improve the productivity of wells in a fractured reservoir. This is done by drilling in a direction that intersects a maximum number of fractures. The drilling direction will normally be at right angles to the dominant fracture direction. Geothermal fields in granite bedrock usually get nearly all of their water exchange from fractures. Drilling at right angles to the dominant fracture direction will drive the well through a maximum number of fractures. E Seal or relieve pressure in an "out-of-control" well. If a well is out of control, a "relief well" can be drilled to intersect it. The intersecting well can be used to seal the original well or to relieve pressure in the out-of-control well. F Install underground utilities where excavation is not possible. Horizontal drilling has been used to install gas and electric lines that must cross a river, cross a road, or travel under a city. E "Relief well" for an "out-of-control" well Relief well: If a well has a problem and begins to flow out of control, it must be sealed at depth or the pressure must be relieved. In this situation a "relief well" can be drilled from a nearby site. The relief well will be a directionally drilled well that intersects the bore of the problem well to drain off some of the pressure or to plug the well by pumping cement into the bore. Rock Units that Benefit Most from Horizontal Drilling Vertical wells can effectively drain rock units that have a very high permeability. Fluids in those rock units can flow quickly and efficiently into a well over long distances. However, where permeability is very low, fluids move very slowly through the rock and do not travel long distances to reach a well bore. Horizontal drilling can increase the productivity in low-permeability rocks by bringing the well bore much closer to the source of the fluid. F Installation of underground utilities Utility line: Utility service lines such as those delivering electricity, water, or natural gas are sometimes installed by directional drilling. This method is used when they must cross a road where excavation would disrupt traffic, cross a river where excavation is impossible, or transverse a community where surface installation by excavation would be extremely expensive and disrupting. Horizontal Drilling and Hydraulic Fracturing in Shales Perhaps the most important role that horizontal drilling has played is in development of the natural gas shale plays. These low-permeability rock units contain significant amounts of gas and are present beneath very large parts of North America. In these rock units the challenge is not "finding" the reservoir; the challenge is recovering the gas from very tiny pore spaces in a low-permeability rock unit. To stimulate the productivity of wells in organic-rich shales, companies drill horizontally through the rock unit and then use hydraulic fracturing to produce artificial permeability that is propped open by frac sand. Done together, horizontal drilling and hydraulic fracturing can make a productive well where a vertical well would have produced only a small amount of gas. Drilling Methodology Most horizontal wells begin at the surface as a vertical well. Drilling progresses until the drill bit is a few hundred feet above the target rock unit. At that point the pipe is pulled from the well and a hydraulic motor is attached between the drill bit and the drill pipe. The hydraulic motor is powered by a flow of drilling mud down the drill pipe. It can rotate the drill bit without rotating the entire length of drill pipe between the bit and the surface. This allows the bit to drill a path that deviates from the orientation of the drill pipe. After the motor is installed, the bit and pipe are lowered back down the well, and the bit drills a path that steers the well bore from vertical to horizontal over a distance of a few hundred feet. Once the well has been steered to the proper angle, straight-ahead drilling resumes and the well follows the target rock unit. Keeping the well in a thin rock unit requires careful navigation. Downhole instruments are used to determine the azimuth and orientation of the drilling. This information is used to steer the drill bit. Horizontal drilling is expensive. When combined with hydraulic fracturing, a well can cost up to three times as much per foot as drilling a vertical well. The extra cost is usually recovered by increased production from the well. These methods can multiply the yield of natural gas or oil from a well. Many profitable wells would be failures without these methods. A New Lease and Royalty Philosophy In the production of gas from a vertical well, the gas is produced beneath a single parcel of property. Most states have long-established mineral rights rules that govern the ownership of gas produced from vertical wells. The gas is often shared by all landowners in a block of land or a radius distance from the producing well. Horizontal wells introduce a new variable: How can the royalties from this gas be fairly shared? This question is normally answered prior to drilling through a combination of government rules and private royalty-sharing agreements. How royalties are divided and how "hold-out" landowners are treated can be more complex than with a vertical well.

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Chapter 5 : Oil well - Wikipedia

Field Development Phase 7. Production Phase from this chapter on methods of oil and gas exploration. The methods described in this Methods of Exploration and.

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Chapter 6 : Field development | Fugro

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Department of the Interior. Oil and natural gas well drilling technologies evolved from the ancient spring pole to percussion cable-tools to the modern rotary rigs that can drill miles into the earth. Cable-tool rigs, powered by a steam engine and boiler, included the bullwheel and drilling cable â€” often high-quality manila rope. Image from The Oil-Well Driller, Oil seeps provided a balm for injuries. A Howard Hughes Sr. Salt was an essential commodity for preserving food and extracting it from brine was a simple process. In in what is now West Virginia, salt brine drillers David and Joseph Ruffner took 18 months to drill through 40 feet of bedrock to a total depth of 58 feet using a spring pole. The Ruffner brothers drilling ingenuity and innovation made the Kanawha River Valley a major salt manufacturing and distribution center in the early s. Many early drilling technologies were developed there. Brantly in the History of Oil Well Drilling. The rapidly growing number of settlers in the frontier needed a lot of salt to preserve food. However, sometimes a good well would be fouled with the intrusion of unsought and unwanted oil. The rainbow sheen and pungent smell of oil was bad news to brine drillers. Chiseling a Hole with Cable Tools The advent of cable-tool drilling introduced the wooden derrick into the changing American landscape. Using the same basic notion of chiseling a hole deeper and deeper into the earth. However, adding the miracle of steam power and clever mechanical engineering, wells could be drilled far more efficiently. Frequent stops were needed to remove the chipped-away rock and other material, bail out water â€" and sharpen the bit. Bull wheels and hemp rope repeatedly hoisted and dropped heavy iron drill strings and a curious variety of bits deep into the borehole. Oil was still an adversary to those in search of either fresh water or brine. However, savvy businessmen like the Ruffner brothers and Samuel Kier of Tarentum, Pennsylvania, learned to profit from this oil. It had long been recognized that oil could be collected and used as a medicine, lubricant, and even a foul-smelling, smoky illuminant. American Indians gathered oil by using blankets to soak it up from natural seeps. The Ruffner brothers sold their oil to marketers of patent medicines and lubrication products. Oil from natural seeps had been used as a balm by Native Americans. When a Yale chemist, Benjamin Silliman, found that oil could be distilled into a kerosene illuminant, the world changed forever. It worked, and the petroleum age was born. Kier soon abandoned his patent medicine and went into the kerosene refining business, buying all the oil he could get. Soon, cable-tool wooden derricks were everywhere, pounding into the earth, searching for oil. In June , J. Rathbone used a steam engine to drill a foot-deep well on the bank of the Great Kanawha River, within the city limits of what is now Charleston, West Virginia. His discovery well produced about barrels of oil a day. In Pennsylvania, West Virginia and Ohio, the soft soil yielded to cable-tool drilling. Sometimes the drilling stools got stuck, threatening the well. See Fishing in Petroleum Wells. Rotary Rigs cut Faster, Deeper Rotary drilling introduced the hollow drill stem that enabled broken rock debris to be washed out of the borehole. A new technology answered the call of necessity and the lure of opportunity. Rotary drilling is most often associated with the spectacular Spindletop Hill discovery near Beaumont, Texas. Instead of the repetitive lift and drop of heavy cable-tool bits, rotary drilling introduced the hollow drill stem that enabled broken rock debris to be washed out of the borehole with re-circulated mud while the rotating drill bit cut deeper. Rotary drilling uses fluids drilling mud to circulate out the rock as it is chipped away. The fluid washes out the drill hole as it goes, making the process more efficient. By applying downward pressure, drilling mud also stops an oil well from bursting forth unexpectedly â€" the dangerous and wasteful gushers. Meanwhile, grinding their way through layers of rock rather than pounding, the heavy fishtail bits made history. Rotary rigs soon became the preferred means of drilling for oil, although to this day they still share the oil patch with a few cable-tool rigs. The record depth recorded for a cable-tool rig is 11, feet. Equipping a Rotary Rig Today, the latest technologies are used for rotary drilling and production, explains John Bestoloffe on a website about the Eagle Ford shale in

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South Texas â€” one of the most actively drilled formations in the United States since Although much improved for efficiency and safety, modern rotary rigs still include the basic components applied more than a century ago. Below are the descriptions Bestoloffe offers in his Anatomy of an Oil Rig. Swivel â€” a big handle that holds the weight of a drill string and allows the string to rotate, making a pressure tight seal on the drilling hole. Drill String â€” made up of the drill pipe normally sections of drill pipe are about 30 feet and are connected together and drill collars which fit around the pipe in order to put weight on the drill bit. Bits can come in many different sizes and shapes and can be made of various materials including diamond and carbide steel. Drill bits are specialized for different types of rock formations and drilling tasks. Rotary or Turntable â€” the component that drives rotating motion by utilizing power from electric motors. Kelly â€” a four or six-sided pipe that will transfer the rotary motion to the rotary table and drill string. Twin Cones of Howard Hughes Sr. Fishtail bits became obsolete in when Howard Hughes Sr. History remembers several men who were trying to develop better drill bit technologies, but it was Hughes who made it happen. Humason of Shreveport, La. Biographers note that Howard Hughes Sr. While waiting for approval of the patent in , Hughes and and business partner Walter B. Sharp had a machine shop manufacture a prototype bit to test in the field. Their secret drilling experiment took place near Houston. After stopping at an oil well that had defied conventional drills, the men ordered field hands away and secretly brought out the bit and attached it to the pipe stem of the rotary rig. In , two Hughes engineers invented the tricone bit, which drilled holes straighter and faster, according to Nicholas Lemann of Texas Monthly. Sharp-Hughes Tool Company manufactured its new drill bits in Houston. Circa photo courtesy Houston Public Library. The Hughes Drill Bit. Frank Christensen and George Christensen developed the earliest diamond bit in The tungsten carbide tooth came into use in the early s. Learn more in Carl Baker and Howard Hughes. Why is a Derrick called a Derrick? For membership information, contact bawells aoghs.

Chapter 7 : Horizontal Drilling & Directional Drilling: Natural Gas Wells

Drilling or "making hole" began long before oil or natural gas were anything more than flammable curiosities found seeping from the ground. For centuries, digging by hand or shovel was the best technologies that existed to pry into the earth's secrets.

It was used to drill many water wells in that areaâ€”many of those wells are still in use. Antique drilling rigs in Zigong, China Until internal combustion engines were developed in the late 19th century, the main method for drilling rock was muscle power of man or animal. The technique of oil drilling through percussion or rotary drilling has its origins dating back to the ancient Chinese Han Dynasty in BC, where percussion drilling was used to extract natural gas in the Sichuan province. Heavy iron bits were attached to long bamboo cables suspended from bamboo derricks and then were repeatedly raised and dropped into a manually dug hole by having two to six men jumping on a lever. RC drilling proved much faster and more efficient, and continues to improve with better metallurgy, deriving harder, more durable bits, and compressors delivering higher air pressures at higher volumes, enabling deeper and faster penetration. Diamond drilling has remained essentially unchanged since its inception. Petroleum drilling industry[edit] Oil and natural gas drilling rigs are used not only to identify geologic reservoirs but also to create holes that allow the extraction of oil or natural gas from those reservoirs. Primarily in onshore oil and gas fields once a well has been drilled, the drilling rig will be moved off of the well and a service rig a smaller rig that is purpose-built for completions will be moved on to the well to get the well on line. Mining drilling industry[edit] Mining drilling rigs are used for two main purposes, exploration drilling which aims to identify the location and quality of a mineral, and production drilling, used in the production-cycle for mining. Drilling rigs used for rock blasting for surface mines vary in size dependent on the size of the hole desired, and is typically classified into smaller pre-split and larger production holes. Underground mining hard rock uses a variety of drill rigs dependent on the desired purpose, such as production, bolting, cabling, and tunnelling. Mobile drilling rigs[edit] Mobile drilling rig mounted on a truck In early oil exploration, drilling rigs were semi-permanent in nature and the derricks were often built on site and left in place after the completion of the well. In more recent times drilling rigs are expensive custom-built machines that can be moved from well to well. Some light duty drilling rigs are like a mobile crane and are more usually used to drill water wells. Larger land rigs must be broken apart into sections and loads to move to a new place, a process which can often take weeks. Small mobile drilling rigs are also used to drill or bore piles. Rigs can range from ton continuous flight auger CFA rigs to small air powered rigs used to drill holes in quarries, etc. These rigs use the same technology and equipment as the oil drilling rigs, just on a smaller scale. The drilling mechanisms outlined below differ mechanically in terms of the machinery used, but also in terms of the method by which drill cuttings are removed from the cutting face of the drill and returned to surface. Drilling rig classification[edit] There are many types and designs of drilling rigs, with many drilling rigs capable of switching or combining different drilling technologies as needed. Drilling rigs can be described using any of the following attributes: Typically this is done when changing a drill bit or when "logging" the well. The presence or absence of vertical pipe racking "fingers" varies from rig to rig. Each has its advantages and disadvantages, in terms of the depth to what it can drill, the type of sample returned, the costs involved and penetration rates achieved. Auger drilling[edit] [[Auger drilling is done with a helical screw which is driven into the ground with rotation; the earth is lifted up the borehole by the blade of the screw. In some cases, mine shafts are dug with auger drills. Small augers can be mounted on the back of a utility truck, with large augers used for sinking piles for bridge foundations. Auger drilling is restricted to generally soft unconsolidated material or weak weathered rock. It is cheap and fast. Percussion rotary air blast drilling RAB [edit] RAB drilling is used most frequently in the mineral exploration industry. This tool is also known as a Down-the-hole drill. The drill uses a pneumatic reciprocating piston-driven "hammer" to energetically drive a heavy drill bit into the rock. The tungsten buttons are the cutting face of the bit. The cuttings are blown up the outside of the rods and collected at surface. Air or a combination of air and foam lift the cuttings. RAB drilling is used primarily for mineral exploration , water bore drilling and blast-hole drilling in mines, as well as for other applications such as engineering, etc. RAB produces lower quality samples because the cuttings are blown up the outside of the rods and can be contaminated from contact with other rocks. RAB drilling at extreme depth, if it encounters water, may rapidly clog the outside of the hole with debris, precluding removal of drill cuttings from the hole. This can be counteracted, however, with the use of "stabilizers" also known as "reamers", which are large cylindrical pieces of steel attached to the drill string, and made to perfectly fit the size of the hole being drilled. These have sets of rollers on the side, usually with tungsten buttons, that constantly break down cuttings being pushed upwards. This, of course, is all dependent on the density and weight of the rock being drilled, and on how worn the drill bit is. Air core drilling[edit] Air core drilling and related methods use hardened steel or tungsten blades to bore a hole into unconsolidated ground. The drill bit has three blades arranged around the bit head, which cut the unconsolidated ground. The rods are hollow and contain an inner tube which sits inside the hollow outer rod barrel. The drill cuttings are removed by injection of compressed air into the hole via the annular area between the innertube and the drill rod. The cuttings are then blown back to surface up the inner tube where they pass through the sample separating system and are collected if needed. Drilling continues with the addition of rods to the top of the drill string. Air core drilling can occasionally produce small chunks of cored rock. This method of drilling is used to drill the weathered regolith , as the drill rig and steel or tungsten blades cannot penetrate fresh rock. Where possible, air core drilling is preferred over RAB drilling as it provides a more representative sample. Air core drilling can achieve depths approaching metres in good conditions. As the cuttings are removed inside the rods and are less prone to contamination compared to conventional drilling where the cuttings pass to the surface via outside return between the outside of the drill rod and the walls of the hole. This method is more costly and slower than RAB. Cable tool drilling[edit] Cable tool water well drilling rig in West Virginia. These slow rigs have mostly been replaced by rotary drilling rigs in the U. Cable tool rigs are a traditional way of drilling water wells. The majority of large diameter water supply wells, especially deep wells completed in bedrock aquifers , were completed using this drilling method. Although this drilling method has largely been supplanted in recent years by other, faster drilling techniques, it is still the most practicable drilling method for large diameter, deep bedrock wells, and in widespread use for small rural water supply wells. The impact of the drill bit fractures the rock and in many shale rock situations increases the water flow into a well over rotary. Also known as ballistic well drilling and sometimes called "spudders", these rigs raise and drop a drill string with a heavy carbide tipped drilling bit that chisels through the rock by finely pulverizing the subsurface materials. The drill string is composed of the upper drill rods, a set of "jars" inter-locking "sliders" that help transmit additional energy to the drill bit and assist in removing the bit if it is stuck and the drill bit. During the drilling process, the drill string is periodically removed from the borehole and a bailer is lowered to collect the drill cuttings rock fragments, soil, etc. The bailer is a bucket-like tool with a trapdoor in the base. If the borehole is dry, water is added so that the drill cuttings will flow into the bailer. When lifted, the trapdoor closes and the cuttings are then raised and removed. Since the drill string must be raised and lowered to advance the boring, the casing larger diameter outer piping is typically used to hold back upper soil materials and stabilize the borehole. Cable tool rigs are simpler and cheaper than similarly sized rotary rigs, although loud and very slow to operate. Since cable tool drilling does not use air to eject the drilling chips like a rotary, instead using a cable strung bailer, technically there is no limitation on depth. Cable tool rigs now are nearly obsolete in the United States. They are mostly used in Africa or Third-World countries. Being slow, cable tool rig drilling means increased wages for drillers. A cable tool rig can drill 25 feet 7. Reverse Circulation Drilling set-up on Vertical Travel Leads at the Port of La Rochelle, France RC drilling is similar to air core drilling, in that the drill cuttings are returned to surface inside the rods. The drilling mechanism is a pneumatic reciprocating piston known as a "hammer" driving a tungsten-steel drill bit. RC drilling utilises much larger rigs and machinery and depths of up to metres are routinely achieved.

RC drilling ideally produces dry rock chips, as large air compressors dry the rock out ahead of the advancing drill bit. RC drilling is slower and costlier but achieves better penetration than RAB or air core drilling; it is cheaper than diamond coring and is thus preferred for most mineral exploration work. Reverse circulation is achieved by blowing air down the rods, the differential pressure creating air lift of the water and cuttings up the "inner tube", which is inside each rod. It reaches the "divertor" at the top of the hole, then moves through a sample hose which is attached to the top of the "cyclone". The drill cuttings travel around the inside of the cyclone until they fall through an opening at the bottom and are collected in a sample bag. As the buttons wear down, drilling becomes slower and the rod string can potentially become bogged in the hole. This is a problem as trying to recover the rods may take hours and in some cases weeks. The rods and drill bits themselves are very expensive, often resulting in great cost to drilling companies when equipment is lost down the bore hole. Most companies will regularly re-grind the buttons on their drill bits in order to prevent this, and to speed up progress. Usually, when something is lost breaks off in the hole, it is not the drill string, but rather from the bit, hammer, or stabilizer to the bottom of the drill string bit. This is usually caused by operator error, over-stressed metal, or adverse drilling conditions causing downhole equipment to get stuck in a part of the hole. Although RC drilling is air-powered, water is also used to reduce dust, keep the drill bit cool, and assist in pushing cutting back upwards, but also when "collaring" a new hole. A mud called "Liqui-Pol" is mixed with water and pumped into the rod string, down the hole. This helps to bring up the sample to the surface by making the sand stick together. When the drill reaches hard rock, a "collar" is put down the hole around the rods, which is normally PVC piping. Occasionally the collar may be made from metal casing. Collaring a hole is needed to stop the walls from caving in and bogging the rod string at the top of the hole. Collars may be up to 60 metres deep, depending on the ground, although if drilling through hard rock a collar may not be necessary. Reverse circulation rig setups usually consist of a support vehicle, an auxiliary vehicle, as well as the rig itself. The support vehicle, normally a truck, holds diesel and water tanks for resupplying the rig. It also holds other supplies needed for maintenance on the rig. The auxiliary is a vehicle, carrying an auxiliary engine and a booster engine. These engines are connected to the rig by high pressure air hoses. Instead, the engines are mounted on the auxiliary vehicle.

Chapter 8 : Making Hole - Drilling Technology - American Oil & Gas Historical Society

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Chapter 9 : Oil & Gas IQ | Drilling and Development

An Introduction. While conventional oil and gas drilling (O&G) for commercial purposes has been occurring in the United States for over years, recent processes utilize a variety of unconventional extraction techniques such as fracking to improve the return of hydrocarbons to the surface.